The pharmaceutical pocket book, 1910-1911 : a guide to the science and art of dispensing, chemical and bacteriological analysis, and the examinations of the Pharmaceutical Society of Great Britain with other useful information for pharmacists and students / edited by John Humphrey.

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The Pharmaceutical Pocket Book, 1910-11.

A Guide to the Science and Art of Dispensing, Chemical and Bacteriological Analysis, and the Examinations of the Pharmaceutical Society of Great Britain; with other useful information for Pharmacists and Students.

Edited by

JOHN HUMPHREY

LONDON:
THE PHARMACEUTICAL PRESS,
AND
SIMPKIN, MARSHALL, HAMILTON, KENT & CO., LTD.
[1910]

LONDON
ST. CLEMENTS PRESS, LIMITED
PORTUGAL STREET, KINGSWAY

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THE PHARMACEUTICAL POCKET BOOK.

THE SCIENCE AND ART OF DISPENSING.

INTRODUCTORY.

OF the many and various kinds of work in which a pharmacist must engage, that which is peculiarly and distinctively his own is the preparation of medicine for human use. It is largely for the sake of their bearing on this work that he is required to study chemistry, physics, botany, and other subjects, and the knowledge of facts and laws to be gained from these finds its application in the art of pharmacy. The preparation of medicines falls naturally into two divisions. In the first, the drugs in their original condition are subjected to various processes by which the valuable constituents are brought into the form of tinctures, infusions, syrups, powders, etc., such processes constituting galenical pharmacy; in the second, the galenical preparations are themselves compounded together or with other substances, in accordance with the instructions of a physician, the product being intended for the use of some individual patient. It is this second division of the preparation of medicines which constitutes dispensing.

While galenical pharmacy is much less practised on the small scale than formerly, the rule in many establishments being to obtain all, or nearly all, galenical preparations ready-made from a wholesale house, dispensing, on the other hand, must necessarily remain largely in the hands of the individual pharmacist. It is true that even here a corresponding change is to be observed to some extent, too many prescriptions being merely an order for a ready-made preparation of some particular maker. But the large majority still require actual com-

will not at present be gone into, but students can obtain useful practice by expanding the abbreviated wording of the prescriptions into full Latin and then translating it into literal English. Similarly, a familiarity with the correct doses of the drugs and preparations employed is necessary to a competent dispenser, in order that he may detect any error that might be dangerous in the quantities ordered; but doses can be learnt from the Pharmacopœia, and the subject will not be dealt with here for a similar reason to that given in the case of Latin.

Maxims for General Use.

Accurate and skilful dispensing is not only the result of intelligent application of principles, but also of the acquirement of good habits and the avoidance of bad ones. It is best to make an invariable rule of reading a prescription right through before commencing to dispense it. Routine methods should be adopted as to the order and manner in which the ingredients are dealt with. When a choice of methods is open the decisive question should always be, "Which will give the best result?" and never "Which is the least trouble?" and not even the accessory portions of the work, such as putting in a cork or putting on a label, should ever be done in a slovenly or careless manner. It is not necessary here, however, to enlarge on the importance of careful work in every part of dispensing. It is enough to have drawn attention to it in passing, and we now proceed to the proper subject-matter of the articles. We shall begin with medicines in liquid form.

MEDICINES IN LIQUID FORM.

The number of different forms in which medicinal combinations may be prepared for administration is very much greater at present than in former times, and tends still to increase. But in a very large proportion of the prescriptions which the pharmacist deals with, the medicine is ordered either as a liquid or a mixture of solid and liquid, in which the latter predominates. This preference shown by prescribers for the liquid form is doubtless partly due to custom, but it is certainly largely due to well-marked advantages of this form, as well as to the fact that many drugs are themselves liquids, and cannot be administered in any other way. It will be well to mention briefly the special considerations which lead to

liquid combinations being ordered, as it is of fundamental importance that the compounding should be done in such a way that all the advantages of the liquid form may be obtained.

In the majority of cases, in order that a drug which is taken internally may exercise its medicinal properties, it is necessary that it should be absorbed by some one or more of the fluids of the body, either the digestive juices of the stomach or intestines, the blood, or the special secretions of particular organs. If, then, the drug is already in solution in a liquid when taken into the body, it will pass more readily and rapidly into the fluids which it there meets with than if it is in the solid state; a dissolved salt, for instance, taken into the stomach, will more readily pass into the circulation than if the same salt were swallowed as a solid, requiring to be dissolved in the liquid contents of the stomach before absorption by the blood could begin. Generally, then, ready absorption and prompt exercise of activity are the desiderata which lead to the liquid form of medicine being prescribed; but other considerations are sometimes also of importance. The insoluble bismuth salts, for example, are sometimes required to exercise a mechanical action in the stomach and intestines, forming a protective layer on the walls, and uniform distribution of such substances is better secured if they are already distributed evenly in a liquid before taking. In the case of a gargle or paint for the throat, or a rectal injection, proper application of the drug would be practically impossible without a liquid vehicle,* and the same applies to liniments and lotions for external use.

The two chief aims of the dispenser, then, in preparing medicines in the liquid form, must be, first, to ensure that every ingredient shall be in such a condition that its full activity is unimpaired, or if its activity is necessarily lessened by some other ingredient ordered with it, that such diminution of activity shall be the least possible; and, second, to secure a perfectly even distribution of each ingredient throughout the whole of the medicine. so that each dose shall contain the same proportion of the various constituents. The securing of these two objects is often not a perfectly simple matter, and the

* The medium in which a more active drug is dissolved or otherwise distributed is termed the *vehicle*; the vehicle may be itself inert, or may have some subordinate medicinal property.

methods required in typical cases will have to be studied. It is important that the objects should be kept in mind, since they furnish the key to the methods to be used.

Lotions, liniments, and other liquid medicines for external or local application are for the most part prepared in the same way as those to be taken internally, and the points in which they differ will be best considered afterwards. We shall commence with "mixtures," by which name are designated medicines for internal use when consisting of more than one dose, and taken in not very small quantity. A single dose ordered by itself is known as a "draught," while concentrated mixtures to be taken in very small doses are termed "drops." The methods of dispensing required in these cases are generally the same as for mixtures, and we shall for the most part deal with them together.

SIMPLE MIXTURES.

When a mixture consists solely of liquid ingredients which do not in any way decompose or combine with each other, very little is required beyond accurately measuring them and putting them into the bottle together with the vehicle. The following is an example of such a simple case:—

℞	Liq Ammon. Acet.	℥vi.
	Tr. Aurant.	℥iii.
	Sp. Ammon. Arom.	℥ii.
	Syrup	℥ss.
	Aq. ad	℥vi.

Even here, however, the order in which the ingredients are mixed is not without importance. The spirit of sal volatile should in this case be added after diluting the other preparations with most of the water. By doing so the loss of ammonia while filling up the bottle and the darkening caused by its action on the colouring matter of the orange are reduced to a minimum.

℞	Liq. Bismuthi	℥ss.
	Tr. Card. Co.	℥ii.
	Tr. Gent. Co.	℥ii.
	Acid. Hydrocyan. Dil.	mxx.
	Aq. Menth. Pip. ad	℥viii.

In this case the hydrocyanic acid must be added last, or there will be a very serious loss while filling up with the peppermint water. Mixtures containing hydrocyanic acid must always have a "Shake the bottle" label attached. Vapour of hydrocyanic acid collects in the space above the liquid (especially when the bottle is

partly emptied), and the shaking re-dissolves this and distributes it evenly among the doses. Some dispensers make a rule of putting a "shake" on every mixture dispensed, whatever it is; and, although this is not necessary, it is better to err by directing shaking when not required than by omitting such direction when it ought to be given.

Solids in Mixtures.

If one of the ingredients in a mixture is a solid which is readily soluble in the vehicle, the case is scarcely less simple than the preceding. In the following example:—

℞ Pot. Bromid. ..... ℥ii.
Tr. Nuc. Vom. ..... ℥i.
Syr. Limon. ..... ℥vi.
Aq. ..... ad ℥vi.

the bromide is easily soluble in a part of the water, and the dispenser has then only to mix liquids. There are, however, several points to be noted.

The usual rule when a solid is to be dissolved is to powder it in a mortar (preferably of glass), dissolve in part of the vehicle, and then strain the solution (if any foreign particles are visible in it, as often happens) through fine muslin into the bottle. In dealing with a salt like potassium bromide, which is very easily soluble, is usually quite clean, and is in large crystals from which any foreign particles can be readily removed, there is no objection to putting it straight into the bottle with some of the water, corking and shaking up till dissolved; but many soluble salts, if so treated, would cling about the neck of the bottle, probably some being lost, and it is on the whole better to keep to the rule of dissolving before putting into the bottle. When it is necessary to shake up the bottle in the process of making a mixture it should always be corked, and not merely closed with the finger. The latter method is less cleanly, and entails loss of a small amount of the contents which clings to the finger. Many of the commoner soluble salts are sometimes kept in solution, and in that case, instead of weighing out the amount of the solid ordered, the corresponding amount of solution is measured. There is no objection to this plan provided it is kept within its proper limits; thus only those salts should be so dealt with which are quite stable in solution, salts of organic acids being generally unsuitable on account of the tendency of their solutions to develop growths of a fungous nature, while some salts, such

as the official ammonium carbonate, undergo gradual decomposition in solution. The usefulness of aqueous solutions is further limited by the fact that they can only be employed in a prescription in which the vehicle is plain water, and are not applicable in all those cases where a medicated water or an infusion is the solvent ordered (unless concentrated infusions are employed, a point we shall deal with shortly). It is, of course, essential, if stock solutions are used, that they shall be prepared accurately, and it is necessary to be on guard against errors arising from confusion of grain-measures (sometimes called fluid grains) and minims. A solution of potassium bromide, for example, may be conveniently made to contain 60 grains in 4 fluid drachms; but this must not be spoken of as a 1 in 4 solution, since a fluid drachm contains 60 minims, but only 54·7 grain-measures.

Soluble Salts in Excess.

When a soluble salt is ordered in a prescription, but in larger quantity than will dissolve in the amount of vehicle available, the case is not quite so simple. In most instances, the degree of solubility of a solid in a liquid is largely affected by temperature, and, as a rule. the solubility is greater at a higher temperature than at a lower; it might be suggested, therefore, that the excess of the salt should be brought into solution by heating the vehicle, or heating the two together until solution is complete. Thus in the following lotion:—

℞ Acid. Boric ..... ℥iii.
Sod. Chlorid. .... ℥ii.
Aq. Rosæ.....ad ℥vi.

the boric acid all dissolves if the mixture is heated to about 45° C. But a little reflection will show that such a plan will not answer, and experience will confirm this view. When the liquid has become quite cold again, the excess of boric acid is no longer held in solution, but crystallises out. This may not occur for some time, as a solution will often remain supersaturated when undisturbed; but if crystallisation takes place after the medicine is in the patient's hands, the dissatisfaction of the latter will be just as great as if it had been received in that condition. The dispenser must not only consider changes that may occur in the course of compounding. but he must accustom himself to look ahead and foresee

reactions that may only take place after an interval, and provide properly against them. In the present case the proper plan is to rub the boric acid and sodium chloride to fine powder in a mortar, add the rose water, and dissolve as much as possible by triturating and shaking, the excess remaining as a sediment in the bottle, which must bear a "shake" label. If, on the other hand, heat is employed, the excess of boric acid is deposited as crystals, which, on account of their form and their adherence to the glass, cannot be evenly distributed through the liquid by shaking.

There are other effects of heat which must be taken into consideration. In the mixture here ordered:—

℞	Sod. Bicarb.	ʒvi.
	Tr. Gent. Co.	ʒii.
	Syrup	℥ss.
	Aq. ad	ʒvi.

the sodium bicarbonate will not all dissolve in $5\frac{1}{4}$ oz. of cold water; but if it is boiled with the water for a few minutes it not only dissolves, but none of it is deposited on cooling. Such a use of heat, however, is no more permissible here than in the former case; solution of a bicarbonate is decomposed by boiling, carbon dioxide escaping, and the corresponding carbonate remaining in the liquid. The excess of bicarbonate is not deposited because the salt has been more or less completely changed to carbonate, which is quite contrary to the prescriber's intention.

The Application of Heat.

The application of heat is necessary in preparing some other forms of medicine, but in the dispensing of mixtures the cases are extremely rare in which it should be used. The general rules must, of course, be that heat is not to be used to produce a change (*e.g.*, increased solubility), which will be reversed on again cooling; and, on the other hand, it must not be employed to produce a permanent change, where the result of this change is the administration to the patient of a different chemical substance from that ordered by the prescriber. If it is desirable to save time by using hot water to dissolve a slowly soluble salt, or to employ heat in any other way, the dispenser must first satisfy himself that the case is one outside these two general rules.

The following mixture presents an instance of what may occur in such cases as those we have been discussing:—

℞ Potass. Chlorat..... ℥ss.
Syrup. Zingib. ..... ʒvi.
Inf. Aurant. .....ad ℥vi.

The quantity of chlorate is more than the vehicle will dissolve at the ordinary temperature, and the excess must remain as a sediment in fine powder. If the patient happens to keep a part of the mixture for some time, the powdered sediment is likely to be gradually replaced by crystals, which can no longer be evenly distributed by mixing, and a complaint to the dispenser may ensue. The explanation of the change is that the medicine has been exposed to variations, either large or small, of temperature; when the temperature rises, a little more chlorate goes into solution, and when it falls, this excess is deposited, but now in crystals; at the next rise of temperature, more of the powder, not the new crystals, will dissolve, to be in turn deposited, and by the continuance of this alternating process the powder gradually comes to be all replaced by crystals.

The last prescription, in which the vehicle is an infusion, raises the question of whether infusions and decoctions should always be freshly prepared according to the official directions, or whether something may be extemporaneously made to represent the required preparation, by the use of the so-called "concentrated infusions," etc. There can, of course, be no question at all that when an infusion is ordered the only strictly correct plan is to employ the freshly made official preparation, and in all important dispensing businesses fresh supplies of the commoner infusions are made every morning, and of others as required. But in pharmacies where dispensing is much less frequent, it is often the rule to use the concentrated liquids, and the actual dispenser is required to conform to the usual practice and not to express an opinion for or against it. In support of this practice it may be said that many doctors certainly expect that concentrated infusions will be used, and make no objection, while among practitioners who dispense their own medicines, the preparation of fresh infusions is quite unusual. Our present purpose, however, is merely to draw attention to certain points that arise when concentrated infusions are used; the prin-

cipal thing to be borne in mind is that these preparations are not purely aqueous like the fresh infusions, but contain spirit, usually to the extent of about 25 per cent., to act as a preservative, and in many cases this spirit must be taken into consideration, particularly in considering the solubility of other ingredients. Another matter to be mentioned is that some dispensers are apt to overlook the significance of the word "ad" in the prescription, and to add a quantity of concentrated infusion corresponding to the total volume of the mixture instead of to the volume of infusion that would be required if the prescription were dispensed exactly as written. Thus, in the above example, if the usual "1 to 7" concentrated infusion is employed, the quantity to be taken is as nearly as possible 5 fl. drachms (the chlorate being taken to occupy half the volume of an equal weight of water), and not 6, as sometimes erroneously dispensed.

Insoluble Salts in Mixtures.

There is practically no difference between having more of a soluble salt than will dissolve, and having one which is quite insoluble in the vehicle ordered. The following is a common example of the latter case:—

℞ Mag. Carb. ..... ℥ii.
Mag. Sulph. ..... ℥ss.
Tr. Rhei ..... ℥ss.
Syr. Zingib. ..... ℥vi.
Aq. Menth. Pip. .....ad ℥vi.

The magnesium sulphate is soluble, the carbonate insoluble; the latter must be rubbed down in a mortar with the syrup of ginger and some of the peppermint water, then transferred to the bottle, and the mortar rinsed with further small quantities of the water; the magnesium sulphate is dissolved as already described, and the tincture of rhubarb added nearly at the end, the measure used for the latter being rinsed with the last small quantity of peppermint water; a "shake" label must, of course, be used. In this case the insoluble ingredient is easily diffused evenly by shaking, and, as it only settles slowly, the patient can take a dose before separation has occurred again to any serious extent. But there are two cases that are not quite so simply dealt with; the first is where the insoluble ingredient is so heavy that it sinks too rapidly for the patient to be able to get the proper proportion in a dose; the second is where an insoluble substance is

formed by reaction between two soluble or liquid ingredients of the prescription, when it is very apt to be formed in clots which cannot be evenly diffused by shaking. In both these cases special means must be adopted, in order that the intentions of the prescriber as to dosage shall not be frustrated.

Precipitation in Mixtures.

The methods to be adopted in dealing respectively with heavy insoluble solids, and solids precipitated in the form of clots in the process of dispensing, are not identical, though similar in some respects. The following prescriptions present instances of the two cases :—

℞ Bismuth. Carb. ..... ℥iii.
Tr. Card. Co. ..... ℥ss.
Acid. Hydrocyan. Dil. ..... ℥ss.
Aq. Chlorof. .....ad ℥vi.

If this is dispensed just as written it will be found that the bismuth salt settles so quickly after shaking up that an ounce of the mixture poured out into a glass will contain considerably less than the 30 grains that ought to be in it; and, even if the dose is taken directly it is poured out, the quantity of the carbonate actually taken will be further reduced by a portion remaining in the glass.

℞ Quin. Hydrochlor. ..... gr. vi.
Sod. Salicyl. ..... ℥ii.
Ammon. Chlor. ..... ℥i.
Tr. Gelsemii ..... ℥iss.
Aq. .....ad ℥vi.

Double decomposition occurs between the quinine hydrochloride and the sodium salicylate, quinine salicylate being precipitated in the form of a bulky flocculent precipitate.

℞ Tr. Tolutan. ..... ℥ii.
Vin. Ipecac. ..... ℥ii.
Syrup. Scill. ..... ℥ss.
Aq. Cinnam. .....ad ℥iv.

The precipitation which occurs here is not due to chemical action, but to the fact that the tolu balsam which is in solution in the tincture is no longer soluble when the spirit of the latter is diluted with the aqueous medium, and a most unpresentable mixture results, in which much of the tolu clings to the sides of the bottle.

In all these cases the remedy lies partly in increasing the viscosity of the vehicle by a suitable addition. In

the first case it is further necessary to bring the bismuth carbonate into the finest possible powder; the minute particles, in a somewhat viscous medium, then settle with comparative slowness. In the other two cases the precipitate must be produced in such a way that the particles are kept from coming into complete contact with each other, so that they cannot coalesce into clots. Many substances—sugar, glycerin, gum, etc.—would increase the viscosity of the vehicle, but, of all these, gum is by far the most efficient; a much smaller quantity is therefore necessary, and, as it is itself inert, and practically without any effect on the taste of the mixture, its addition is permissible where the addition of sugar, glycerin, or similar substances would not be. Two official gums are available for the purpose—viz., acacia and tragacanth. It is not a matter of indifference which is used, but each is to be preferred in certain cases. When the principal requirement is to increase viscosity, as in the first two of the above examples, tragacanth is the more serviceable. Where the function of the gum is chiefly to coat the particles of a precipitate and keep them apart, as in the third example, acacia is the best.

Bismuth Mixtures.

To take now the dispensing of the first prescription in detail:—

℞ Bismuth Carb. ..... ʒiii.
Tr. Card. Co. ..... ℥ss.
Acid. Hydrocyan. Dil. ..... ʒss.
Aq. Chlorof. ..... ad ʒvi.

The first thing to do is to rub the bismuth carbonate to very fine powder in a mortar. This salt is always supplied in powder, but it is by no means always equally fine, some samples containing a considerable proportion of dense particles, which would fall to the bottom of any mixture far more rapidly than the fine fragments obtained by rubbing the salt well in a mortar. To the powder is next added some powdered tragacanth, about 12 grains being sufficient for the 3 drachms of bismuth salt, and the two well mixed; the compound tincture of cardamoms is next added and triturated with the powders, and, while still stirring, about 1 oz. of the chloroform water is added all at once. After stirring until the mixture is homogeneous and smooth, it is diluted with further portions of chloroform water and

transferred to the bottle, and the mortar well rinsed with further quantities of the water, shaking the bottle well after transferring each addition to it. The hydrocyanic acid is, of course, added last.

If the tincture is not poured on to the powders, but water added directly to them, it is difficult to prevent the tragacanth mucilage being formed in lumps which it is almost impossible to break down afterwards. For this reason any alcoholic liquid ordered should always be added to tragacanth before bringing it into contact with water (compare the official directions for making mucilage of tragacanth); glycerin will do instead of spirit if it is an ingredient of the mixture.

If bismuth subnitrate is ordered in place of the carbonate, a new difficulty arises. On mixing this salt with water, a small quantity of nitric acid is liberated, the salt becoming more basic, and this nitric acid causes gelatinisation of the tragacanth mucilage after a longer or shorter time. This acidity may be neutralised by adding a very little ammonia, and compound tragacanth powder is then used as a suspending agent. The best plan is to rub the bismuth subnitrate in a mortar and add about half the water in portions, transferring the mixture to the bottle and shaking well; then add to this three drops of the official Liquor Ammoniæ for each drachm of subnitrate and shake well; add this mixture gradually to the compound tragacanth powder in a mortar, taking 30 grains of the latter for each drachm of subnitrate, and triturate till smooth; transfer to the bottle, and rinse the mortar with further portions of water. If any of the other ingredients makes the use of ammonia objectionable, the suspending must be done with acacia with about one-fifth of its weight of compound tragacanth powder (respectively 30 and 6 grains to each drachm of bismuth salt); in this case the subnitrate should be rubbed with half the water, and the gums with the other half, and the two portions mixed in the bottle by shaking. Some dispensers prefer to use compound tragacanth powder for bismuth carbonate also. Whichever is ordered by the prescriber must, of course, be employed, and if, as often happens, it is left to the option of the dispenser, a small note should be made on the prescription by the chemist who first dispenses it, showing what has been used, for the guidance of future dispensers.

While on the subject of bismuth mixtures we may notice another point which is raised by the following prescription:—

℞ Bismuth. Subnit. ..... ℥ii.
Sod. Bicarb. ..... ℥ii.
Syr. Aurant. ..... ℥ss.
Tr. Gent. Co. ..... ℥ii.
Aq. ..... ad ℨviii.

Bismuth subnitrate and sodium bicarbonate mixed together with water slowly react, bismuth subcarbonate and sodium nitrate being formed, and half the carbonic acid of the bicarbonate being set free. This reaction proceeds so slowly that if the mixture is dispensed in the ordinary way it is far from complete, and gradual production of carbonic acid gas will continue, and ultimately lead to the cork being blown out or the bottle bursting, perhaps after it is in the patient's hands. Some dispensers recommend using bismuth carbonate in place of subnitrate, but this is only permissible if the consent of the prescriber can be obtained; otherwise the proper plan is to hasten the reaction and get it completed before the medicine is sent out. Rub down the two salts in a mortar and add to them a little boiling water, when the reaction will soon be over; then add the Pulv. Tragacanth. Co. and proceed as described above. It will be seen that the boiling water is here only used to *accelerate* a change which is inevitable, and not to produce something different from what the prescriber has ordered.

Double Decomposition in Mixtures.

Coming to the second prescription given:—

℞ Quin. Hydrochlor. ..... gr. vi.
Sod. Salicyl. ..... ℥ii.
Ammon. Chlor. ..... ℥i.
Tr. Gelsemii ..... ℥iss.
Aq. ..... ad ℨvi.

The *modus operandi* is as follows:—Put the tincture of gelsemium into the bottle, and shake so that the inside of the latter is thoroughly wetted with it; then add about 9 grains of powdered tragacanth, shake, and quickly add 2 oz. of water and again shake (or an ounce and a-half of tragacanth mucilage may be taken); dissolve the quinine hydrochloride in half the remainder of the water, add the solution, and shake well; dissolve the sodium salicylate and ammonium chloride in the rest of the water, and add it in two or three portions, shaking

well after each. The precipitate that is then formed is far more easily diffused evenly by shaking than if no tragacanth is employed; if the quantity of quinine were larger the precipitate would still tend to clot together, and it is here quite permissible to replace the quinine hydrochloride by an equivalent quantity of quinine salicylate, reducing the sodium salicylate by a corresponding amount, and adding the equivalent of sodium chloride; the composition of the mixture is not altered, but it is now possible to rub the quinine salicylate to fine powder in a mortar, and suspend it like any other insoluble salt.

If in place of quinine hydrochloride in the above mixture tincture of quinine were ordered, the amount of alcohol is then sufficient to prevent precipitation occurring at once; but on standing in a cold place crystals of quinine salicylate will be deposited. This is one of the changes that a dispenser must foresee; quinine salicylate may be used as just described, and an equivalent quantity of tincture of orange in place of the tincture of quinine; this should be added last.

Tolu Mixture.

In our third case, acacia, as already noted, is more suitable than tragacanth:—

℞	Tr. Tolutan.	℥ii.
	Vin. Ipecac.	℥ii.
	Syrup. Scill.	℥ss.
	Aq. Cinnam. ad	℥iv.

Dissolve 2 drachms of powdered acacia gum in a little of the cinnamon water, and dilute with more to 2 oz.; stir the tincture of tolu and the syrup of squills together in a measure, and add this in three or four portions to the dilute mucilage, shaking gently after each addition.

In these and other examples students should not only follow the directions given, but should also vary them and observe the result. Thus, in the case of the bismuth mixture trials should be made with different quantities of Pulv. Tragac. Co., say, 20, 40, and 60 grains to each drachm of bismuth salt. The effect of other ingredients besides those named, such as are often ordered in similar mixtures, should be tried. It is only by experimenting and proving facts for himself that a dispenser can become competent to deal with the difficulties to be met with in prescriptions which he has not encountered before.

Dilute the ipecacuanha wine with the rest of the cinnamon water, add, and mix with a final gentle shake.

When Suspending Agents are not Needed.

It is, of course, by no means the case that all insoluble substances when ordered in mixtures require the addition of gum or other suspending agent. Some insoluble salts, like magnesium carbonate, are easily diffused through the mixture by shaking, and do not settle again so quickly as to seriously interfere with the proper dose being taken; the same is true of many vegetable drugs of which the powder is prescribed in mixtures, such as rhubarb. In these cases, however, it will not do to put the powder straight into the bottle and shake with some of the vehicle; some powders may contain small lumps which require to be broken down, and all are liable to retain some air entangled with the particles which prevents the latter being distributed through the liquid; the mixture will then have a film of dry powder floating on the top, or small bubbles of air coated with powder, and in either case the appearance is bad, and the doses will not be uniform. The student can easily observe this by shaking up a little Pulv. Rhei Co. in a bottle with water. It should be a rule without exception to rub down an insoluble powder in a mortar, and it is often best to add to it one of the other ingredients before any of the vehicle. In the following example:—

℞ P. Rhei ..... ℥ii.
Sod. Bicarb. ..... ℥i.
Syr. Zingib ..... ℥vi.
Aq. M. Pip. ..... ad ℥vi.

the two powders are rubbed together in a mortar, then the syrup added and the mixture rubbed quite smooth, adding a little of the peppermint water if necessary; then add enough of the latter, still stirring, to make the mixture thin enough to pour easily, and transfer to the bottle, rinsing out the mortar with further quantities. Syrup, glycerin, and thick liquids generally are usually the best thing to add to a powder that is to be rubbed smooth; in the stiff mixture that results, small lumps cannot evade the pestle in the way they would in a thinner liquid.

℞ P. Rhei Co. ..... ℥iss.
Tinct. Card. Co. ..... ℥ss.
Aq. Chlorof. ..... ad ℥iij.

Here there is no thick liquid; but the tincture is quite suitable to add to the powder. An alcoholic liquid penetrates better than water into a powder containing ginger (as this does), the oil and resin of which are soluble in alcohol but not in water; in addition, the much greater mobility of alcohol causes it to break down air-bubbles entangled in the powder, which would offer considerably more resistance to water.

The Use of Syrup or Glycerin in Mixtures.

We referred before to the aid which is given by syrup or glycerin in suspending powders, and we have now spoken of their use in rubbing powders down to smoothness. They are often of service also in retarding or even preventing changes that would otherwise occur at once; and the order in which the ingredients of a prescription are mixed with the vehicle or with one another has often a very important influence on the result. When any two ingredients are liable to react with one another—and this is a very common case, and the question must always be considered—the order of mixing should almost always be that which will prevent the reaction or retard it as much as possible. The only exception to this "always" is provided by cases where it is obvious that the prescriber wishes the change to occur and wants the product of the change. For instance, the following or a similar prescription is sometimes seen:—

℞	Pot. Bicarb.	ʒi.
	Acid Citric	℈ii.
	Syr. Aurant.	ʒss.
	Aq. ad	ʒiv.

Nothing will prevent reaction between the bicarbonate and the citric acid, and it is clearly the doctor's intention that the patient shall have a solution of potassium citrate saturated with carbonic acid; in this case, add the syrup after the reaction has taken place. Hot water is sometimes recommended to accelerate the completion of the reaction, but as this would leave far less carbonic acid gas in solution it should certainly not be employed, as the chief reason for ordering acid and bicarbonate instead of the potassium citrate itself must be that the prescriber wishes the liquid to be saturated with gas, which both improves the taste and has a slight action in the stomach.

The Order of Mixing.

The following are further illustrations of the different results to be obtained by slight differences in the method of mixing:—

℞ Sod. Iodid. ..... ℥iii.
Tr. Nuc. Vom. ..... ℥ii.
Ext. Cinchon. Liq. ..... ℥ii.
Glycerin ..... ℥iv
Aq. .....ad ℨviii.

If the iodide is dissolved in a little water, the other ingredients added, and the bottle filled up, an unsightly precipitate which cannot be evenly diffused by shaking results from reaction between the iodide and the alkaloids of the cinchona. The best plan is to dissolve the iodide in half the water and add the tincture of nux vomica, mix the liquid extract of cinchona and glycerin, and add to them the other half of the water, and then mix the two liquids. By proceeding in this way the precipitate is in a very finely divided state, and can be diffused evenly by a gentle shake.

℞ Tr. Ferri Perchlor. ..... ℥i.
Tr. Digitalis ..... ℥iss.
Acid Phosph. Dil. ..... ℥iss.
Syr. Zingib. ..... ℨss.
Aq. .....ad ℨvi.

If the first four ingredients are put into the bottle without water, or with only a little water, and the latter added afterwards, a very dark mixture results; this is due to the action of the iron on the tannin of the digitalis. If the iron tincture and the acid are diluted with half or two-thirds of the water, and the tincture of digitalis and syrup with the remainder and the two liquids mixed, there is no such darkening, and this is the method that should be followed.

Consideration of such cases as these leads us on to the general subject of incompatibility, which may be of different kinds. Therapeutic incompatibility, or the ordering together of drugs having opposite actions on the body, does not of course concern the dispenser; this is the sort of incompatibility which the prescriber is most certain to take into account, and which is therefore seldom met with. Very many drugs, however, may have a similar therapeutic use, and yet be quite unsuitable for administering together. An extreme case of this is seen in the following example:—

℞ Mist. Cretæ ..... ℥iii.
Acid. Sulph. Dil. ..... ℥iii.
Tr. Card. Co. ..... ℥iii.
Aq. .....ad ℨvi.

Chalk mixture is prescribed for diarrhœa, and dilute sulphuric acid also checks the action of the bowels; but, if ordered together in this way, reaction occurs between the calcium carbonate and the acid, carbon dioxide escapes, and calcium sulphate is precipitated which it is certainly not the intention of the prescriber to administer.

Incompatibles in Mixtures.

The problems presented by cases of incompatibility are endless, and require great variety in the methods of dealing with them. Only rules of a very general nature can be laid down. The dispenser must endeavour as far as possible to fathom the intentions of the prescriber; if the incompatibility is such that the apparent intention will be frustrated, he should, if possible, communicate with the prescriber; if this cannot be done, it may be his duty to alter the prescription in the same way as if a poisonous dose of a drug were ordered. For instance, in the following prescription:—

℞	Liq. Arsenicalis	ʒii.
	Liq. Strych.	ʒii.
	Ammon. Brom.	ʒiii.
	Aq. M. Pip. ad	ʒvi.

It is clearly the intention of the prescriber to administer both arsenic and strychnine in solution, but if dispensed as written the alkali of the arsenical solution will decompose the strychnine hydrochloride and strychnine will be precipitated. This change will probably not occur at once, but only slowly, the strychnine, perhaps, being deposited as small crystals. There is here very grave risk that the patient will get an overdose of strychnine in the last dose of the mixture. If the doctor is accessible this must be pointed out to him, and, if he cannot be communicated with, Liquor Arsenici Hydrochlor. must be substituted for Liquor Arsenicalis, and a note made on the prescription that this has been done.

It must not be hastily concluded because two ingredients are chemically or pharmaceutically incompatible that there is an error in prescribing. Such a prescription as the following is sometimes seen:—

℞	Tr. Ferri Perchlor.	m80
	Syrup	ʒss.
	Sp. Ammon. Arom.	ʒii.
	Aq. ad	ʒviii.

Reaction occurs between the alkali and the iron, and

ferric hydroxide is precipitated, but some prescribers like to give this in a freshly precipitated condition, and the reaction may have been foreseen and intended. In such a case the dispenser must only follow the method which will give the precipitate in the most finely divided and diffusible form—that is, dilution of the reacting ingredients as far as possible before mixing them. The addition of a suspending agent is sometimes necessary, as in the case of tincture of tolu previously given.

Although the question of how to deal with incompatible ingredients may arise in connection with other forms of medicine besides the liquid, it is of much more frequent occurrence in the cases of mixtures, lotions, and liniments than in others, and especially in that of mixtures. The reasons for this are not difficult to discover; the very great variety of drugs that are ordered in this form more or less frequently, and the favourable conditions for chemical reaction offered by their presence in a liquid medium, are enough to account for it. Before we pass on to the special group of mixtures known as emulsions it will be well to discuss a few typical cases of incompatibility.

Reaction Between Salts.

As students of analytical chemistry are well aware, the production of a precipitate on mixing solutions of two salts is an extremely common occurrence; when this occurs in dispensing, it is usually a simple matter to decide what is happening, and whether it is intentional or ought to be prevented if possible. An instance has previously been given of a case in which it was probably desired by the prescriber, and another, where a strychnine salt was one of those reacting, in which the consequences were dangerous. We proceed to the consideration of a few other cases:—

℞	Zinc. Sulph.	gr. xl.
	Liq. Plumbi Subacet. Fort.....	℥iss.
	Tinct. Opii.....	℥ss.
	Aq.....ad	℥vi.

In this lotion the prescriber has evidently overlooked the reaction that will occur between the lead subacetate and the zinc sulphate, all the lead being precipitated as sulphate and thus rendered useless. Such an oversight should be brought to the doctor's notice if possible; if this cannot be done, the prescription must be dispensed as written, as no alteration which would be permissible

to the dispenser would prevent the precipitation. These remarks apply equally to the next example, but it is here the zinc that is precipitated, as borate :—

℞ Sod. Bibor. ..... gr. xx.
Zinc. Sulph. ..... gr. v.
Aq. Rosæ ..... ad ℥iij.

A simple reaction between two ingredients may cause a good deal of trouble when it does not lead to a precipitate. The following is a fairly common case :—

℞ Ammon. Carb. ..... gr. xx.
Vin. Ipecac. ..... ℥iss.
Syr. Tolut. ..... ℥iii.
Syr. Scill. ..... ℥iii.
Inf. Senegæ ..... ad ℥iv.

Syrup of squills contains free acetic acid, which acts on the ammonium carbonate with evolution of carbon dioxide ; this is produced very slowly, and the syrupy constituents of the mixture and the senega cause much froth to be produced. The syrup of squills should be diluted with part of the infusion (or, if concentrated infusion is to be used, with water), and added to the powdered ammonium carbonate in the bottle ; the latter is gently warmed and set aside, lightly corked, and gently shaken at intervals until the reaction is complete. It is sometimes recommended to substitute for the syrup of squills the equivalent quantities of simple syrup, tincture of squills, and acetic acid ; the last-named is then added to the ammonium carbonate and the reaction got over at once. If the prescription is for a linctus, the whole being syrupy and little or no water added, this is the only practical way to do it.

Precipitation of Alkaloids.

Mercuric chloride and potassium iodide are often ordered together in solution, and the resulting mixture is practically diluted Mayer's solution, and is, of course, a precipitant of alkaloids, which are sometimes ordered in the same mixture :—

℞ Liq. Hyd. Perchlor. ..... ℥iss.
Potass. Iodid. ..... ℥ii.
Syr. Zingib. ..... ℥ss.
Inf. Cinchon. Acid ..... ℥ii.
Aq. ..... ad ℥viij.

The alkaloids of the cinchona are precipitated as by Mayer's solution ; the precipitate contains much of the mercury, and it is important that the patient shall not

get too much in one dose. Add the syrup and half the water to the decoction, and the other half of the water to the other ingredients, and mix the liquids, with only gentle shaking. It must be remembered that most alkaloids are not only precipitated by alkaline hydroxides and carbonates, but also by salts which are alkaline in nature, though not in constitution, such as ordinary sodium phosphate ; in such cases, if there is no evidence that the prescriber intends the medicine to be alkaline the alkaloid may be redissolved by the addition of just sufficient acid for the purpose.

Precipitation by the Vehicle.

Precipitation may occur not from the production of a new substance by reaction, but from the composition of the vehicle. One of the commonest cases of this is when a salt soluble in water is precipitated by the presence of a large quantity of tincture or other alcoholic liquid ; there is then a good deal of probability that the precipitate will be in crystalline form, or even in large crystals. It is necessary to foresee such an occurrence, and accelerate it by dissolving the salt in the least possible quantity of water and adding this solution to the alcoholic liquids, or in some such way, in order that the precipitate may be reduced to fine powder, and the mixture sent out with a "shake" label. The following presents a somewhat similar case :—

℞ Ferri Phosph. (scale) ..... ℥ii.
Syrup. Zingib. ..... ℥ss.
Acid. Phosph. Dil. ..... ℥ss.
Aq.....ad ℥viii.

The scale phosphate of iron (not official) contains ferric phosphate and sodium citrate, and is soluble in water, but on the addition of dilute phosphoric acid a precipitate of ferric phosphate is produced. This is soluble is a large excess of acid, but the amount required is much more than the dispenser would be justified in adding. In the next prescription a similar result is produced by double decomposition :—

℞ Ferri et Quin. Cit. ..... ℥i.
Acid. Phosph. Dil. ..... ℥i.
Tr. Card. Co. ..... ℥iii.
Syr. Limonis ..... ℥ii.
Aq.....ad ℥ii.

In this case the precipitation may be almost or quite prevented by dissolving the scale salt in two-thirds of

the water with the syrup, and diluting the acid with the rest of the water before mixing. The tincture is added last.

Liberation of Iodine.

Perchloride of iron is sometimes inadvertently ordered with potassium iodide; such a mixture develops free iodine on standing, the iron being reduced to the ferrous state. The amount of iodine that may be liberated is liable to be dangerous, and such prescriptions should not be dispensed, but the prescriber communicated with. In the following this reaction is complicated by secondary ones:—

℞	Ferri et Quin. Cit.	ʒii.
	Potass. Iodid.	ʒii.
	Syrup.	ʒvi.
	Aq. ad	ʒiv.

The amount of acid here, in the solution of the double citrate, is small, and iodine is only slowly liberated; iodine in potassium iodide solution is a general precipitant of alkaloids, and a nearly black precipitate of periodide of quinine will be produced. Addition of enough alkali to neutralise the solution of the scale salt before adding to the iodide will considerably delay the reaction.

Precipitation by Acid.

℞	Quin. Sulph.	gr. xv.
	Acid Sulph. Dil.	ʒi.
	Ext. Glycyrrh. Liq.	ʒss.
	Aq. ad	ʒiij.

The liquid extract of liquorice is here evidently intended to cover the taste of the quinine; but the acid precipitates the glycyrrhizin, making a turbid mixture and much reducing the sweetness of the liquorice. The prescription must be dispensed as written, but the prescriber, if accessible, may be asked to authorise omission of the acid and suspension of the quinine instead.

Spirit of Nitrous Ether.

Iodine may be liberated from an iodide in dangerous quantity by spirit of nitrous ether. Ordinary specimens of the latter are always acid, and if the acid is first neutralised by shaking the spirit with sodium bicarbonate the reaction is much retarded (caustic alkali must never be used in neutralising the spirit, as this would decompose the ethyl nitrite). When antipyrine and spirit of nitrous ether are dispensed together in a mixture

reaction occurs and a green liquid results. This reaction also is much retarded if the spirit is first neutralised, and this should always be done. Another substance that is incompatible with this spirit is tannin. Ordinary tannic acid is not very likely to be ordered with it, but very many vegetable drugs contain tannin, and some of these are occasionally the cause of trouble in such a mixture. The reaction that occurs involves decomposition of the ethyl nitrite, with production of nitric oxide. In a dilute liquid it only takes place slowly, and if the dispenser is not on his guard the bottle may be burst. The medicine should be kept back as long as possible before delivery, in order that the reaction may be completed, and the patient should be warned to loosen the cork of the bottle as soon as received.

EMULSIONS.

We now come to the special class of mixtures known as emulsions, in which two naturally immiscible substances, such as oil and water, are brought into intimate mixture by the addition of a third substance, aided by proper manipulation. There is, of course, no hard and fast line between emulsions and some of the cases which we have already dealt with, as, for instance, the suspension of tolu in water by adding mucilage in a mixture containing tincture of tolu. An emulsion is understood to be a mixture of an oil, a resin, an oleo-resin, or a greasy substance not strictly an oil, such as vaseline, with water or some aqueous vehicle. Emulsification of an oil is the commonest case, and we shall deal with it first.

If a little oil and water are shaken up together in a bottle, some degree of mixing does occur; the oil is broken up into globules of varying size, and these are distributed through the water. But as soon as shaking is stopped, the oil rises to the top, the globules coalesce again, and we have merely a layer of oil above a layer of water. In order to make a permanent mixture, two things are necessary; first, some means by which the globules of oil can be divided so minutely that the ultimate globules no longer appear as individuals; and second, some means of preventing the globules so formed from coalescing again. For the coalescence of the globules they must, of course, come into actual contact; and, in order that they may do so, the vehicle which

separates the globules must be one that does not cling at all to their surface. Water is such a liquid; but, on the other hand, a water solution of certain gums clings tenaciously to the surface of the globules; and, so long as ever so thin a film persists between adjacent globules, they can no more run together than if they were widely separated. As regards the former requisite, the division of the oil into small globules, if we once secure that the globules shall not run together as fast as formed, there are several good means of subdivision. The method which is usually the best is gentle trituration in a mortar; if a little oil and mucilage, syrup, or glycerin, are rapidly but lightly stirred together in a mortar, keeping the pestle moving in the same direction all the time, it is easy to see that each globule of oil is drawn out into a long shape, then it divides across the middle, and each of the smaller globules resulting is in turn drawn out and divided; with syrup or glycerin, the limit of this process is soon reached, as the globules are not prevented from again coalescing; with mucilage we can carry it much further. This subdivision is, of course, only possible in a thick medium; otherwise the globules would slip away from the pestle.

When an oil or resin is made into an emulsion, there is another advantage besides the production of a uniform mixture. It is usually the case that the extremely small particles of oil can be more readily assimilated by the patient's stomach than if a quantity of the oil were administered in the undivided state; this is a well-known fact with cod-liver oil, and furnishes the *raison d'être* for the numerous emulsions of this oil that are on the market. The dispenser, therefore, must always aim at the most perfect sub-division possible; and this not only makes the best preparation from the therapeutic point of view, but the finer the sub-division, the more stable the emulsion, other things being equal. The reason for this is that the surface tension of a minute sphere (of oil or other substance) is relatively far greater than of a larger one, and therefore a given medium far more efficiently prevents coalescence between such spheres or globules than it would if they were larger.

Emulsification by Acacia.

As already stated, acacia mucilage is in most cases a much better aid to emulsification than mucilage of traga-

canth, the latter being preferable for suspending powders. There are many other emulsifying agents besides these two gums, some of which we shall deal with later; we commence with common oils and acacia mucilage. It must be noted that the mucilage must be of fairly recent preparation; after keeping a short time it becomes acid, and it is then impossible to obtain good results with it. It is often the best plan to take the powdered gum in dispensing, preparing the mucilage in the actual operation of making the emulsion.

The following may be taken as a typical example of an emulsion:—

℞ Ol. Amygd. ..... ʒiii.
Mucil. Acac. ..... ℥iii.
Aq. ..... ad ʒiv.

Put the mucilage into a mortar, stir it round a little so as to get some on the sides and on the pestle, then add the oil in a slow stream, stirring lightly all the time. Triturate for two minutes or so, until the mixture appears quite uniform; then add about a drachm of water, and stir until uniform and creamy; then add further small quantities of water, mixing each quantity until the product is quite uniform before adding the next; as the process proceeds larger quantities of water can be added at once until the emulsion is quite thin and milky, when it may be transferred to the bottle and the rest of the water added there. In this example the amount of mucilage is larger than the minimum necessary; the aim of a dispenser should always be to add as little as possible of gum or any other agent required (unless a larger quantity is ordered by the prescriber). Generally speaking, for the ordinary fixed oils, 1 part of gum is necessary for 4 parts of oil; for practical purposes, 1 part of gum may be taken as equivalent to 2 parts of mucilage. Using powdered gum in minimum quantity, the above prescription becomes:—

℞ Ol. Amygd. ..... ʒiii.
P. Acaciæ ..... gr. xlv.
Aq. ..... ad ʒiv.

This may be dispensed by rubbing the gum in a mortar with about 45 minims of water, allowing sufficient time for it to become dissolved, and then proceeding as before. This is the safest plan; but another method may be followed, and some dispensers give preference to it; this is to rub the dry powdered gum with the oil until tho-

roughly mixed, then add 1½ drachms of water in one quantity, and stir well until quite creamy; the mucilage is thus produced in contact with the oil and in the process of emulsification. It must be remembered that acacia gum dissolves somewhat slowly, and, in addition, it is delayed in coming into contact with the water by the oil. This stage of the process, therefore, must not be unduly hurried; when the product is quite creamy and homogeneous in appearance more water is added in small quantities, taking care that each addition is perfectly mixed in before the next is made.

Students should try the first prescription given above as written, and also with the use of only 2 drachms and 1½ drachms of mucilage; repeating the attempt, if necessary, until a good result is obtained with 1½ drachms (the quality of the gum is important, as well as the freshness of the mucilage). The second prescription should also be tried by both the methods described, and all the emulsions so made should be put aside and compared after several days' standing.

Spirits and Salts in Emulsions.

In the examples which we have so far considered, nothing is present but the actual constituents of the emulsion, *i.e.*, the two immiscible liquids (in this case oil and water), and the emulsifying agent, gum. But, as a rule, some other substance or substances are ordered in the same prescription with these, and such additional substances may have a considerable influence on the emulsion, and this influence is usually in the direction of making the emulsion more troublesome to prepare or more liable to separate on keeping. The following are common examples of such mixtures:—

℞	Ol. Ricini	ʒiii.
	Mucil. Acaciæ	ʒii.
	Syrup	ʒiss.
	Tr. Zingib.	ʒss.
	Aq. ad	℥iii.
℞	Copaibæ	℥ss.
	P. Acaciæ	ʒii.
	Sp. Eth. Nit.	ʒiii.
	Pot. Chlor.	gr. 36
	Aq. Chlorof. ad	℥vi.

Generally speaking, either alcoholic preparations such as tinctures and spirits, or solutions of salts, are hostile to the emulsion; we must here follow the rule already given of keeping such ingredients as much apart as possible,

and diluting before mixing. Make the emulsion with the essential ingredients only, add most of the vehicle, and transfer to the bottle; dissolve the salt in, or dilute the tincture, etc., with, the remainder of the vehicle (keeping from one-sixth to one-quarter for this purpose, and add in portions to the emulsion, shaking *gently* after each addition). Salts which are alkaline in reaction are usually rather favourable than otherwise to an emulsion; the alkali saponifies a small portion of the oil, or combines with a small portion of the resin, in either case making a soap which assists emulsification. Some emulsions are prepared with alkali only; we shall deal with these later.

Castor Oil Emulsions.

In the first stage of making an oil emulsion the consistence of the mixture is of considerable importance; if oil and mucilage of acacia are triturated together in a mortar, a stiff sticky mixture results; in such a medium each globule of oil that comes under the pestle is broken or drawn out into smaller globules, but if the mucilage had been previously diluted the medium would not offer enough resistance to the globules, and they would slip away from the pestle, a poor emulsion or a complete failure being the result. On the other hand, the medium must not be so stiff as to resist proper mixing; on gradually adding oil to mucilage the mixture in many cases becomes too stiff, and it must then be thinned by adding a little water; for this reason it is necessary in many cases to add alternately small quantities of oil and water, mixing well after each. If the dispenser will bear in mind the importance of a proper consistence during the mixing, he will be able to judge for himself when this method of alternate additions should be followed, and how much water should be added at a time. The official castor oil mixture furnishes a case where this method is useful; it is:

Castor Oil	3 fl. oz.
Mucilage of Acacia	1½ fl. oz.
Orange-flower Water (triple)	1 fl. oz.
Cinnamon Water	2½ fl. oz.

The oil is added gradually to the mucilage in a mortar with trituration, portions of the mixed waters being added alternately with the portions of oil; an excellent product results, far superior to the mixture formerly official, in which the emulsifying agent was alkali, and the product consequently of a soapy nature.

Acacia gum is a very useful emulsifying agent for other substances besides fixed oils, and we shall consider certain of these before passing on to other emulsifiers. There is another of the official mixtures in which this gum is ordered, viz., Mist. Amygdalæ Co. ; the real substance to be emulsified here is the fixed oil contained in the almonds, and as the latter also contain some gum, an emulsion may be formed by simply beating them with water ; but the quantity of gum is insufficient to retain the oil permanently emulsified, and further gum is, therefore, ordered. If the almonds are well ground with the sugar and gum, their whole substance becomes well subdivided ; and as the oil is already in minute globules in the seed, the conditions are very favourable for preparing an emulsion, and an excellent result is obtained with ease.

Male Fern Emulsions.

Liquid extract of male fern differs both in mode of preparation and in nature from other liquid extracts, which are for the most part like either very strong tinctures or solutions of solid extract in water or spirit. In the case of male fern, however, the liquid extract is made by percolation with ether, and on distilling off the solvent an oily, thick liquid remains. This is not miscible with water, and when ordered in a draught or mixture it must be dispensed as an emulsion. Several emulsifying agents may be used, acacia being one of them ; a larger proportion is necessary than in the case of fixed oils, as in the following :—

℞ Ext. Filicis Liq. ..... ʒii.
Mucil. Acac. ..... ʒii.
Aq. Cinnam. .....ad ʒii.

The extract is poured on to the mucilage in a mortar or measure, and the two mixed by stirring with the pestle or a glass rod, and the cinnamon water is then added in small quantities, mixing by trituration. Or the extract may be mixed in a mortar with 1 drachm of powdered acacia, then 3 drachms of cinnamon water added in one quantity, and the whole triturated till an emulsion is formed ; the rest of the water is added gradually. This liquid extract, however, may be made into a better emulsion with some of the other agents, which we shall mention later.

A little practice with male fern extract will impress on the student the fact, which should be borne in mind

in making any emulsion in a mortar, that what is required is a rapid, *light*, action of the pestle, and *not pressure by any means.*

Copaiba Emulsions.

Copaiba, often incorrectly termed a balsam, is really an oleo-resin, and both the essential oil and resin of which it consists require to be emulsified if it is to be made into a mixture. A satisfactory result can be obtained with acacia, although other agents are often ordered. In the following:—

℞ Copaiba..... ℥ss.
Mucil. Acaciæ ..... ℥ss.
Sp. Eth. Nit. ..... ℥ii.
Aq..... .....ad ℥iv.

first put the mucilage in the mortar, add a small quantity of the copaiba, and mix well; continue the addition of small quantities, adding also a little water from time to time, so as to keep the mixture of the right consistence for working; when all the copaiba is added, and the emulsion is milky, transfer to the bottle, and make up to 3½ ounces; dilute the spirit with an equal volume of water and add it last.

Cod Liver Oil Emulsion.

Cod-liver oil may be emulsified by means of various agents, and generally speaking, acacia is not so good as some others; but when, as is often the case, the oil is ordered with a large quantity of other medicaments, it is then better to trust to acacia. The following is a typical example:—

℞ Ol. Morrhuæ ..... ℥iiss.
Syr. Ferri Iodid. ..... ℥ii.
Aq. Chlorof. ..... ℥viii.

Four drachms of acacia gum will be required for this quantity of oil; it is to be first made into a mucilage by stirring with ½ ounce of chloroform water, allowing a few minutes for solution to become complete; the oil is then added in small quantities with constant trituration, a little chloroform water being added at intervals whenever the mixture is becoming too thick; the emulsion is made up to 6 fluid ounces and the syrup added last.

Turpentine and Resins in Emulsions.

Turpentine may be emulsified by meants of acacia, 1 drachm of the powder being taken for each 2 fluid

drachms of the turpentine; this emulsion can be better made in a bottle than in a mortar, in the following manner. Take a dry bottle and into it put the powdered gum, and then the turpentine; shake well. Then add, in one quantity, an amount of water equal to the amount of turpentine employed, and again shake well. Then add more water, but only half as much this time, repeat the shaking, and add more water in quantities equal to the last, shaking after each addition, until the whole has been added.

The use of acacia in dispensing resinous tinctures in an aqueous vehicle has been already referred to; tincture of cannabis indica, simple or compound tincture of benzoin, and others, may be treated in the manner described for tincture of tolu. Balsam of Peru is treated like a fixed oil.

Although tragacanth is generally much inferior to acacia as an emulsifying agent, there are many cases in which it is of use, though mostly as an aid to some other agent. We shall refer to it in what follows in connection with some of the other substances dealt with.

Emulsification by Casein.

In passing on to consider emulsifying agents other than gums, it is interesting to notice that the most perfect naturally occurring emulsion—milk—contains no gum. Milk consists of about 88 per cent. of water, with fat, lactose, casein, and mineral salts; the fat is in the form of extremely small globules, much smaller than the globules in most emulsions produced at the dispensing counter, and although when milk is left at rest a great deal of the fat rises to the surface in the form of cream, the globules do not coalesce. The important agent in keeping the fat emulsified is the casein, and this constituent can be extracted from milk and used in other mixtures. Casein belongs to the class of bodies known as proteids or proteins, which contain nitrogen, in addition to carbon, hydrogen, and oxygen, and are the principal flesh-forming ingredients of foodstuffs. In extracting casein from milk, it undergoes a certain amount of change, and the unaltered substance as it exists in fresh milk is more correctly termed caseinogen, although the name casein is in common use for it; the extracted casein is not soluble in plain water, but if treated with a very little alkali and water the greater part dissolves, the remainder

being suspended, and giving a milky appearance. In milk casein exists in association with mineral salts, principally phosphates, which have the effect of making it soluble. It is now prepared from milk on a very large scale, and is used commercially for a great variety of purposes; a familiar form of it is "plasmon" and other similar preparations, which consist essentially of casein, with just sufficient alkali to make it soluble. These preparations may be used as emulsifying agents, or a "soluble casein" may be prepared of—

Commercial Casein, in fine powder ..	8·5 parts
Sodium Bicarbonate	1·5 parts

When this mixture is treated with water combination occurs, and sodium caseate is formed; the dry powder swells and becomes somewhat gelatinous, and if sufficient water is employed the greater part dissolves. Such a "soluble casein" will go farther than an equal weight of gum in making an emulsion. The following is an example:—

Castor Oil	2½ fluid ounces
Soluble Casein	3 drachms
Chloroform Water.....to	16 fluid ounces

Rub the soluble casein with enough water to produce a moderately thin paste, after allowing one or two minutes for the swelling of the material that occurs; then add the oil in about four portions, mixing well between each addition and alternating with small quantities of the chloroform water to keep the consistence right, then gradually add the rest of the water. A beautiful milky emulsion is obtained, which, however, tends, on standing, to separate into two layers, the upper being a sort of cream and the lower nearly clear. These are readily mixed again by slight shaking, and there is no breaking of the emulsion. In any casein emulsion which is required to be kept for long, chloroform water or an alcoholic preparation, or some other preservative, is desirable, as casein solutions are very favourable media for the growth of organisms, and go bad, if alone, more rapidly than acacia mucilage, and with production of bad-smelling substances.

Emulsification by Yolk of Egg.

Casein is not the only member of the class of proteins that is of use in making emulsions. The white of an egg consists of albumen, which is a protein, and this material —uncooked, of course—can be used as an emulsifying

agent. Preference is usually given, however, to the yolk, which consists principally of one or more proteins, together with a good deal of oil already emulsified. Egg-yolk is a remarkably efficient emulsifier, one yolk, with a little tragacanth, being sufficient to emulsify 5 oz. of cod-liver oil, and it is in much favour for the purpose. The following prescription may be taken as an example of such emulsions :—

℞	Ol. Morrhuæ	℥v.
	Ovi Vitell.	i.
	P. Tragac.	gr. v.
	Elixir Saccharini.....	ʒss.
	Aq. Cinnam. .....ad	℥x.

Break the egg and carefully separate the "white" from the yolk as completely as possible; failure to remove all the "white" is sometimes a cause of trouble with the emulsion. Mix a little of the oil, 2 drachms or so, with the tragacanth in a mortar, add the yolk, and mix thoroughly by trituration; then add further quantities of oil, alternating sometimes with a little cinnamon water as may be necessary to keep the mixture of a good consistence; after all the oil is incorporated, add most of the remaining water in portions, retaining a little to dilute the elixir, and adding this last.

Yolk of egg is a useful means of emulsifying turpentine, and in this case, as in the acacia turpentine emulsion already described, the operation is best carried out in a bottle. The yolk is first mixed in a mortar with twice its volume of water, and, after straining through muslin if necessary, 1 to 1½ part of this mixture is taken for 1 part of turpentine; the diluted yolk is put in the bottle and shaken up, then the turpentine added all in one quantity, and the two well shaken together, the water being then gradually added, with more shaking. As with casein, egg-emulsions should contain some preservative.

Emulsification by Gelatin or Malt Extract.

Another nitrogenous substance of animal origin, although not strictly a protein, which is sometimes of assistance in making emulsions is gelatin. A very little gelatin considerably increases the viscosity of aqueous liquids, and this property may be made use of in emulsions; when gelatin is used it is commonly in addition to an alkaline salt or some such substance, which must be regarded as the more important agent in emulsifying.

Gelatin has not come into very much use in this way, although it finds large application in some other branches of dispensing, which we shall deal with later.

A very usual combination of cod-liver oil is that with malt extract; the latter consists principally of maltose and dextrin, with a smaller proportion of protein. Its action in dividing an oil and keeping the globules apart is probably partly due to the protein and the dextrin, but it is largely a mechanical effect due to the great viscosity of the extract. If malt extract is stirred in a warm mortar it becomes considerably more fluid, and cod-liver oil is then added gradually, stirring all the time until nearly cold. The amount of oil may vary much, even an amount equal to the weight of the extract being capable of incorporation. A little acacia gum or saccharated solution of lime is sometimes added.

Emulsification by Alkalies.

The use of lime water, or other alkaline substances, in making emulsions depends on a chemical change which occurs between the alkali on the one hand and the oil or resin on the other. Fixed oils consist of combinations of one or more fatty acids with glycerol, or some other of the higher alcohols; by treatment with alkali these combinations are broken up, the alkali combining with the acids, and the glycerol or other alcohol being set free. The compound of the alkali (or alkali earth) with a fatty acid is a soap, and it is to the soap thus produced that the formation of the emulsion is really due. Most ordinary oils contain more or less of free fatty acids, which combine with the alkali to form soap before any of the glycerol combination is decomposed, and in any case the amount of the latter that is actually decomposed is very small indeed. In the case of resins the result is very similar; most resins consist chiefly of organic acids, and these combine readily with alkali, forming substances of a somewhat soapy nature. Instead of thus forming a soap from alkali and oil or resin, a ready-made soap may be employed as an emulsifier. We shall next consider a few examples of the three methods.

A good illustration of an emulsion of oil made by means of alkali is given by the castor oil mixture which was official in the Addendum to the 1885 Pharmacopœia.

The formula and directions for making this emulsion were—

Castor Oil	6 fluid drachms.
Oil of Lemon	10 minims.
Oil of Cloves	2 minims.
Syrup	1½ fluid drachms.
Solution of Potash	1 fluid drachm.
Orange-flower Water to	2 fluid ounces.

Mix the oils in a mortar, then incorporate one-third of the solution of potash, and afterwards the syrup; then an additional third of the solution of potash, then gradually half of the orange-flower water, the remainder of the solution of potash, and, lastly, sufficient orange-flower water to produce the required volume.

This proportion of alkali and this method may also be employed for other oils and oily substances, with more or less of modification; the formula was abandoned because of its unsuitability for the administration of castor oil, not for faults of the emulsion. The flavouring agents selected, and the soapy nature of the product, made it very disagreeable; for such an oil as castor oil, which can be perfectly emulsified with the aid of gum, its partial conversion into a soap is not justified.

The official liniments of ammonia and of lime illustrate the production of soaps from alkali and oil, the directions in both cases being merely "shake together"; the liniments must be regarded as emulsions, a small part only of the oil being saponified, and the remainder emulsified by means of the soap so produced. The amount of alkali present in either case is not nearly enough to saponify the whole of the oil. Many toilet preparations (*e.g.*, "lime juice and glycerin," etc.) belong to the same class; the alkali used in these cases is often borax, in which the boric radical has such feebly acid properties that the salt behaves in many respects like a free alkali.

One of the commonest examples of an emulsion produced by the use of alkali with a resinous substance is seen in the usual way in which copaiba is dispensed. Copaiba, although commonly called a balsam, is in reality an oleo-resin—that is, a combination of resin and essential oil; the resin, like most other resins, is of the nature of a weak acid, and combines easily with alkali to form a resinate or resin soap, and the essential oil is easily suspended in the solution of this soap. On shaking copaiba with diluted solution of potash in a bottle, a milky result is at once obtained (the sides of the bottle

should be well wetted with the potash before putting in the copaiba), and this is the method usually followed. The miscible or soluble "Liquor. Copaibæ Conc." is usually made by boiling copaiba with alkali for some time. By this means not only is the resin fully combined with the alkali, but the volatile oil is driven off, and the resulting liquid consequently mixes with water without milkiness. Copaiba may be most elegantly dispensed as an emulsion by the use of both potash and mucilage, as in the following:—

℞	Copaiba	ʒiv.
	Liq. Potass.	ʒii.
	Muc. Acac.	ʒvi.
	Sp. Eth. Nit.	ʒii.
	Syrup	℥ss.
	Aq. ad	ʒvi.

Put the mucilage into the bottle, and add the copaiba to it by degrees, shaking after each addition; dilute the potash with an equal volume of water, and add and shake well; add more water gradually, lastly adding the spirit and syrup mixed with about an ounce of water.

Emulsification by Soap.

The use of an ordinary soap is naturally not resorted to for making emulsions for internal administration, except for veterinary medicines, and occasionally in other cases. For embrocations or liniments, however, soap is often a very useful agent, and soft soap (in which the alkali is potash) is usually employed for the purpose. The official liniment of turpentine is an illustration of this use of soap; the following simple turpentine emulsion is another example:—

℞	Sapo Mollis	ʒiv.
	Ol. Terebinth	ʒi.
	Aq ad	ʒiv.

The soap is dissolved in an ounce of the water (previously heated) and the solution strained into the bottle; the turpentine is then added in small portions, shaking after each addition, until it is all emulsified; the rest of the water is then added in the same way.

Other Emulsifying Agents.

Various other emulsifying agents are in occasional use, although the very large majority of emulsions of all kinds are made with one or more of the agents that we have described. One of the chief of these subsidiary agents is

saponin; this is a general name applied to a class of bodies occurring in many plants, some of them being highly poisonous; the solution of a small quantity of a saponin in water froths when shaken, like a soap solution, but usually more readily. Quillaia bark is one of the commonest sources of saponin, and a tincture of this bark has strong emulsifying properties; for this purpose the tincture may be made of the strength of 4 oz. to the pint (of rectified spirit). This tincture is serviceable for emulsifying many substances, the method of employment being simple; for instance—

℞ Ol. Ricini ..... ℥i.
Tr. Quillaiæ ..... ℥i.
Aq. ..... ad ℥ij.

Put the tincture into a bottle, add the oil and shake; then add the water and shake well, and the emulsion is made. On standing the emulsified oil rises to the top in a sort of cream, which is diffused again on shaking.

℞ Ext. Filicis Liq. ..... ℥i.
Tr. Quillaiæ ..... ℥ss.
Syr. Zingib. ..... ℥ss.
Aq. ..... ad ℥i.

The method is similar to the above. Copaiba and turpentine may be emulsified by means of an equal quantity of the tincture of quillaia.

Irish moss contains a considerable quantity of mucilaginous constituent, which can be extracted by boiling with water. The decoction so obtained finds some application as an emulsifying agent for oils; the emulsions thus produced are generally characterised by considerable stability, but the oil is not as a rule so finely divided as by acacia mucilage. The following is an example:—

Irish Moss ..... ¼ oz.
Water ..... 24 oz.
Soak for an hour, boil for five minutes, and strain.
Cod-liver Oil ..... ℥i.
Irish Moss Mucilage ..... ℥vi.
Water ..... ℥ij.
Mix.

Emulsions of Petroleum, Fatty Substances, and Essential Oils.

A substance which has come into great favour in the form of an emulsion during recent years is petroleum. Sometimes the heavy petroleum oil is used, and sometimes the semi-solid soft paraffin or vaseline. Petroleum

cannot be emulsified by means of alkali, since it is not capable of saponification; but by methods involving no chemical change, such as the use of gum or of yolk of egg, it can be treated like a vegetable or animal oil; if vaseline is used it must first be melted, and emulsified at a temperature sufficiently high to prevent its re-solidifying. The following is a typical formula:—

Calcium Hypophosphite	40 grains
Sodium Hypophosphite	60 grains
Gum Acacia, powder	1 oz.
Liquid Paraffin	2 fl. oz.
Elixir of Gluside	40 minims
Essential Oil of Almonds	½ minim
Water	to 6 fl. oz.

The method to be followed is the same as has been described for cod-liver oil.

Other solid substances of a fatty nature, such as oil of theobroma, spermaceti, and beeswax, are occasionally required in the form of emulsions. Generally speaking, the method to be followed is the same as for fixed oils, but the solid fat must be first melted and a hot mortar and pestle employed so that solidification shall not occur until the emulsion is completed; the amount of acacia taken should be equal to that of the fat or wax to be dealt with.

Essential oils usually appear in emulsions only as flavouring agents, along with fixed oils. In such cases, if an alcoholic liquid is present, the essential oil may be dissolved in it; or (better) it may be added to the fixed oil. If, however, an essential oil is to be emulsified by itself, mucilage is required in considerable quantity, and the mixing is best carried out in the bottle. Turpentine (called more correctly oil of turpentine) is an essential oil, and the directions that have been given for dealing with it should be followed, although in most cases a larger proportion of gum will be required. Terebene is of a similar nature, and should be treated in a similar manner.

In leaving the subject of emulsions, we may repeat the advice that has been already given, that a dispenser should never be content with knowing particular methods for particular cases, but should endeavour to understand fully the principles on which the methods are based. Such a grasp of principles, together with the expertness that comes of much practice and a readiness to experiment with new difficulties, will fit a dispenser to deal with any demands that are likely to be made on him, either in the examination-room or in the pharmacy.

PILLS.

In spite of the many forms of medicine of more recent introduction, such as cachets, capsules, tablets, etc., pills easily take the next place after mixtures in importance, from the point of view of the dispenser. By far the greater part of the pills produced to-day are made in large quantities by machinery, and reach the public either through the pharmacist—who obtains them as "stock" pills—or in the form of some proprietary article. The work of the dispenser, however, does not lie with these wholesale quantities, but consists in the preparing of from one or two pills up to a few dozen, according to some medical prescription; there is, of course, far greater variety in the formulæ that are made at the dispensing counter, and far more difficulties are to be encountered than in the manufacture of large quantities.

Guiding Principles.

Before discussing the difficulties in detail and the methods of overcoming them, we may recall the objects which are to be aimed at, and which are the same for pills as for mixtures. We have previously stated these to be (1) preparation of the medicine in a form in which it can be readily absorbed or assimilated, (2) even distribution of the medicaments among the doses, and (3) the prevention of mutual decomposition or reaction among the different medicaments if they are liable to such change, except in those cases where reaction is known to be desired. Applying these general principles to the case of pills, we see that (1) requires the pills (and the coating, if there is any) to be easily dissolved or disintegrated in the stomach; (2) requires that the pill-mass shall be homogeneous and divided into pills of equal weight. Besides these therapeutic requirements, we must consider the demands of elegant pharmacy, which requires that the pills shall be as agreeable to take as possible (*e.g.*, not larger than necessary), and that they shall be well rounded, and shall retain their shape when kept under fair conditions.

The Excipient.

It is sometimes the case that the particular medicaments ordered in a pill are of such a nature that by merely mixing them and well working together with the pestle, a mass results which is suitable for rolling and

dividing into pills. This, however, is quite an exception; as a rule, it is necessary to add some inert ingredient or ingredients in order to make such a mass. This inert addition is known as the excipient, and prescribers very commonly leave to the dispenser the selection of the excipient and the adjustment of the quantity of it that should be used. Even when the prescription includes an excipient it is recognised that a dispenser is within his rights in altering it if there is any reasonable occasion for doing so. The active ingredients may be powders or substances that can be powdered, or even partly powders and partly liquids (*e.g.*, essential oils), which, when mixed, form a dry or nearly dry material, and in such a case the excipient must be something which will bind the powder into a mass. On the other hand, the ingredients may be wholly or in part extracts, or liquids, so that when mixed a fluid or semi-fluid material results; in this case the kind of excipient and manipulation required will be the reverse of what was used in the former instance. While the number of substances that may occasionally be required as excipients is large, a small number suffices for most ordinary pills. No hard and fast rules can be given as to which should be used in every case, as in a great many cases several are equally good, and each dispenser will probably do best with the one to which he is accustomed. For binding dry powders the principal excipients are, glycerin of tragacanth, confection of roses, malt extract, simple syrup, syrup of glucose, mucilage of acacia; for dry extracts or other powders of a sticky nature, water, spirit, dilute glycerin; for masses that are already too soft, powdered liquorice, marshmallow, tragacanth. Soft masses may be stiffened by drying, which is often better, as we shall see, than adding powder; on the other hand, liquorice or marshmallow must sometimes be added, not as drying agents, but because of their fibrous nature. Pills to which some such fibrous substance has been added often retain their shape better than without it.

Manipulation.

The art of making good pills involves a good deal more than merely selecting the right excipient, and proper familiarity with the necessary manipulation can only be obtained by experience. Generally speaking, a good deal of "elbow grease" is necessary in pill-making. An

amount of excipient which, gently stirred into a powder, would barely suffice to make it sticky, may be ample to make it into a soft mass if well worked into it; this is no doubt partly due to the fibres in the powder being squeezed closer together and a larger quantity of them therefore becoming coated with a given quantity of the sticky material present, but it is also partly the result of the heat generated by the friction, which softens ingredients of an "extract" or resinous nature, and so helps them to spread further. The mass should be rolled out and cut into pills as soon as it is made and the pills rounded off. After a few minutes a well-made mass will in most cases become appreciably harder, and it is best for this only to occur after the pills are made. Manipulation of the mass with the fingers is so often advantageous, or even necessary, that it cannot be objected to. It is hardly needful to add that the hands should be washed before pill-making.

Some Rules to be Observed.

A few further rules for pill-making may be laid down which dispensers will do well to observe.

(1) Make a note in the prescription book of the excipient used and the weight to which the pills are made up, so that if they are repeated they may be of the same composition and size.

(2) For pills over 1 grain in weight use as little excipient as possible; pills under 1 grain should be made up to 1 grain by some inert substance.

(3) If any alteration is made in the prescription, as is sometimes necessary (*e.g.*, replacing a hydrated salt by the equivalent weight of the dried, or dividing one pill into two), make a note on the prescription as a guide to future dispensers; also if a pill of very small weight is made up to 1 grain, a note should be made on the prescription. A patient naturally suspects error if pills of very different size are supplied to the same prescription at different pharmacies.

(4) If all the ingredients of a pill are white, do not use a dark excipient, but dispense as a white pill if possible.

(5) If a volatile ingredient is ordered, or one which is liable to be decomposed by contact with the air, varnish the pills and make a note on the prescription.

(6) Mix all ingredients that are powders well together before adding any excipient or ingredient of a binding

nature. Never trust to powders becoming mixed in the process of massing. All dry ingredients should be in the finest powder possible.

Simple Prescriptions.

The following may be taken as a type of straightforward pill-making involving no difficulty :—

℞ Ferri Sulph. Exsicc. ..... gr. xx.
Aloes Barb. ..... ℈ii.
P. Cinnam. Co. ..... ʒj.
Excip. ..... *q.s.*
Ft. pil. xxxvj.

A suitable excipient to use here will be syrup of glucose, of which about 50 grains will be required. It will be noticed that this is the official Pil. Aloes et Ferri; the amount of syrup of glucose ordered in the Pharmacopœia (calculated to the quantities in the above prescription) is "60 grains, or a sufficient quantity." In most of the official formulæ the allowance of excipient is somewhat liberal, and there is no difficulty in making the pills with rather less. Other official pills which give useful practice in dispensing simple formulæ are :—Pil. Aloes Barb. (or Soc.), Pil. Aloes et Myrrh., Pil. Coloc. Co., Pil. Ipecac. *c.* Scill., Pil. Plumbi *c.* Opio., Pil. Rhei Co., Pil. Scammon. Co., and Pil. Scill. Co.

Weighing Fractions of a Grain.

It not infrequently happens that a small fraction of a grain of some active ingredient is ordered in one pill, and the number of pills to be made requires less than a grain of this ingredient to be taken, perhaps a rather inconvenient fraction. The difficulty may, of course, occur equally in dispensing powders and other forms of medicine, but may as well be dealt with here once for all. The following prescription is a case of the kind :—

℞ Strychninæ ..... gr. $\frac{1}{60}$.
Acid. Arsenios ..... gr. $\frac{1}{50}$.
Ferri Redact. ..... gr. iiss.
Ft. pil i. Mitte xxiv.

The ordinary dispensing scales and weights cannot usually be trusted for quantities less than 1 grain; the quantities here required are strychnine 24/60ths, or 2/5ths, arsenious acid, 24/50ths, or 12/25ths. Weigh out 1 grain of strychnine and 1½ grain of sugar of milk. Powder the strychnine, mix carefully and thoroughly with the milk sugar, and take 1 grain of this mixture for the prescription. Weigh out 1 grain of arsenious acid and 11½

grains of sugar of milk, mix thoroughly, and take 6 grains of the mixture for the prescription. Reduced iron does not bind well, and a little tragacanth is desirable to prevent the mass crumbling. For the quantity here ordered, 4 grains of tragacanth may be employed, and the mass then made with syrup of glucose, or 2 grains of tragacanth and extract of malt to mass. It is a general rule that tragacanth or acacia should never be used unless necessary, and then only in small quantity, as pills containing a considerable quantity of either of these gums do not disintegrate at all readily in the stomach.

Rolling, Cutting, and Finishing Pills.

It is not necessary to multiply examples of simple prescriptions for pills presenting no difficulty; the novice desiring practice in the actual manipulation (and such practice is essential) will do well to prepare small batches of those of the official pills enumerated above. There are various small matters in practical work in which the difference between a good and a bad dispenser is likely to be shown, and, before passing on to special difficulties, it will be well to mention a few of these matters. The pill machines in general use are made to cut twenty-four pills at one time; if a larger number than this is ordered in a prescription the mass should always be divided into the requisite number of parts by weighing, never by trusting to the eye for their equal size. If 5-grain pills are to be made, and the machine to be used is of the 5-grain size, it is only necessary to roll out the mass to a cylinder of the exact length corresponding to the number of pills to be made, and cut them with a rapid to-and-fro movement of the cutter, using gentle pressure at first and gradually increasing it; after a little practice the pills so produced will require no further rounding. The production of a cylinder of perfectly uniform thickness, however, requires some care; application of pressure at the ends only of the roller tends to make the ends of the cylinder of pill-mass rather thinner than the middle; and from the fact that the middle portions of the roller and of the bed of the pill-machine get more wear than the outer portions, they gradually come to be slightly hollowed, which also has the result of making the middle part of the cylinder thicker than the ends. It is usually necessary, therefore, when the mass is rolled out to rather

less than the required length, to apply the roller in a direction at right angles to the usual one, that is, with one end towards and the other directly away from the operator, so that pressure is only put on to the cylinder over a portion equal in length to the width of the pill roller, any irregularities in thickness being thus corrected and the cylinder brought to perfect uniformity as judged by the eye. It often happens that pills have to be made on a machine that is intended for a larger pill, say 3-grain pills on a 4-grain or 5-grain machine, and in this case the cutting will not as a rule give round pills, but elongated ones; it is then usually necessary to make each pill approximately round by pressure between finger and thumb, in order that they may run when rotated under the rounder or finisher. The knack of using the rounder is not difficult to acquire; a circular rotatory motion is required, and the pressure should be very gentle at first, then gradually increased to a maximum varying with the hardness of the mass, and again diminished as the motion is reduced and stopped. In rolling and rounding pills, as well as in making the mass, the heat generated by friction plays an important part: a very hard mass may be made quite plastic by vigorous handling, and a few minutes after the pills are finished they will be quite hard and in no danger of losing their shape. It is usually desirable to use a little powder to prevent the mass sticking to the machine in rolling and cutting, and to prevent the pills sticking together in rounding. Many powders are used for the purpose, and probably the best is a mixture of about equal portions of starch and French chalk (talc); it is usual to put a little powder in the box with the finished pills, but, if this is done, the quantity should be very small.

Preparation of the Mass.

We can now return to the preparation of the mass. When it is possible to avoid the addition of an excipient altogether or only to use one which will be removed again by evaporation, it is of course desirable to do so. The following presents such a case:—

℞ Camphoræ,
Asafetidæ,
Galbani,
Myrrhæ.....aa gr. i.
Ft. pil. Mitte xxiv.

If the asafetida, galbanum, and myrrh are worked well together in a warm mortar with a warm pestle, it will be possible to then incorporate the camphor (previously powdered), usually without any excipient; if, however, the mass is not quite soft enough a very small quantity of spirit can be added. In the official Pil. Galbani Co. also the three gum-resins are heated together, but syrup of glucose is here employed as excipient and the surplus moisture removed by the heat employed. In the next prescription a little alcohol is all the addition that is necessary for making a mass.

℞ Ext. Aloes Barb. ..... gr. xii.
Pulv. Nucis Vom. ..... gr. vi.
Mastich ..... gr. vi.
M. ft. pil. no. vi.

Pills containing aloes, either Socotrine or Barbadoes, or extract of aloes, have always a tendency to "fall," that is, to flatten on standing, the tendency being more or less noticeable according to the proportion of aloes. The nature of aloes is a sufficient explanation of this, since it is so easily softened by heat, and especially by heat with a little moisture; advantage should be taken of this in making the mass, vigorous working being employed, so that the mass becomes well warmed, and the whole operation of massing, cutting, and finishing being carried through without interruption; a minimum of moisture is then necessary, and pills can be made which are soft enough while being finished, but rapidly become hard on standing. If the pill does not contain any fibrous material, such as a powdered vegetable drug, it is best to add a little liquorice. An excipient which is much used for making pills containing aloes is Decoct. Aloes Co.; a very little of this is very effective, probably chiefly because of the potassium carbonate which it contains, and although it is always undesirable to use as excipient anything that is itself a medicine, it would be absurd to condemn the use of the decoction in such cases, since the quantity used is so small and the active ingredient the same as that in the pill. Decoction of aloes should not be used in any case where the potassium carbonate would be incompatible with some other ingredient of the pill.

Dry Substances in Pills.

Camphor is often a troublesome ingredient; it must in all cases be finely powdered, which can be easily done

by adding a few drops of spirit to the camphor and then rubbing it in a mortar. Tragacanth in some form is usually necessary; if camphor is the only ingredient glycerin of tragacanth is best; in other cases powdered tragacanth and syrup of glucose may be better, depending on the nature of the other ingredients. A few examples are here given:—

℞ Hyd. Subchlor.,
Camphoræ,
Asafetidæ,
P. Pip. Nig. ..... aa gr. xii.
Ext. Opii. ..... gr. vi.
M. Div. in pil. xii.

Powder the camphor finely, and mix with the calomel and pepper and 2 grains of tragacanth; then work the extract of opium with this; soften the asafetida with a few drops of spirit, and then work all together.

Soap and oil are sometimes employed with camphor, as in the next:—

℞ Camphor ..... gr. xxiv.
Ol. Ricini ..... gtt. iii.
Saponis ..... gr. ii.
Ft. pil xii.

The addition of a few drops of spirit makes this "go" pretty well.

Quinine and camphor are sometimes ordered together, as in the next:—

℞ Quin. Sulph.
Camphor ..... aa gr. i.
Ft. pil. Mitte xx.

The camphor is finely powdered, then thoroughly mixed with the quinine and 3 grains of tragacanth, and enough syrup of glucose added for massing.

Carbolic acid, more correctly known as phenol, is not infrequently ordered in pills, and is apt to give some trouble. There are several ways of dealing with it, and the particular excipient to be employed in a given case will depend to some extent on what other ingredients are in the prescription, as well as on the usual practice of the dispenser. Powdered marshmallow root with a small quantity of acacia may be employed, and the mass made with syrup. Perhaps the excipient in most favour is powdered soap: if this is to be used, only neutral soap is permissible, as any alkali will combine with the phenol, and the patient will get something different from what is intended; it has been objected that even a neutral soap may react with the phenol and partly neutralise it, but this is not likely to occur to any serious extent. The quantity of soap may be from $\frac{1}{3}$ to 1 grain for each grain of phenol; if no powdered vegetable drug is in the prescription

a little liquorice will be an advantage; in some cases a little tragacanth and syrup will also be necessary.

Potassium permanganate is likely to give very serious trouble to anyone who omits to consider its powerful oxidising property, but is easily made into pills when once the correct method is known. The ordinary excipients, such as confection of roses, glycerin of tragacanth, etc., are not only inadmissible because they exercise a reducing action on the permanganate, but also because they become so changed themselves that they will not answer the purpose. In fact, if permanganate is powdered and then worked vigorously with such an excipient, reaction may be sufficiently violent to cause spontaneous combustion. It is necessary that the binding material shall be something that is not oxidised by permanganate under ordinary conditions. Paraffin ointment, resin ointment, and anhydrous wool fat are such substances, and permanganate may be massed with either of these; a stiffening agent, however, is also necessary, and for this purpose fullers' earth or kaolin is suitable; liquorice and other vegetable powders are, of course, excluded. It has been recommended to omit the grease, and a mass can be made with fullers' earth, 1½ grain to 1 grain of permanganate, and a little water only.

Quinine is very frequently ordered in pills, both alone and with other ingredients; it does not as a rule present particular difficulty. It is desirable that a soluble salt should be employed, and when the sulphate is ordered it is usual to add a little acid, which both assists the massing and gives a more soluble product. In the official pill of quinine sulphate 1 grain of tartaric acid is added to 30 grains of the sulphate, and a mass made with tragacanth and glycerin; it is by no means certain that this gives as soluble a pill as is obtained by using rather more tartaric acid—say, 3 grains, omitting the tragacanth and massing with glycerin and water in very small quantity. If it is required to keep the size of quinine pills as small as possible, they may be made up with dilute sulphuric acid alone; a very small quantity suffices to yield a workable mass. In this case part of the quinine is converted to the bisulphate, a soluble salt.

Valerianate of zinc may be massed by means of glycerin of tragacanth after adding a little liquorice or marshmallow powder. Another method is to add a little acacia, and mass with spirit. It is, of course, necessary

to not only give the pestle and mortar a very thorough cleaning after making these pills, but also the pill machine and rounder, in order that the strong flavour of the valerianate shall not be imparted to the next batch of pills.

The most unlikely powders are sometimes ordered in pills, and even after long experience the dispenser must expect to be occasionally faced by novel difficulties. But although powders may differ much in composition and therapeutic action, their physical properties usually bring them under some familiar class; by considering whether a powder is soluble or insoluble in water or spirit, whether it contains vegetable tissue or not, whether it is a single chemical substance or a complex mixture, and a few other such questions, it is usually not difficult to succeed in massing it with the first excipient selected.

Extracts in Pills.

It often happens, as we have remarked earlier, that the ingredients of a prescription for pills may be such that the question is not how to bring dry powders into the form of a coherent mass, but how to bring a mixture of soft extracts, or even a liquid, to a sufficiently solid state to make it into pills. There are two principal ways of doing this: one is to add a sufficient quantity of an absorbent or other dry powder to stiffen the mass; the other is to remove the superfluous moisture by evaporation. Very commonly both methods must be employed. The two powders chiefly employed to absorb moisture and stiffen a mass are liquorice root and marshmallow root—of course, in very fine powder. Sometimes the further addition of a small quantity of tragacanth is necessary. Such pills as the following:—

℞ Ext. Belladon. Alc. ..... gr. $\frac{1}{6}$.
Ext. Hyoscy. ..... gr. $\frac{1}{4}$.
Ext. Opii ..... gr. $\frac{1}{2}$.
Ft. pil. i.

℞ Ext. Colchici Acet. ..... gr.
Ext. Nuc. Vom. ..... gr.
Ft. pil. i.

will mass quite easily with the addition of a little liquorice, and this method should be followed; but with such as

℞ Ext. Ergotæ ..... gr. xl.
Ft. pil. viii.

℞ Elaterin ..... gr. $\frac{1}{10}$
Ext. Hyoscy. ..... gr. iv.
Ft. pil. i.

it is at once evident that so much powder would be re-

quired that the pills would be of an excessive size. In these cases evaporation must be employed. The ingredients are placed in a small, flat-bottomed dish, or on a glazed tile, and the dish or tile heated by means of a water-bath. It is a safe rule always to heat extracts or other vegetable preparations as little as possible, and the mass should accordingly be worked with a pill-knife during the heating, as evaporation is thus promoted and the time of evaporation reduced. In pills like the above, consisting entirely, or almost entirely, of soft extracts, about 1 grain of liquorice should be added to each pill, in addition to removing moisture. Remember that the mass will be considerably stiffer when cold than while still hot, and remove it from the heat while still fairly soft; roll and finish without loss of time. Weigh the finished pills and make a note of the weight to which they have been brought for future guidance.

It is a convenient plan to keep some of the commoner extracts in a ready-dried condition; liquorice powder is mixed with them in sufficient quantity to make up to the original weight or to a convenient weight less than the original. In the latter case the ratio between equivalent quantities of the soft and dried extract must be plainly stated on the label, as, for instance, "Ext. Ergotæ Sicc., 4 grains=5 grains soft extract." Some extracts can be brought to a powder in this way, but the form of granules is more easily attained, and is very convenient. It is useful to also keep ready the mixed powders for some of the official pills, to be used in place of the pill-mass in certain cases. If, for instance, the following is ordered:—

℞ Pil. Rhei Co.
Ext. Hyoscy .....aa gr. iiss.
Ft. pil. i.

if the mixed powders (and oil of peppermint) for Pil. Rhei Co. are at hand, it is only necessary to take 1·87 grain for each pill and mass at once with the extract of henbane.

Liquids in Pills.

Essential oils often form ingredients in pills, and are occasionally the principal ingredients. In such cases it is, of course, necessary to employ some substance that will absorb the oil, as any evaporation would now remove not moisture, but the actual medicament itself. Soap is usually the best thing for making essential oils into

pills. If a dry vegetable powder is not in the prescription, some liquorice should also be added; generally about ½ grain of soap and 2 to 3 grains of liquorice will suffice for 1 minim of essential oil; spirit or water will then usually suffice for massing. Curd soap is better in most cases than castile.

Creosote is rather often ordered in pills, and may be made up by the method just given for essential oils. For mixing with other ingredients it is a good plan to put equal parts of curd soap and creosote into a wide-mouthed stoppered bottle and heat in a water-bath till they combine; on cooling, a mass is obtained which is well suited for mixing with other substances to make pills. A small creosote pill can be made by taking ½ grain of curd soap for each drop of creosote, and adding enough calcium phosphate to stiffen into a mass.

Croton oil, though not very often ordered now, may be required in pill form. In this case also curd soap is a most useful addition; a little glycerin of tragacanth may be needed for massing.

Pill Ingredients that React.

Chemical reaction between the ingredients of a pill does not take place as easily as between the constituents of a liquid mixture, but nevertheless it cannot be ignored. In certain cases it may be the prescriber's intention that double decomposition shall take place, but in others such action may not have been foreseen, and here, as in the case discussed in a previous chapter, the dispenser must turn his chemical knowledge and general experience to account in deciding whether a particular change is desired or otherwise. If it is clear that reaction is *not* desired, the ingredients which are liable to affect one another must, of course, be kept as much out of contact with one another as possible. This can usually be managed better in pills than in mixtures, as each can be diluted with some other ingredient or an inert powder or excipient before mixing, or they may even be made into separate masses and these finally mixed. By these means the proportions of the two ingredients that react together may be kept very small. But in other cases reaction between two ingredients is intended, and the pills are required to contain the freshly made product of the double decomposition. The most important instance of this is seen in Blaud's Pills, officially represented by the Pilula

Ferri of the Pharmacopœia. Blaud's Pill is intended for the administration of ferrous carbonate. This substance is rapidly decomposed if kept exposed to the air, the principal product being ferric oxide, and it is therefore necessary to prepare it freshly. For this purpose dried sulphate of iron is mixed with glycerin, water, and syrup, and dried sodium carbonate added. The water dissolves a portion of each salt, these at once reacting together to form sodium sulphate and ferrous carbonate. Further quantities of ferrous sulphate and sodium carbonate are then dissolved and react, and this process going on continuously, after a few minutes the whole quantity of these salts has become converted to ferrous carbonate and sodium sulphate; meanwhile, the glycerin and sugar protect the ferrous carbonate from oxidation. In the pharmacopœial directions fifteen minutes' standing is ordered for the completion of the reaction; acacia and a little tragacanth are then added, and the whole worked into a mass. When the pills are dry the ferrous carbonate is out of contact with the air, except on the extreme surface, and will keep unchanged for a long time; even surface action is usually avoided by coating the pills. This is a very satisfactory formula for Blaud's Pills, and only needs reasonable care in preparation. If, as sometimes happens, this pill is ordered in combination with other ingredients, they must be added at an appropriate stage of the making. A few instances are here given:—

℞ Acid. Arsenios,
Strych. .....aa gr. $\frac{1}{60}$.
Aloin ..... gr. $\frac{1}{3}$.
Pil. Ferri..... gr. iv.
Ft. pil. i. Mitte xxxvj.

The three first ingredients should be thoroughly mixed together, and then with the mixed syrup, glycerin, and water. They will not interfere at all with the subsequent reaction, and their proper distribution is most effectually secured.

℞ Ext. Aloes Barb. ..... gr. xij.
P. Nucis Vom. ..... gr. vj.
Pil. Ferri.....ad ℥iv.
M. ft. pil. 48.

The nux vomica may be mixed with the liquids as in the previous case; but as the extract of aloes would appreciably retard the reaction, it should be mixed with

the acacia and tragacanth, and added with them when the change is complete.

℞ Mangan. Dioxid. Precip. ..... gr. ij.
Pil. Ferri..... gr. iij.
Ft. pil. i. Tales xxiv.

In this case the iron pill mass should be made first and the manganese dioxide added afterwards, as otherwise reaction would almost certainly occur to some extent between it and the sodium carbonate.

Varnishing Pills.

Before leaving the subject of pills, it will be best to say something about the final processes which they often undergo after the making is complete, those, namely, of varnishing and coating with various materials. Pills should never be coated with silver, talc, sugar, or anything that greatly alters their appearance, unless such treatment is ordered on the prescription or asked for by the patient; but it is within the province of the dispenser to decide whether they should be varnished or not, and the cases in which this should be done are many. Pills containing substances liable to be changed by contact with the air, either by oxidation or by absorption of moisture leading to swelling, deliquescence, or chemical change, and pills having an objectionable odour and taste or containing a volatile ingredient are all improved by varnishing. Several formulæ for pill varnishes are in use. They are either solutions of sandarac in alcohol, alcohol and ether, or chloroform and ether, or are made by macerating balsam of tolu, after it has been used for making syrup, in ether. One part of spent tolu in three parts by measure of ether is a suitable strength, the undissolved portion being separated by pouring off. For sandarac varnishes the following may be used:—

(1) Sandarac ..... 4½ parts.
Chloroform ..... 4 parts.
Ether Meth. (specific gravity, 0.717).. 10 parts.

(2) Sandarac ..... 1 part.
Absolute Alcohol ..... 2 fluid parts.
Ether..... 1 fluid part.

(3) Sandarac ..... 1 part.
Alcohol ..... 2 fluid parts.

A varnish made with ether will, of course, dry most quickly, and one in which alcohol is the solvent most slowly. When the solvent is likely to have any effect

on anything in the pill itself, the most rapid drying is, of course, preferable.

The method of varnishing is extremely simple. The pills, which must not have any powder on their surfaces, are put into a covered pot, a little varnish added (usually two or three drops to a dozen fair-sized pills), and the pills shaken and then rotated in the pot for a few moments. They are then turned out on to a tile or plate, separated from one another with the least touching possible, and allowed to dry. Before they are quite dry they should be moved about a little by giving a slight rotatory movement to the plate. The spot which has been in contact with the plate during drying is then not apparent.

Silver Coating Pills.

When pills which are to be silver coated contain any ingredient capable of acting on a thin layer of silver, they must be varnished before coating. The application of the silver leaf may be carried out in a covered pot, or in one of the boxwood "silver coaters" supplied for the purpose. One silver leaf of the ordinary size is usually required for each six 5-grain pills, and the leaf is put into the pot or box first. The pills are then shaken in another pot with a few drops of dilute acacia mucilage till every part of each is moistened with it, using the least quantity of mucilage that will suffice, and turned into the pot containing the silver. This pot is closed and rotated, shaking smartly once or twice to ensure that the pills are separated. The rotatory motion is continued until the pills are uniformly covered.

Pearl Coating Pills.

A perfect pearl coating can only be obtained when working on much larger quantities of pills than are usually ordered in prescription; but with a little care and perseverance very good results can be obtained with small quantities. A tin or copper vessel with a rounded bottom is best, and such vessels are supplied for the purpose; but in their absence a large covered pot will answer. Talc, otherwise known as French chalk, is the material of the coating, and only the very finest powder ("subtiliss.") is suitable. A small quantity of this powder is placed in the coating vessel, and the pills shaken in another pot with a weak mucilage, but using three or four times as much of the latter as is required

for silver coating. The moistened pills are then thrown into the talc and the vessel steadily rotated. Small additions of the fine talc are made at intervals of one or two minutes until inspection shows that a sufficient thickness of coating has been taken up. Rotation is continued for a little longer to polish the surfaces, and a final burnish is given by putting the coated pills into a long flannel bag somewhat like a stocking, and running them from end to end a few times.

Gelatin Coating Pills.

A thin layer of gelatin forms a suitable protection in many cases, and being transparent it does not change the appearance of the pill except by giving a glazed surface instead of a dull one. Various formulæ are in use for the gelatin solution that is used. the following being probably the one most frequently employed:—

Gelatin	4 ozs.
Acacia Gum	1 oz.
Boric Acid	¼ oz.
Water	2 pints

Soak the gum and gelatin in the water for some hours, then dissolve with the aid of gentle heat (a water-bath should be employed to avoid burning), and add the boric acid; strain if necessary. This forms a solid mass when cold, and it is melted on a water-bath for use. The pills to be coated are stuck on the points of needles, the eye-ends of the needles being fixed in corks, which serve as handles A dozen or more needles may be fixed in one large cork. The pills having been impaled on the needles are dipped into the melted jelly and withdrawn. They are held turned downwards till a drop of the surplus liquid forms on each, and these drops are then removed by just touching the surface of the liquid with them. The cork, with needles and pills, is then turned the other way up, and the coating left to dry. In gelatin coating on the large scale needles are not used, but the pills are held by suction against small tubes and dipped half-way only into the gelatin solution. When the coating has dried the pills are held by the coated side and the other half is then dipped.

Sugar coating cannot be satisfactorily performed on the ordinary dispensing scale, and a description of it would, therefore, not be in place here.

POWDERS.

Powders may be prescribed for use in several ways; the commonest requirement is for internal administration, the mixing of the powder with some suitable vehicle being left to the patient. In other cases one powder is to be taken with each dose of a mixture, the material of the powders being then usually one which reacts with an ingredient of the mixture, causing effervescence. But powders may also be ordered for external use, as dusting powders, etc., or for local application, such as to the throat by blowing the powder on with bellows, or for snuffing, etc.; these latter are usually termed insufflations and snuffs. When required for swallowing, powders are now often ordered in the special form of cachets. It will be necessary to say a little about each of these forms.

It will readily be apparent to anyone who has followed what has been said about mixtures and pills that considerably less difficulty may be expected in the dispensing of powders, since most of the trouble encountered in the other cases is due either to physical immiscibility or chemical incompatibility among some of the ingredients; and powders being necessarily in the same physical state can hardly be immiscible, while chemical action is not very likely to occur between dry substances. Such a surmise is perfectly correct, and this fact will enable us to dismiss powders in a much shorter space than pills or mixtures. But it must not be supposed that chemical reaction *cannot* occur between two substances when mixed in the form of powders; reaction does occur in a quite considerable number of cases, and the dispenser should be always on the look-out for such a possibility.

In considering in general terms the requirements of good dispensing we gave the second place in order, though not in importance, to the accurate division of the medicine into equal doses; in dispensing such powders as present no special difficulty such accurate division becomes the chief consideration, and, of course, includes the mixing of the ingredients into a perfectly homogeneous compound. A few simple rules must be observed to this end; thus, powdering and mixing simultaneously should never be attempted, but if a substance in crystals, granules, or coarse powder is to be mixed with a fine powder, it should itself be ground down to fine powder first, and the mixing then performed. If a very small

quantity of one substance is to be mixed with a much larger quantity of another, the latter should be added in small quantities at a time to the former, each addition being thoroughly mixed in before the next is made. Never try to mix two very unequal quantities of powder by putting the whole of each in a mortar and simply triturating together. In the following, for instance,

℞ Ac. Arsenios..... gr. i.
P. Sacch. Alb. ..... ʒi.
M. Div. in pulv. xx.

the wrong way is to put the whole of the two ingredients into a mortar and triturate, and a candidate who followed this method in the examination room would probably not remain there for long. The arsenious acid must be mixed with two or three grains of the sugar very thoroughly, then three or four grains more sugar added and thoroughly mixed in, and the remainder of the sugar added in gradually increasing quantities. Such a powder brings up the question of how the mixing is best done, whether in a mortar or on paper with a spatula; there is a great deal to be said for the latter method, and in some cases it is certainly the better, as when friction would have a deleterious effect on any of the ingredients. If carefully and thoroughly performed, mixing on paper is probably as good in almost every case as mixing in a mortar when only a few grains are to be dealt with. In the case given above it will be best to mix in the first quantities of sugar both by trituration and on paper, and the final quantities in a mortar only. With some powders the friction that may be obtained by use of pestle and mortar is not only disadvantageous, but dangerous; potassium chlorate, for instance, mixed with sugar or other organic and easily oxidisable substance, gives a mixture which may be caused to explode by the heat of friction.

It is often best to divide one ingredient and mix portions of it with others separately, finally mixing the powders so obtained. For instance, in the following:—

℞ Strychninæ..... gr. $\frac{1}{32}$
Elaterin ..... gr. $\frac{1}{24}$
Bism. Subnit..... gr. ii.
P. Cinnam. Co. ..... gr. x.
Ft. pulv. i. Mitte tales lx.

the method to be adopted will be:—Weigh out 2 grains of strychnine, powder finely; weigh out 62 grains of com-

pound cinnamon powder, and add it little by little to the strychnine. When the mixing is complete, weigh 60 grains of this mixture and set aside, rejecting the remaining 4 grains. Then weigh out $2\frac{1}{2}$ grains of elaterin and 60 grains of compound cinnamon powder, and mix these together in the same manner, and put aside. Then weigh out 120 grains of bismuth subnitrate and 482 grains of compound cinnamon powder, mixing about a third of the latter with the bismuth. Then mix the diluted strychnine with the diluted elaterin, add the diluted bismuth, and finally the remainder of the compound cinnamon powder.

When a perfectly homogeneous mixture has been produced its accurate sub-division is usually merely a matter of careful weighing. Very small quantities, however, may be divided quite as accurately by trusting to the eye, and the limitations of dispensing weights and of the accuracy of dispensing scales sometimes require this method to be adopted. For instance, in the above prescription, as written, each powder should weigh $12\frac{7}{96}$ grains; as dispensed, the total weight is $724\frac{1}{2}$ grains, giving $12\frac{3}{40}$ for each powder. The only plan here is to weigh out 12-grain powders and divide the small quantity that remains over as accurately as possible among all the powders.

Powders which React.

Certain solid substances when mixed in the solid condition slowly come into reaction or combination, producing a liquid. The commonest example is, perhaps, chloral and camphor, and there are several substances giving similar results among the higher alcohols and phenols, such as menthol, thymol, etc. Probably, however, the only substances which show this behaviour that are likely to be ordered as powders are antipyrine with a salicylate. Antipyrine and sodium salicylate, for instance, may be prescribed together as a powder through inadvertence; when mixed, however, they form a liquid containing antipyrine salicylate. In this case, if the dispenser can refer to the prescriber, he may suggest that an equivalent dose of antipyrine salicylate should be substituted; but if the prescriber is not accessible the only plan is to dispense the incompatibles separately, altering the directions so that the two powders shall be taken together by the patient. Apart from such cases,

however, reaction may occur between the ingredients of a powder if they are damp, as in the following:—

℞ Sod. Bicarb. ..... gr. xxii.
Acid. Tart. ..... gr. xx.
Ft. pulv. i. Mitte vi.

Reaction may then be avoided by using the ingredients in perfectly dry condition and wrapping each powder in waxed paper, with white paper outside; the latter precaution must also be taken with all powders that have a tendency to absorb moisture and become damp.

Powders with Mixtures.

When it is desired to give a mixture which shall be in a state of effervescence when taken by the patient, it is usual for one of the ingredients to be a bicarbonate, tartaric or citric acid being ordered in powders, one to be taken with each dose; in other cases, however, two mixtures, one acid and the other alkaline, are ordered, to be mixed at the time of taking. It is occasionally necessary to reverse the method and prescribe the bicarbonate in powders on account of some other ingredient, as in the following:—

℞ Liq. Strych. m40
Syr. Limon. ..... ʒiij.
Acid. Citric. ..... ʒij.
Aqua ..... ad ʒvj.
M pro dos. c. pulv. uno, in stat. eff. sumend.

℞ Sod. Bicarb. ..... gr. xxiv.
Ft. pulv. i. Mitte vj.

Both the Liquor Strychninæ and the syrup of lemon would react with the soda if it were in the mixture, strychnine being precipitated with possibly dangerous consequences.

Dusting Powders.

Dusting powders are, of course, not sub-divided into portions, but the amount ordered is dispensed in bulk. Essential oils in small quantity are not infrequently present, and these should be added to the most absorbent ingredient, or a small portion of it, and then further quantities of powder added until there is no longer an appearance of dampness. Liquid of any sort should never be added to the whole bulk of mixed powder. Dusting powders should be sifted finally, either through a fine-mesh metal sieve or through very fine muslin. A piece of muslin stretched across a chip box after removing the bottom makes a convenient sieve for small quan-

tities. It is a good plan to sift any powder in which the nature of the ingredients makes extra mixing desirable.

Insufflations and Snuffs.

These are for the most part prepared in the same way as other powders. Sometimes special methods may be necessary, as in the following:—

℞ Tr. Benzoin. Simp. ..... ℥j.
Acid. Boric ..... ℥j.
P. Amyli ..... ℥j.
Ft. pulv. pro insuff. ut dict.

The two powders are to be well mixed, the tincture added and stirred in, and the whole then exposed in a flat dish in a moderately warm place until the alcohol has evaporated.

Powders of this kind are usually dispensed in bulk, but are occasionally ordered to be divided into doses, one of which is to be applied with an insufflator.

CACHETS.

In order to facilitate taking by the patient, powders are often ordered to be dispensed in cachets. These are hollow receptacles, consisting chiefly of rice flour; when dry they are stiff and brittle, but by dipping in water they are rendered very soft, and one is then easily swallowed with a draught of water, and the contents are not set free in contact with the tongue, hence the powder is not tasted. Cachets are made in halves to allow of the powder being put in, and the method of filling is extremely simple. The mixing and weighing out of the powders are, of course, just the same as when they are to be wrapped in paper, but each powder is placed inside one of the half-cachets, the edges of the other half are damped with water or very thin mucilage, and the two halves pressed together. It is best to use the apparatus made for the purpose; in this the proper number of half-cachets are arranged in spaces provided for them in a metal plate, and the powders introduced by aid of a small funnel. The other halves are arranged in corresponding places in another plate of the apparatus, and their edges damped with a roller; the plate carrying these is then brought over the other, to which it is hinged, and by gentle pressure all the cachets are sealed simultaneously. Cachets are made in a variety of sizes, and the smallest size which will hold the powder ordered should

always be employed. A bulky material like quinine sulphate may be put into a much smaller space after it has been rubbed down in a mortar; this should always be done, whether it is to be put in a cachet or folded in paper.

CAPSULES.

It is an easy transition from cachets to capsules, which are sometimes used for administering powders; more frequently, however, cachets are employed for powders and capsules for liquids or soft semi-liquid substances. The object is the same in both cases—namely, to enclose the medicament in a receptacle which can be easily swallowed whole, and which will readily dissolve in the stomach and has not of itself any therapeutic activity. In the case of capsules, the principal material of which the receptacle is made is gelatin, though gum also enters largely into the composition of some. For dispensing purposes the soft gelatin capsule is employed, and the methods of making, filling, and sealing do not allow of great variety of practice. A very large proportion of the capsules now on the market are made in large quantities by machinery by other methods, but, as this is obviously not possible in dispensing, such methods will not be dealt with here.

Mass for Capsules.

The first step when capsules are to be made is to prepare the mass of which the envelope itself is to consist. Sufficient of this may be made to keep some always at hand, only requiring to be melted for use, like the mass for gelatin-coating pills. The following is a suitable formula:—

Gelatin	30 oz.
Water	50 oz.

Soak until the gelatin has absorbed the water, then add:—

Glycerin	15 oz.
Acacia Mucilage	7½ oz.

and heat on a water-bath, with gentle stirring, until the mixture is uniform throughout. For other suitable formulæ see the 'British Pharmaceutical Codex.'

The moulds on which the empty capsules are to be made are necessarily of the same shape, and very nearly of the same size, as the capsules will be; they consist of solid oval pieces of metal rounded at one end, but prolonged at the other into a thin stem an inch or more in length. A

number of these moulds are usually attached to a flat disc of wood with a handle, in much the same way as a number of pills stuck on needles are attached to one cork for gelatin coating. Before using, each mould is wiped with an oily cloth, leaving a very thin film of oil on its surface to prevent the gelatin mass sticking.

A sufficient quantity of the mass having been melted in a water-bath, which should be considerably below boiling temperature, the surface of the mixture, which is usually more or less frothy, is skimmed to one side, and the moulds are immersed in the gelatin mixture until the surface is a quarter-inch or rather less up the stems; they are then slowly withdrawn, excess of the molten mass being thus allowed to drain off, and at once inverted, and kept turned upwards until the mass on the moulds has set, which quickly occurs. As soon as they are thoroughly cooled each capsule can be slipped off its mould, the elastic nature of the material allowing the narrow neck to slip easily over the thicker part of the metal. The necks of the capsules are then trimmed almost away with scissors, and they are ready for filling. In making the capsules care and a little practice are necessary to get the walls of each uniformly thick in different places and the walls of one as thick as those of another. Shrinkage occurs as the capsules dry, and uneven thickness of the walls will lead to a finished capsule of bad shape, while if some have thicker walls than others their capacity will be different after a short time, even when made on exactly equal moulds.

Filling the Capsules.

If dry powders are to be placed in the capsules, which does not often happen, they are prepared and weighed out just as for papers or cachets. Each capsule in turn is attached to a small funnel, by inserting the stem of the latter for a short distance into the open end, and the powder is shaken in through the funnel. As a rule, however, the required medicament is a liquid, or a thin paste, and in such cases a sufficiency of it is put into the barrel of a glass or brass syringe, and the capsules in turn are slipped on to the nozzle and filled by pressure on the piston. It is best to support the syringe in a vertical position by a clamp stand. Care must be taken to not quite fill the capsules, but to leave a small empty space at the top, or proper sealing will be interfered with. When

a sufficient number has been filled, the sealing can be done by touching the mouth of each in turn with a hot glass rod dipped in the molten mass; the mass for this purpose should be a good deal hotter than for making the capsules. The hot rod just melts the edges of the material, and the small quantity of the gelatin mixture that is left behind by it makes a stopper which on cooling is continuous with the walls. A brush is sometimes used instead of a glass rod; this carries more of the molten mass, but does not melt the edges of the opening as well as the rod. It is obvious that capsules of this kind must not be used for aqueous liquids or any others that will cause the gelatin to swell or dissolve; oily liquids are best, and dry or nearly dry materials are usually made into a thin paste by mixing with a sufficient quantity of oil.

COMPRESSED TABLETS.

Although a considerable proportion of the tablets that are sold are manufactured in large quantities by steam-driven machinery, as is also the case with pills, the preparation of medicines in this form belongs legitimately to the province of dispensing, and in view of the frequency with which tablets are prescribed, no one should consider himself a competent dispenser if he has not learnt how to prepare them properly in small quantities. It may further be remarked in passing that the chemist who has a good hand tablet machine for dispensing purposes will usually find it pay him well to prepare all, or nearly all, the compressed tablets which he sells otherwise than in dispensing, and the additional practice in manipulation which is gained in making these larger quantities will lead to better results being obtained in making the small quantities ordered in prescriptions.

The tablet occupies in some respects an intermediate position between the powder and the pill. If, for instance, sulphonal is ordered in tablets, it is required that within a very short time after taking it the drug shall be in the same condition in the stomach as it would be if it had been swallowed in a cachet; the tablet form is employed in this case chiefly because of its compactness and portability, and partly perhaps because some patients may prefer taking a tablet to taking a cachet or a powder. The tablet here approximates very closely to a form of powder, and the principal requirement is that it shall

become a powder very readily. In other cases tablets are ordered containing extracts, etc., such as are usually made into pills, and the chief difference between such tablets and pills is that of shape, though it is sometimes also possible to ensure more rapid dissolution in the stomach when some formulæ are made into tablets instead of pills. Other tablets, again, are strictly lozenges, and hardness and slow solubility are the qualities chiefly to be aimed at. In addition to the special requirements in these different cases, perfect uniformity of the material, the greatest possible uniformity in the weight of the individual tablets, and the best possible appearance and "finish," are, of course, always to be aimed at.

The Tablet Machine.

There is far more divergence in the patterns of tablet machines for dispensing than is to be found among pill machines; they agree, however, in the essential parts, which are as follows:—(1) An upper and lower punch, usually of steel, between which the material is compressed into a tablet; (2) an eye, or small cylinder of steel bored with a hole of just large enough diameter for the punches to move freely in it; this cylinder is the measure in which the exact amount of material for one tablet is measured, and is also the chamber in which the actual compression takes place; (3) a feeder, consisting of a hopper in which the material is placed, and by which it is supplied to the eye; by a simple arrangement the foot of the hopper is usually made to push aside the tablet made at the previous stroke, before giving a fresh supply of material for the next. The force of the stroke in a hand machine is sometimes given directly by forcing down a lever, in others indirectly by giving another lever a to-and-fro motion; the latter plan is better calculated to secure uniformity of pressure, and therefore of hardness in the products.

With a little practice, regularity in working the machine is easily attained, and most of the skill in tablet-making is required in preparing the material for compression; most of the differences between good and bad tablets are due to differences in the preparation before compressing. We will first consider the requirements which are common to all materials, before discussing special difficulties.

Condition of the Material.

The machine is adjusted for producing tablets of different weights by the use of eyes (and punches) of different diameters, and also by raising or lowering the lower punch in the eye, until the latter, when filled to the top by the feeder, holds exactly the weight of material required in one tablet. These adjustments having been made, the weights of the individual tablets in a batch will depend on the particles of the material in the hopper being uniform in size, and in such a condition that they will run *easily* through the opening in the foot of the hopper. Fine powders will not run easily, and must not be used; a granular powder, the particles of which will just about pass a No. 20 brass sieve, is usually the best. If there is much finer powder with the granules it will sift to the bottom of the hopper with the vibration, and since it will lie closer than the coarser granules, the tablets produced at first will weigh considerably more than those which follow. If, on the other hand, the granules are too coarse, the quantity that fills the eye will vary from time to time, and some of the tablets will be too light.

Preparation of the Granules.

In the simplest cases all that is necessary for producing satisfactory granules is to coarsely powder the material. Potassium bromides may be taken as an example of the substances that can be dealt with in this way: the salt is rubbed down in a mortar and shaken through a sieve of No. 20 mesh; the coarser pieces which do not pass the sieve are again rubbed down; the whole should be transferred to the sieve at short intervals, so that the particles which are small enough to pass shall not be crushed still smaller. It is inevitable, however, that some finer powder should be produced, and when all the salt has passed the No. 20 sieve it must be put into a rather finer one, about No. 30 being best, and all that will pass this finer sieve is rejected. (This can, of course, be used for other dispensing purposes.) The remainder will now be in very nearly uniform particles; if not perfectly dry, as is probable (owing to traces of moisture being enclosed in the original large crystals), it should be dried for a short time, and is then ready for compressing without further addition or treatment: the granules will run easily, and the amount that fills the eye

each time will be practically constant. Many soluble salts, though not all, can be prepared in a similar way.

When dealing with a soluble substance it is not usually necessary to add anything to assist in disintegrating it, and it is undesirable to add anything which will prevent it forming a bright solution. But many of the substances most frequently ordered in tablets, such as phenacetin, sulphonal, etc., are not soluble in aqueous liquids, and if compressed alone would form tablets that would only be very slowly absorbed after swallowing; it is therefore necessary to add something which will assist the disintegration of the tablets, and such a material is found in starch. Potato starch (known commercially as farina) and arrowroot starch are more efficient than other kinds, and one of these should always be employed. The amount that is necessary varies somewhat in different cases, and is usually from 5 to 10 per cent.; if any addition is to be made, it is best to add enough to really ensure the object in view, and half a grain of starch in a five-grain tablet, or even one grain if necessary, cannot be objected to. Phenacetin and similar materials must be finely powdered first, and the starch then added; the powder must then be moistened, and various liquids are suitable for this purpose in different cases, the principal being water, spirit, or very weak solutions of sugar, gum, or dextrin. Many substances can be granulated quite well with plain water or spirit, and when an adhesive substance like dextrin is required, the smallest possible quantity should be used. All that is required is to prevent the granules falling to powder after drying, when transferred from vessel to vessel or subjected to the vibration of the hopper of the machine. Having damped the powder with sufficient of the liquid which experience has shown to be best to give it a clinging character, it is gently passed through a No. 20 sieve, when it will come through in the form of small moist granules; it is then spread out in a thin layer to dry, in a fairly warm place. When dry, it may with advantage be passed through a No. 20 sieve again, to break down any aggregations into larger masses. In order that it may run easily, a lubricant must now be added. Finely powdered French chalk (talc) is most frequently employed, and from 1 to 3 per cent. is usually required; this is scattered over the granules in a thin layer, and the whole then gently

shaken in a dry bottle or other vessel. The material is then ready for compression.

Other lubricants besides French chalk may be used for the granules; if the material of the tablets is soluble in water, it is not desirable to add an insoluble substance, and boric acid can then generally be employed in place of talc. Pure liquid paraffin can also be used, this being sprayed on to the granules with a fine spray; in other cases a solution of white soft paraffin in ether is preferred, the granules being then exposed to the air after spraying until all the ether has evaporated. Oil of theobroma is also very useful, and a convenient method involving its use has been devised, by which the lubricating and granulating are done in one operation. An emulsion of oil of theobroma is prepared by aid of soap and a little tragacanth (or acacia and tragacanth for cases where soap would be objectionable), and the powder for compression is moistened with this emulsion and passed through a No. 20 sieve; granules are formed by so doing, and these are dried by exposure to the air, after which they are ready for compression without further lubrication. When the material to be compressed is of such a nature that it would become unduly sticky when moistened with a watery liquid, a solution of oil of theobroma in ether and alcohol may be used in place of the emulsion; this has the further advantage that the granules dry more rapidly, and it is on that account more suitable in dispensing. In making larger quantities of tablets the emulsion is, of course, preferable in those cases where it is admissible, on account of its lower cost. Further details of the use of oil of theobroma in tablet making are given in a paper by Messrs. White and Rodwell in *The Pharmaceutical Journal*, of August, 1903.

We have referred to the fact that many formulæ which are prescribed in the form of tablets could equally well be dispensed as pills; in these cases rapid disintegration of the tablet is not, as a rule, required, but it would be a great mistake to suppose that a pill-mass should be prepared, and then dried and compressed. In making a pill-mass, a considerable degree of cohesion is required to permit of rolling, cutting, rounding, etc., and this has to be attained by the use of a fair amount of moisture with some sticky substance, such as an extract. But the pressure exerted in making a tablet is so great that an apparently perfectly dry powder, if it

contains an extract, is at once made perfectly coherent; in preparing the material for compression, therefore, only the least possible amount of moisture is to be added. Extracts should be dried and powdered, either alone or with some drying powder; all the ingredients should be finely powdered and mixed, then just moistened with a suitable liquid, and granulated, and the granules dried, lubricated, and compressed as already described.

In the following example:—

℞ Aloin ..... gr. xx.
Strychnin. ..... gr. iss.
Ext. Bellad. ..... gr. xij.
Excip. *q.s.* ..... ad gr. C.
M. Ft. pil. vel tablett. 100.

if pills are to be made, the 66½ grains of excipient would be about 30 grains of powdered liquorice, and the remainder confection of roses or some other binding material. But if tablets are desired, the whole 66½ grains should be milk sugar; after thorough mixing enough water is added to make the powder just moist, when it is passed through a sieve, forming granules which are dried and lubricated, and are then ready for the machine.

Like any other branch of dispensing, tablet-making is an art, in which proficiency can only be attained by practice. Before leaving the subject, however, two general rules may be mentioned, due observance of which will go far to enable even the beginner to turn out tablets with a proper finish. These are:—

(1) Do not compress granules that are not properly dried; slightly moist granules are prone to stick to the punches, and do not feed well.

(2) Remember that it is impossible to turn out tablets with a good finish if the surfaces of the punches are at all rough; it is not only necessary to clean and dry them thoroughly after each using, but they should be well polished with the finest emery at short intervals.

PASTILLES.

It is sometimes required to administer certain medicines in such a way that their action shall be exerted locally on the throat. This can of course be done in some cases by making them into a gargle, but the method more frequently adopted is to employ a lozenge

or similar combination that can be slowly dissolved in the mouth. The production of ordinary lozenges is not a dispensing operation, and will not be described here; but there are two methods by which what is practically a lozenge can be prepared, which are not infrequently required at the dispensing counter. The first is the production of compressed tablets which are to be slowly dissolved in the mouth; these are prepared by the processes we have been describing, no disintegrating material being added, and the tablet being compressed as hard as possible; dies of rather large diameter are usually required for such tablets. The second method is to prepare a sort of jujube, or pastille, in which the required medicament is combined with a slowly soluble basis; this method is easily carried out, and can be employed for drugs that are not well suited for making into tablets. The basis of pastilles is a stiff mass of gelatin with glycerin, which is commonly known as glyco-gelatin. An excellent formula for this will be found in the 'British Pharmaceutical Codex,' but the following simpler formula is from the Pharmacopœia of the Throat Hospital:—

Gelatin	1 oz.
Glycerin	2½ oz.
Solution of Carmine, Ammoniated,	a sufficiency.
Orange-flower Water	2½ fl. oz.

Soak the gelatin in the water for two hours, then dissolve on a water-bath, add the glycerin and mix, and add the colouring when partly cooled. Other flavouring agents may of course be used. When required in dispensing, the proper quantity of this mass is weighed out and melted by the heat of a water-bath and the medicament incorporated with it. If the latter is a soluble substance, as, for instance, cocaine hydrochloride, it can be dissolved in the basis and evenly distributed by stirring. If it is not soluble, it can be rubbed to a smooth mixture with a little glycerin or water and stirred in. The mass is then poured out into a suitable tray, which may usually be extemporised from the lid of a tin, if necessary, and allowed to set. When cold, it is taken out and cut into the correct number of equal portions with scissors; or separate moulds may be used, and each pastille cast separately, in which case care must be taken to fill all the moulds equally, or the products will contain variable doses of the drug.

CONFECTIONS.

Closely allied to pastilles are confections or electuaries, and mention may conveniently be made of them here. No gelatin is employed in making them, consequently the mixture does not set to a solid, but remains in the condition of a paste, which is supplied to the patient in bulk, and the division into doses is made by the latter taking out with a teaspoon or other rough measure the quantity ordered. Of the official representatives of this class of preparations confections of senna and roses are best prepared on the manufacturing scale; the latter of these has no medicinal properties, but is employed as a vehicle or excipient. The other two pharmacopœial confections, those of pepper and sulphur, are fairly representative of the preparations of this kind which are made at the dispensing counter, and the absence of any special difficulty in their production is sufficiently indicated by the laconic nature of the directions, which consist of the one word "mix." It is of course important that only fine powders should be employed, and these should be well mixed together before adding the liquid ingredients, the whole being then well triturated together.

PASTES AND JELLIES.

Very similar, from the point of view of production, are the external applications known as pastes and jellies, which have been introduced principally by the dermatologist Dr. Unna. The following represent the two classes:—

PASTE OF IODINE AND STARCH.

Starch, in powder	1 oz.
Glycerin	2 fl. oz.
Distilled Water	6 fl. oz.
Solution of Iodine (B. P., 1885)	1 fl. oz.

Rub down the starch with the glycerin and water, and boil the mixture; when nearly cold, add the iodine solution and mix well.

ZINC JELLY.

Gelatin	1 oz.
Water	2½ oz.
Zinc Oxide	1 oz.
Glycerin	2½ fl. oz.

Soak the gelatin in the water; mix the zinc oxide and glycerin and add to the gelatin, then heat on a water-

bath till the latter is dissolved and the mixture is homogeneous.

Although properly described as a jelly, this preparation is generally known as Unna's paste. The 'British Pharmaceutical Codex' should be consulted for further examples.

OINTMENTS.

The pastes and jellies last dealt with are of comparatively recent introduction, for the purpose of applying medicaments externally without the use of a greasy basis. When a basis of a fatty or oily nature is employed, the resulting compound (if solid or semi-solid) is an ointment, and the use of ointments is of far greater antiquity and is still very frequent. Although in the case of any external application no question of uniform division into doses can arise, it is not less important that the active ingredient or ingredients should be uniformly distributed throughout the whole; it is also of importance that the medicament shall be presented in an unaltered condition, any undesirable chemical decomposition being guarded against with as much care as in making a mixture for internal use. Since, however, the basis of an ointment is not nearly so favourable a vehicle for chemical reaction as a liquid in which two substances are dissolved, there is much less likelihood of incompatible substances being brought into reaction, and ointments do not, therefore, present many difficulties due to the occurrence of chemical changes. Ointments may be divided broadly into two groups—viz., those in which the active ingredient is merely mixed with the basis and those in which it dissolves in it; the former of these groups may be subdivided into those in which the active ingredient is a solid and those in which it is a liquid. All these three kinds of ointment are well represented in the British Pharmacopœia, and we will deal with them in order.

Ointments with Solid Active Ingredients, not Soluble in the Basis.

The first and invariable requirement when a solid is to be mixed with a fatty basis is that it should be powdered as finely as possible; this is not only with a view to its even distribution, but also to avoid the irritation that would be caused by applying an ointment in which solid particles of an appreciable size were present. The

official gall ointment, lead acetate ointment, and several others belong to this class. Such ointments may either be made in a mortar with a pestle, or on a slab of marble or glazed earthenware by working the ingredients together with a spatula; for quite small quantities the latter is, perhaps, the better method, and is usually employed; for amounts exceeding an ounce or so the mortar and pestle are preferable. If a substance is not easy to powder finely, and is, on the other hand, readily soluble in an inert liquid, it is best to dissolve it in a small quantity of the latter and then mix the solution with the fat; this is the method followed in the official potassium iodide ointment. In dispensing an unofficial ointment containing a solid, the dispenser must judge from the nature of the substance whether it is better to dissolve it or not. A volatile solvent that might evaporate and leave the substance in crystals must obviously not be employed.

Some solids which are ordered in ointments cannot well be powdered finely, such as extracts; in order to secure thorough mixing and uniformity in such a case the solid is dissolved in or mixed with a small quantity of liquid. Thus an aqueous extract should be rubbed quite smooth with enough water to make it a rather thick liquid; for an alcoholic extract a little rectified spirit is similarly used, and the liquid produced is then mixed with the basis. This is practically the method employed in the official belladonna ointment (and, with slight differences, in hemlock and hamamelis ointments), where the liquid extract is evaporated to a small bulk and mixed with the basis, instead of using the solid extract.

Ointments with Liquid Active Ingredients, not Soluble in the Basis.

When the active ingredient is a liquid, or is ordered in solution, the preparation of the ointment is usually very simple, and is best performed with a spatula on a slab. The official lead subacetate ointment is an example of this kind. The various bases used for ointments differ greatly in their capacity for taking up water and other liquids to form a homogeneous ointment, lanoline excelling all other bases in this respect. It occasionally happens that a prescriber orders a larger quantity of a liquid in an ointment than the prescribed basis will take up, and in such cases the difficulty can often be got over

by employing a small quantity of lanoline (the anhydrous being usually the best) in place of an equal weight of the lard, soft paraffin, or whatever the basis in the prescription may be; but any such alteration should only be made if absolutely necessary, and it is always best to get the prescriber's sanction if possible.

Ointments with Active Ingredient Soluble in the Basis.

In some cases, of which chrysarobin ointment is an example, the medicament ordered is soluble in the basis; in order to obtain complete dissolution and also uniformity, it is usually necessary to melt the basis, and a risk then arises that an ingredient may be soluble in the hot molten fat, but may crystallise out more or less completely on cooling. Thus, if a considerably larger proportion of chrysarobin is ordered than in the official ointment, it may still be dissolved in the hot lard, but on cooling part of it will slowly crystallise out; the ointment is then not homogeneous, and the crystals are apt to be very irritating when the ointment is used. When there is any likelihood of this occurring it is best to powder the substance finely and mix it with the basis without melting; or, if the dispenser knows how much will remain dissolved when the ointment is cold, he may dissolve this amount in the basis with the aid of heat, and after the ointment so produced has thoroughly cooled incorporate with it the remainder of the medicament in the state of fine powder. Glycerin is often a very useful ingredient both for assisting in rubbing a substance to a smooth powder, for dissolving it, and for preventing crystallisation; it is used for one or more of these purposes in the official ointments of carbolic acid, iodine, and iodide of sulphur, and it is a very suitable solvent for mercuric chloride when this is required in the form of an ointment.

Alkaloids are generally more soluble in a fatty basis than their salts; if an alkaloidal salt is ordered in an ointment it is best to dissolve it in a very small quantity of water. In the official alkaloidal ointments (aconitine, atropine, cocaine, and veratrine) the alkaloid is first dissolved in oleic acid, forming the oleate, and this solution is then mixed with lard; but although this is an excellent method, the addition of oleic acid to dissolve an alkaloid, when not ordered by the prescriber, is scarcely permissible.

General Precautions.

When heat is required in the preparation of any ointment it is a safe rule to never heat more than is actually necessary; a water-bath should always be employed and not the direct heat of a flame. An exception must be made in the case of nitrate of mercury ointment, in preparing which a sand-bath is ordered to be used and a temperature of 290° F. is required; but this operation belongs rather to manufacturing pharmacy than to dispensing.

During cooling more or less separation of the ingredients of an ointment that has been made by aid of heat may occur, and to obviate this it is usually necessary to stir constantly during the cooling, as in the preparation of spermaceti and paraffin ointments.

The spatula used in ointment-making should usually be of bone, horn, or vulcanite; a flexible steel spatula is more convenient in some cases, but should never be employed when there is a possibility of the iron being acted on by one of the ingredients. Vegetable extracts very frequently contain tannin and a small amount of some organic acid, and such extracts are darkened to a greater or less degree if manipulated with a steel spatula. If no moisture is present this action does not occur, and an ointment containing tannic acid itself is not darkened by a steel spatula if all the ingredients are free from moisture, but it is better to be on the safe side and use a spatula of some other material. Salicylic acid is even more readily discoloured by iron than tannin, and when it, or a salicylate, is an ingredient of an ointment steel must be avoided. Salts of mercury are attacked by iron with the liberation of metallic mercury if a vehicle is present which permits them to come into reaction; with a dry fatty basis no change occurs.

SUPPOSITORIES.

Under the head of suppositories we may also include pessaries and bougies, whether urethral or nasal, since all these only differ in size and shape; only suppositories are official. For these forms of administering medicines the requirements are, first, the uniform distribution of the active ingredients throughout the mass; second, sufficiently accurate division into doses; and, third, the use of a vehicle which shall give sufficient hardness to

permit of the suppository, etc., being easily introduced, but which shall liquefy wholly or in great part at the temperature of the body. The case is thus very similar to that of pills, but instead of using a small quantity of an excipient which will dissolve in the fluid of the stomach or intestine, we must here employ a larger quantity of some material which will liquefy and so set free the medicament when in contact with the mucous membrane of the rectum, vagina, urethra, or nose, as the case may be, and without itself causing irritation.

The Moulds.

The method which is commonly employed in making suppositories is that of casting—that is, putting the material when in a molten state into moulds in which it solidifies. On removing the products from the moulds they should require little or no further treatment, and the appearance of the finished suppositories is considerably affected by the condition of the moulds. The usual shape for suppositories and pessaries is that of a blunt cone with flat base, although for the former a good deal of favour is now shown for a shape which tapers in both directions; this has the advantage that as soon as the widest part of the suppository has passed the sphincter the pressure of the latter ensures it being carried well up into the rectum. For urethral bougies the shape is that of a cylinder of even diameter or tapering very slightly to near one end and then more rapidly to a blunt point; while for nasal bougies the shape is intermediate between those of the urethral bougie and the suppository. Suppositories and bougies are usually made to occupy a volume of about one mil, and pessaries from four to eight mils. For the ordinary sizes gun metal moulds for six or twelve are usually employed; the mould is made in two pieces held together by a screw and separated when the material has solidified thoroughly, in order to remove the suppositories, etc., that have been cast. The two parts of the mould are usually made to separate in the plane containing the long axis of the suppositories; but sometimes in a plane at right angles to this, cutting the suppositories transversely near the small end. The former pattern is to be preferred, chiefly for the reason that it lends itself better to thorough cleaning of the mould after use. If the

interior surface of the moulds is rough the probability of the suppositories sticking and being broken in removing is considerable, even when a lubricant is employed on the mould before filling; but if the surface is perfectly smooth the suppositories can usually be easily taken out without any lubricant being necessary. The moulds are best when silver-plated, the plating being renewed as often as necessary; a very superior appearance of the suppositories is thus obtained.

In many cases suppositories are better made by what is known as the cold process—that is, instead of being melted and poured into the moulds the material is introduced in the form of a coarse powder or a somewhat plastic mass, which is then forced to take the shape of the mould and to cohere by the application of pressure. For this method the moulds are usually arranged so that each in turn can be brought under a tube of the same diameter as the base of the required suppositories, in which fits a plunger or piston for the application of the necessary pressure.

Extempore Moulds.

In smaller pharmacies, where suppositories and similar preparations are not dispensed with sufficient frequency to warrant a complete set of moulds of all sizes being kept, it may easily happen that a suppository or bougie is required of a size for which no mould is at hand, and it is desirable in such a case to be able to extemporise one. Serviceable moulds may be made as follows:—Soften the end of a stick of sealing-wax and model it with the fingers to the shape required, or trim a piece of wood with a pen knife until it has the requisite tapering sides and rounded point, finally smoothing it well with fine emery paper. Then make a rather stiff mixture of linseed meal and water and put it into a tray or box of greater depth than the height of the suppositories to be made; carefully wrap tinfoil round the model of sealing-wax or wood, creasing it as little as possible; push it down into the linseed mixture and withdraw the stick, leaving the tinfoil surrounded by the firm linseed. As many moulds as are necessary may be made in this way and the molten mixture poured into them. Suppositories so prepared may require the surface to be finally smoothed after taking out of the tinfoil, and this can be done with a cloth.

Bougies may be moulded conveniently in pieces of glass tubing. One end of the tubing is dipped in the melted material, and suction applied to a piece of rubber tubing attached at the other end. When the tube is filled to a sufficient height the india-rubber tube is pinched, and the glass tube then transferred to ice-cold water until the contents have set firmly. This is repeated with other tubes until the requisite number have been filled. The cylinders of material are then pushed out of the tubes with a piece of glass rod of the right size to just slide in the tube, and, if too long, cut down to the correct size; one end of each is then moulded with the fingers to a rounded point.

The Basis, or Vehicle.

In the large majority of suppositories, pessaries, and bougies oil of theobroma (cacao butter) is employed as the basis; it is used in all the official suppositories except that of glycerin. This fat has the great advantage that it is quite firm and hard at the ordinary temperatures, but melts entirely some degrees below the normal temperature of the body; it is also much less prone to rancidity than most other fats. When the nature of the medicament is such that the melting-point of the mixture is lowered to an inconvenient extent, or in very hot weather a little white wax may be added; from one to three grains of wax for each fifteen-grain suppository can be used without unduly raising the melting point. On the other hand, when the other ingredient or ingredients are such that the melting-point of the mixture would be too high, more or less of lard may be added in place of part of the cacao butter.

Various other materials have been proposed for general use as a basis, the chief being coco-nut stearin and a mixture of stearic and oleic acids; they do not, however, possess any advantage over cacao butter, and they have not been adopted to any considerable extent. For certain medicaments a non-fatty basis is best, and a jelly composed of glycerin and gelatin is then employed. Glycerin itself is often required in the form of a suppository for the relief of constipation. It may be made into a stiff jelly with gelatin, as in the official formula for glycerin suppositories, which contains 70 per cent. of glycerin, or a mass may be made by aid of sodium stearate, as in

the U.S. Pharmacopœia, when as much as 95 per cent. of glycerin in the suppository can be attained. Glycerin suppositories made with sodium stearate are very hygroscopic, and each should be wrapped separately in tinfoil or waxed paper; this precaution is less necessary for those made with gelatin. When a jelly is required merely to act as the basis for a medicament, and the local therapeutic effect of the glycerin is not required, it should be made with a much smaller proportion of glycerin than the official suppository. The following is a suitable composition:—

Gelatin	10 parts
Water	40 parts
Soak, then dissolve with the aid of heat; add	
Glycerin	15 parts

and evaporate on a water-bath until all the water is driven off—that is, until the whole weighs 25 parts.

Substances soluble in water, if ordered in quantities that cannot be made into a homogeneous mixture with cacao butter, can be dissolved and mixed with the melted gelatin base. The proportions of gelatin and glycerin can be varied according to the purpose for which the mass is required, and in some cases it is best not to evaporate off the whole of the water, thus obtaining a softer mass.

Before a mould is actually employed for making medicated suppositories, its true capacity should be ascertained by making a batch of plain cacao butter suppositories in it, and then weighing them; if each space holds a little more than the fifteen grains ordered in the Pharmacopœia it is of no consequence, provided that proper allowance is always made for the capacity of the moulds in weighing out the cacao butter to be used in any given case. The exact quantity to be taken will, of course, depend on the amount of medicament; if this amounts to one grain or less, an equal weight of cacao butter may be deducted from the total capacity of the mould; but if larger quantities of medicament are to be employed, regard must be had to the fact that this may displace more or less than its own weight of cacao butter, according to its density. Experience will soon teach a dispenser what allowance to make for each of the drugs ordinarily prescribed in this form. In case of any uncertainty, the best plan is to weigh out the amount of the drug for one suppository, mix it with three or four grains of melted cacao butter, and put the whole into a mould

and then fill up with more of the melted fat. When cold, this trial suppository is taken out and weighed, and the correct amount of cacao butter to be employed for the batch is then readily ascertained.

Lubrication of the Mould.

If the surfaces of the mould are in very good condition, lubrication of the mould is often unnecessary; in many cases, however, it is best to apply a mixture of soap liniment one part, glycerin three parts, with a camel-hair brush, then turning the mould upside down until the mass is quite ready to pour in, so that as much as possible of the lubricant shall drain out. If, however, the gelatin base is to be employed, the best lubricant is oil, of which a minute quantity is applied by wiping out the mould with the slightly oiled corner of a cloth. Before filling, the mould should be fairly but not extremely cold.

Preparation of the Mass.

The quantity of each ingredient to be taken should be enough for one more than the required number of suppositories; this allows for the small quantity that always remains in the dish, and for the trimming of the bases of the suppositories. Melt the cacao butter in a small dish on a water-bath, not allowing its temperature to rise much above melting-point; finely powder any dry ingredient, and rub an extract with sufficient water or alcohol (according as it is an aqueous or alcoholic extract) to make it thin and smooth. Mix a small quantity of the melted fat with the other ingredient or ingredients on a slab (warmed if necessary) with a spatula until smooth and homogeneous; then transfer this mixture to the dish containing the rest of the fat, stir until thoroughly mixed, and pour into moulds; the whole mass should be only warm enough to be just fluid when poured. Each mould must be slightly overfilled to allow for the contraction that occurs in the cooling and setting. When the suppositories have just set, put the mould on ice and leave it there for some time, until they are quite hard. It is best not to put it on ice until the mass has solidified, or it contracts and sets so quickly that a small cavity may form down the middle of each suppository, too small to be filled by pouring in more of the mass. After cooling, scrape off with a knife all the mass which projects

above the level of the edges of the moulds; on then unscrewing, the suppositories should be readily detached, and if the operation has been properly performed, they require nothing further, but are ready to be boxed and sent out. If too much lubricant was left on the moulds, wipe the surface of the suppositories gently with a cloth. In cases where the medicament is soluble in the melted base, it may, of course, be added directly to the latter in the dish. When the gelatin base is used, the drug is generally one that is soluble in water, and it is then dissolved in the smallest quantity possible of the latter, and the solution added to the melted base in the dish. Heating is then continued further or not, according as a stiffer or a softer suppository is required.

Moulding in the Cold.

Not infrequently some drug is ordered in suppositories with a fatty base, of such a nature that it rapidly separates from the melted fat on standing. In such a case, even if the mixture were kept homogeneous by constant stirring while filling the moulds, separation would occur in the latter during cooling, and streaky or mottled products would result. To avoid this, the mixture is allowed to set in the dish, stirring all the time; a homogeneous mass is thus obtained, which requires to be divided and moulded without re-melting. This can sometimes be done by shredding or coarsely powdering, then filling the coarse powder into the moulds and ramming it down with a plunger until it coheres and the moulds are full. Other masses are more plastic, and can be rolled out like a pill-mass and weighed out into portions of the right size, each of these being then moulded by manipulation with the fingers or by forcing it into the metal mould.

The difficulties to be encountered in suppository making, after a proper degree of manipulative skill has been attained, mostly arise from immiscibility of the medicament and the base; by suitable modification of the latter they can usually be overcome. It must be borne in mind that it is important that the base should not be irritating, and that it must melt below the normal body temperature, but must be firm enough to permit of convenient introduction of the suppository; subject to its fulfilling these requirements, however, it may be varied

as required. A little hydrous wool fat will often permit of the incorporation of ingredients that would not mix with the cacao butter, and if the mass is made too soft by its addition a small proportion of wax will probably put it right again. If no such modification of the base will give a satisfactory result a presentable suppository may often be made as follows:—Fill the moulds with plain melted cacao butter; when the outer portion of each suppository, in contact with the mould, has become solid, invert the latter, and thus empty out the still fluid middle portion of each; in this way hollow cones are obtained, and the setting of the fat must be allowed to proceed far enough to give walls of proper thickness. The required dose of medicament can now be introduced into each, either alone or after mixing with some suitable vehicle; each cone is then filled up with melted cacao butter, and the suppositories finished off as usual. Liquids can be administered in this way.

Suppositories, bougies, etc., should be sent out in boxes If a volatile or hygroscopic ingredient is present each one should be wrapped separately in tinfoil or waxed paper.

PLASTERS AND BLISTERS.

The spreading of plasters is not very frequently required at the dispensing counter now, the plaster as a means of applying drugs externally having been largely displaced by other and more elegant methods; the plasters that are wanted, too, are most frequently cut from a large piece which has been spread by machinery. But since many plaster masses are official and are occasionally required to be spread by the dispenser (in the examination room and elsewhere) the competent pharmacist must be prepared to deal with them. The material usually employed as the support for the layer of plaster mass is a rather thin white leather, usually known as plaster skin; this usually requires to be smoothed by pressing it with a hot iron before the plaster is spread on it. A "shape" for the plaster is cut out of paper by marking with a pencil the exact size and shape that is to be occupied by the medicated surface, folding the paper and cutting this out with scissors; a second cut outside the first and distant by about an inch leaves a strip of paper about an inch wide, surrounding a space

of the required dimensions. This strip of paper, or "shape," is next soaked in water for a few minutes, then spread out evenly on the skin and pressed down with a cloth, when it will adhere lightly; the plaster mass can now be spread on the area of skin so surrounded, overlapping slightly on to the paper; on subsequently removing the latter a clean edge is left. The amount of plaster mass to be spread is cut from the roll, allowing about 15 grains to the square inch; the plaster spatula is heated in a bunsen flame, taking care that it does not become hot enough to burn the material, and the plaster mass is melted by means of the hot spatula on a small piece of brown paper. When it is thin enough in consistency it is quickly transferred to the skin and spread evenly over the latter by a few firm strokes; it is best to move the spatula from left to right only, turning the skin round if it is necessary to move any of the mass the other way. The evenness with which the plaster is spread depends principally on keeping an even pressure on the spatula; no description can take the place of actual practice in imparting skill in this manipulation. When the spread mass has set, but before it is quite cold, the paper shape is torn through and gently pulled off; the skin is then cut, so as to leave a margin of half or three-quarters of an inch round the actual plaster.

Blisters are made by spreading the official cantharides plaster, not on skin, but on ordinary adhesive plaster; in this case no heat is employed. A paper shape is cut as described above, but instead of merely wetting it, it is soaped on one side and pressed down on the plaster. A sufficiency of the cantharides plaster is then softened in the hand and spread evenly with the thumb, moving the latter from left to right. The surface may be subsequently finished off by lightly passing a warm spatula over it. The shape is removed and the blister cut out, leaving a sufficient margin of adhesive plaster.

DOSES OF OFFICIAL MEDICAMENTS.

Imperial and Metric.

THE following table shows the doses, in imperial weights and measures, and approximate metric doses, of chemicals, drugs, and galenical preparations official in the British Pharmacopœia, 1898, and the Indian and Colonial Addendum, 1900, the names of the latter being marked with an asterisk (*). Abbreviations used: gr. = grain; min. = minim; fl. dr. = fluid drachm; oz. = ounce; fl. oz. = fluid ounce; Gm. = gramme; Dgm. = decigram; Cgm. = centigram; Mgm. = milligram; Mil = millilitre (cubic centimetre); Dml. = decimil; R.A. = for repeated administration; S.A. = for a single administration; V.F.R. = very frequently repeated.

NOTE.—Half a decimil equals one drop from a pipette made to deliver twenty drops to one gramme of distilled water.

Name.	Official Dose.	Metric Dose.
Acetanilidum	1 to 3 gr.	½ to 2 Dgm.
Acetum Ipecacuanhæ	10 to 30 min.	½ to 2 Mils.
Acetum Scillæ	10 to 30 min.	½ to 2 Mils.
*Acetum Urgineæ	10 to 30 min.	½ to 2 Mils.
Acidum Aceticum Dilutum	½ to 2 fl. dr.	2 to 8 Mils.
Acidum Arseniosum	$\frac{1}{60}$ to $\frac{1}{15}$ gr.	1 to 4 Mgm.
Acidum Benzoicum	5 to 15 gr.	3 to 10 Dgm.
Acidum Boricum	5 to 15 gr.	3 to 10 Dgm.
Acidum Carbolicum	1 to 3 gr.	½ to 2 Dgm.
Acidum Carbolicum Liquefactum	1 to 3 min.	½ to 2 Dml.
Acidum Citricum	5 to 20 gr.	3 to 12 Dgm.
Acidum Gallicum	5 to 15 gr.	3 to 10 Dgm.
Acidum Hydrobromicum Dilutum	15 to 60 min.	1 to 4 Mils.
Acidum Hydrochloricum Dilutum	5 to 20 min.	3 to 12 Dml.
Acidum Hydrocyanicum Dilutum	2 to 6 min.	1 to 4 Dml.
Acidum Nitricum Dilutum	5 to 20 min.	3 to 12 Dml.
Acidum Nitro-hydrochloricum Dilutum	5 to 20 min.	3 to 12 Dml.
Acidum Phosphoricum Dilutum	5 to 20 min.	3 to 12 Dml.
Acidum Salicylicum	5 to 20 gr.	3 to 12 Dgm.
Acidum Sulphuricum Aromaticum	5 to 20 min.	3 to 12 Dml.
Acidum Sulphuricum Dilutum	5 to 20 min.	3 to 12 Dml.
Acidum Sulphurosum	½ to 1 fl. dr.	2 to 4 Mils.
Acidum Tannicum	2 to 5 gr.	1 to 3 Dgm.
Acidum Tartaricum	5 to 20 gr.	3 to 12 Dgm.
Æther	10 to 30 min. (R.A.)	6 to 20 Dml.
	40 to 60 min. (S.A.)	25 to 40 Dml.
Æther Aceticus	20 to 40 min. (R.A.)	12 to 25 Dml.
	60 to 90 min. (S.A.)	4 to 6 Mils.
Aloe Barbadensis	2 to 5 gr.	1 to 3 Dgm.
Aloe Socotrina	2 to 5 gr.	1 to 3 Dgm.
Aloinum	½ to 2 gr.	3 to 12 Cgm.
Alumen	5 to 10 gr.	3 to 6 Dgm.
Ammoniacum	5 to 15 gr.	3 to 10 Dgm.
Ammonii Benzoas	5 to 15 gr.	3 to 10 Dgm.
Ammonii Bromidum	5 to 30 gr.	3 to 20 Dgm.
Ammonii Carbonas	3 to 10 gr.	2 to 6 Dgm.

Name.	Official Dose.	Metric Dose.
Ammonii Chloridum	5 to 20 gr.	3 to 12 Dgm.
Ammonii Phosphas	5 to 20 gr.	3 to 12 Dgm.
Amyl Nitris	2 to 5 min. (as inhalation)	1 to 3 Dml.
Antimonii Oxidum	1 to 2 gr.	6 to 12 Cgm.
Antimonium Sulphuratum	1 to 2 gr.	6 to 12 Cgm.
Antimonium Tartaratum	$\frac{1}{24}$ to $\frac{1}{8}$ gr. (as diaphoretic)	3 to 8 Mgm.
	1 to 2 gr. (as emetic)	6 to 12 Cgm.
Apomorphinæ Hydrochloridum	$\frac{1}{20}$ to $\frac{1}{10}$ gr. (as hypo. inject.)	3 to 6 Mgm.
	$\frac{1}{10}$ to $\frac{1}{4}$ gr.	6 to 16 Mgm.
Aqua Laurocerasi	$\frac{1}{2}$ to 2 dr.	2 to 8 Mils.
Argenti Nitras	$\frac{1}{4}$ to $\frac{1}{2}$ gr.	15 to 30 Mgm.
Argenti Oxidum	$\frac{1}{2}$ to 2 gr.	3 to 12 Cgm.
Arsenii Iodidum	$\frac{1}{20}$ to $\frac{1}{8}$ gr.	3 to 12 Mgm.
Asafetida	5 to 15 gr.	3 to 10 Dgm.
Atropina	$\frac{1}{200}$ to $\frac{1}{100}$ gr.	$\frac{1}{3}$ to $\frac{2}{3}$ Mgm.
Atropinæ Sulphas	$\frac{1}{200}$ to $\frac{1}{100}$ gr	$\frac{1}{3}$ to $\frac{2}{3}$ Mgm.
Balsamum Peruvianum	5 to 15 min.	3 to 10 Dml.
Balsamum Tolutanum	5 to 15 gr.	3 to 10 Dgm.
Bismuthi Carbonas	5 to 20 gr.	3 to 12 Dgm.
Bismuthi Oxidum	5 to 20 gr.	3 to 12 Dgm.
Bismuthi Salicylas	5 to 20 gr.	3 to 12 Dgm.
Bismuthi Subnitras	5 to 20 gr.	3 to 12 Dgm.
Borax	5 to 20 gr.	3 to 12 Dgm.
Butyl-Chloral Hydras	5 to 20 gr.	3 to 12 Dgm.
Caffeina	1 to 5 gr.	$\frac{1}{2}$ to 3 Dgm.
Caffeinæ Citras	2 to 10 gr.	1 to 6 Dgm.
Caffeinæ Citras Effervescens	60 to 120 gr.	4 to 8 Gm.
Calcii Carbonas Præcipitatus	10 to 60 gr.	$\frac{1}{2}$ to 4 Gm.
Calcii Chloridum	5 to 15 gr.	3 to 10 Dgm.
Calcii Hypophosphis	3 to 10 gr.	2 to 6 Dgm.
Calcii Phosphas	5 to 15 gr.	3 to 10 Dgm.
*Calotropis	3 to 10 gr. (as tonic)	2 to 6 Dgm.
	30 to 60 gr. (as emetic)	2 to 4 Gm.
Calx Sulphurata	$\frac{1}{4}$ to 1 gr.	15 to 60 Mgm.
Cambogia	$\frac{1}{2}$ to 2 gr.	3 to 12 Cgm.
*Cambogia Indica	$\frac{1}{2}$ to 2 gr.	3 to 12 Cgm.
Camphora	2 to 5 gr.	1 to 3 Dgm.
Carbo Ligni	60 to 120 gr.	4 to 8 Gm.
Catechu	5 to 15 gr.	3 to 10 Dgm.
*Catechu Nigrum	5 to 15 gr.	3 to 10 Dgm.
Cerii Oxalas	2 to 10 gr.	1 to 6 Dgm.
Chloral Hydras	5 to 20 gr.	3 to 12 Dgm.
Chloroformum	1 to 5 min.	$\frac{1}{2}$ to 3 Dml.
Cocainæ Hydrochloridum	$\frac{1}{8}$ to $\frac{1}{2}$ gr.	12 to 30 Mgm.
Codeina	$\frac{1}{4}$ to 2 gr.	15 to 120 Mgm.
Codeinæ Phosphas	$\frac{1}{4}$ to 2 gr.	15 to 120 Mgm.
Colchici Cormus	2 to 5 gr.	1 to 3 Dgm.
Confectio Piperis	60 to 120 gr.	4 to 8 Gm.
Confectio Sennæ	60 to 120 gr.	4 to 8 Gm.
Confectio Sulphuris	60 to 120 gr.	4 to 8 Gm.
Copaiba	$\frac{1}{2}$ to 1 fl. dr.	2 to 4 Mils.
Creosotum	1 to 5 min.	$\frac{1}{2}$ to 3 Dml.
Creta Præparata	10 to 60 gr.	$\frac{1}{2}$ to 4 Gm.

Name.	Official Dose.	Metric Dose.
Cubebæ Fructus	30 to 60 gr.	2 to 4 Gm.
*Cucurbita Semina Præparata	3 to 4 oz.	84 to 112 Gm.
Cupri Sulphas	¼ to 2 gr. (as astringent)	15 to 120 Mgm.
	5 to 10 gr. (as emetic)	3 to 6 Dgm.
Cusso	½ to ½ oz.	7 to 14 Gm.
*Decoctum Acaciæ Corticis	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Agropyri	½ to 2 fl. oz.	15 to 60 Mils.
Decoctum Aloes Compositum	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Cissampeli	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Gossypii Radicis Corticis	½ to 2 fl. oz.	15 to 60 Mils.
Decoctum Granati Corticis	½ to 2 fl. oz.	15 to 60 Mils.
Decoctum Hæmatoxyli	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Hygrophilæ	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Ispaghulæ	½ to 2 fl. oz.	15 to 60 Mils.
*Decoctum Sappan	½ to 2 fl. oz.	15 to 60 Mils.
Digitalis Folia	½ to ½ gr.	3 to 12 Cgm.
Elaterinum	1/40 to 1/10 gr.	2 to 6 Mgm.
Elaterium	1/10 to ½ gr.	6 to 30 Mgm.
*Embelia	60 to 240 gr.	4 to 16 Gm.
Ergota	20 to 60 gr.	12 to 40 Dgm.
Eucalypti Gummi	2 to 5 gr.	1 to 3 Dgm.
*Extractum Acalyphæ Liquidum	5 to 30 min.	¼ to 2 Mils.
*Extractum Adhadotæ Liquidum	20 to 60 min.	1 to 4 Mils.
*Extractum Agropyri Liquidum	1 to 2 fl. dr.	4 to 8 Mils.
Extractum Aloes Barbadensis	1 to 4 gr.	½ to 2½ Dgm.
Extractum Anthemidis	2 to 8 gr.	1 to 5 Dgm.
*Extractum Belæ Liquidum	1 to 2 fl. dr.	4 to 8 Mils.
Extractum Belladonnæ Alcoholicum	¼ to 1 gr.	15 to 60 Mgm.
Extractum Belladonnæ Viride	¼ to 1 gr.	15 to 60 Mgm.
Extractum Cannabis Indicæ	¼ to 1 gr.	15 to 60 Mgm.
Extractum Cascaræ Sagradæ	2 to 8 gr.	1 to 5 Dgm.
Extractum Cascaræ Sagradæ Liquidum	½ to 1 fl. dr.	2 to 4 Mils.
Extractum Cimicifugæ Liquidum	5 to 30 min.	¼ to 2 Mils.
Extractum Cinchonæ Liquidum	5 to 15 min.	½ to 10 Dml.
*Extractum Cissampeli Liquidum	½ to 2 fl. dr.	2 to 8 Mils.
Extractum Cocæ Liquidum	½ to 1 fl. dr.	2 to 4 Mils.
Extractum Colchici	¼ to 1 gr.	15 to 60 Mgm.
Extractum Colocynthidis Compositum	2 to 8 gr.	1 to 5 Dgm.
Extractum Ergotæ	2 to 8 gr.	1 to 5 Dgm.
Extractum Ergotæ Liquidum	10 to 30 min.	½ to 2 Mils.
Extractum Euonymi Siccum	1 to 2 gr.	6 to 12 Cgm.
Extractum Filicis Liquidum	45 to 90 min.	3 to 6 Mils.
Extractum Gentianæ	2 to 8 gr.	1 to 5 Dgm.
Extractum Glycyrrhizæ Liquidum	½ to 1 fl. dr.	2 to 4 Mils.
*Extractum Glycyrrhizæ Spirituosum	½ to 1 fl. dr.	2 to 4 Mils.
*Extractum Gossypii Radicis Corticis Liquidum	½ to 1 fl. dr.	2 to 4 Mils.
*Extractum Grindeliæ Liquidum	10 to 20 min.	6 to 12 Dml.
Extractum Hamamelidis Liquidum	5 to 15 min.	3 to 10 Dml.
Extractum Hydrastis Liquidum	5 to 15 min.	3 to 10 Dml.
Extractum Hyoscyami Viride	2 to 8 gr.	1 to 5 Dgm.
Extractum Ipecacuanhæ Liquidum	½ to 2 min. (as expectorant)	3 to 12 Cml.
	15 to 20 min. (as emetic)	10 to 12 Dml.

Name.	Official Dose.	Metric Dose.
Extractum Jaborandi Liquidum	5 to 15 min.	3 to 10 Dml.
Extractum Jalapæ	2 to 8 gr.	1 to 5 Dgm.
*Extractum Kavæ Liquidum	30 to 60 min.	2 to 4 Mils.
Extractum Krameriæ.....	5 to 15 gr.	3 to 10 Dgm.
Extractum Nucis Vomicæ.....	¼ to 1 gr.	15 to 60 Mgm.
Extractum Nucis Vomicæ Liquidum	1 to 3 min.	½ to 2 Dml.
Extractum Opii.....	¼ to 1 gr.	15 to 60 Mgm.
Extractum Opii Liquidum	5 to 30 min.	¼ to 2 Mils.
Extractum Pareiræ Liquidum.....	½ to 2 fl. dr.	2 to 8 Mils.
Extractum Physostigmatis	¼ to 1 gr.	15 to 60 Mgm.
*Extractum Picrorhizæ Liquidum ..	20 to 60 min.	12 to 40 Dml.
Extractum Rhei	2 to 8 gr.	1 to 5 Dgm.
Extractum Sarsæ Liquidum.....	2 to 4 fl. dr.	8 to 15 Mils.
Extractum Stramonii	¼ to 1 gr.	15 to 60 Mgm.
Extractum Strophanthi.....	¼ to 1 gr.	15 to 60 Mgm.
Extractum Taraxaci	5 to 15 gr.	3 to 10 Dgm.
Extractum Taraxaci Liquidum.....	½ to 2 fl. dr.	2 to 8 Mils.
*Extractum Viburni Prunifolii Liquidum	1 to 2 fl. dr.	4 to 8 Mils.
Fel Bovinum Purificatum.....	5 to 15 gr.	3 to 10 Dgm.
Ferri Arsenas.....	$\frac{1}{10}$ to ¼ gr.	4 to 16 Mgm.
Ferri Carbonas Saccharatis.....	10 to 30 gr.	½ to 2 Gm.
Ferri et Ammonii Citras.....	5 to 10 gr.	⅔ to 6 Dgm.
Ferri et Quininæ Citras.....	5 to 10 gr.	⅔ to 6 Dgm.
Ferri Phosphas	5 to 10 gr.	⅔ to 6 Dgm.
Ferri Sulphas.....	1 to 5 gr.	⅓ to 3 Dgm.
Ferri Sulphas Exsiccatus.....	⅓ to 3 gr.	¼ to 2 Dgm.
Ferrum Redactum	1 to 5 gr.	⅓ to 3 Dgm.
Ferrum Tartaratum.....	5 to 10 gr.	⅔ to 6 Dgm.
Galbanum	5 to 15 gr.	3 to 10 Dgm.
Glycerinum.....	1 to 2 fl. dr.	4 to 8 Mils.
Glycerinum Pepsini.....	1 to 2 fl. dr.	4 to 8 Mils.
Guaiaci Resina	5 to 15 gr.	3 to 10 Dgm.
Homatropinæ Hydrobromidum	$\frac{1}{80}$-$\frac{1}{20}$ gr.	¾ to 3 Mgm.
Hydrargyri Iodidum Rubrum	$\frac{1}{32}$-$\frac{1}{16}$ gr.	2 to 4 Mgm.
Hydrargyri Perchloridum.....	$\frac{1}{32}$-$\frac{1}{16}$ gr.	2 to 4 Mgm.
Hydrargyri Subchloridum.....	½ to 5 gr.	¼ to 3 Dgm.
Hydrargyri cum Creta	1 to 5 gr.	⅓ to 3 Dgm.
Hyoscinæ Hydrobromidum	$\frac{1}{200}$-$\frac{1}{100}$ gr.	⅓ to ⅔ Mgm.
Hyoscyaminæ Sulphas	$\frac{1}{200}$-$\frac{1}{100}$ gr.	⅓ to ⅔ Mgm.
*Infusum Alstoniæ	½ to 1 fl. oz.	15 to 30 Mils.
*Infusum Andrographidis.....	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Aurantii.....	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Aurantii Compositum.....	½ to 1 fl. oz.	15 to 30 Mils.
*Infusum Azadirachtæ Indicæ	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Buchu.....	1 to 2 fl. oz.	30 to 60 Mils.
Infusum Calumbæ	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Caryophylli	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Cascarillæ.....	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Chiratæ	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Cinchonæ Acidum.....	½ to 1 fl. oz.	15 to 30 Mils.
*Infusum Coscinii	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Cuspariæ	1 to 2 fl. oz.	30 to 60 Mils.
Infusum Digitalis.....	2 to 4 fl. dr.	8 to 16 Mils.
Infusum Ergotæ	1 to 2 fl. oz.	30 to 60 Mils.
Infusum Gentianæ Compositum	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Krameriæ	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Lupuli	1 to 2 fl. oz.	30 to 60 Mils.
Infusum Quassiæ.....	½ to 1 fl. oz.	15 to 30 Mils.

Name.	Official Dose.	Metric Dose.
Infusum Rhei	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Rosæ Acidum	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Scoparii	1 to 2 fl. oz.	30 to 60 Mils.
Infusum Senegæ	½ to 1 fl. oz.	15 to 30 Mils.
Infusum Sennæ	½ to 1 fl. oz. 2 fl. oz. (S. A.)	15 to 30 Mils. 60 Mils.
Infusum Serpentariæ	½ to 1 fl. oz.	15 to 30 Mils.
*Infusum Tinosporæ	½ to 1 fl. oz.	15 to 30 Mils.
*Infusum Toddaliæ	1 to 2 fl. oz.	30 to 60 Mils
Infusum Uvæ Ursi	½ to 1 fl. oz.	15 to 30 Mils
Injectio Apomorphinæ Hypodermica	5 to 10 min.	3 to 6 Dml.
Injectio Cocainæ Hypodermica	2 to 5 min.	1 to 3 Dml.
Injectio Ergotæ Hypodermica	3 to 10 min.	2 to 6 Dml.
Injectio Morphinæ Hypodermica	2 to 5 min.	1 to 3 Dml.
Iodoformum	½ to 3 gr.	¼ to 2 Dgm.
Ipecacuanhæ Radix	¼ to 2 gr. (as expectorant). 15 to 30 gr. (as emetic).	15 to 120 Mgm. 1 to 2 Gm.
*Ispaghula	50 to 150 gr.	3 to 10 Gm.
Jalapa	5 to 20 gr.	3 to 12 Dgm.
Jalapæ Resina	2 to 5 gr.	1 to 3 Dgm.
*Kaladana	30 to 50 gr.	2 to 3½ Gm.
*Kaladanæ Resina	2 to 8 gr.	1 to 5 Dgm.
Kino	5 to 20 gr.	3 to 12 Dgm.
*Kino Eucalypti	5 to 20 gr.	3 to 12 Dgm.
Liquor Ammonii Acetatis	2 to 6 fl. dr.	8 to 23 Mils.
Liquor Ammonii Citratis	2 to 6 fl. dr.	8 to 23 Mils.
*Liquor Andrographidis Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
*Liquor Aristolochiæ Concentratus	½ to 2 fl. dr.	2 to 8 Mils.
Liquor Arsenicalis	2 to 8 min.	1 to 5 Dml.
Liquor Arsenici Hydrochloricus	2 to 8 min.	1 to 5 Dml.
Liquor Arsenii et Hydrargyri Iodidi	5 to 20 min.	3 to 12 Dml.
Liquor Atropinæ Sulphatis	½ to 1 min.	3 to 6 Cml.
*Liquor Berberidis Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Bismuthi et Ammonii Citratis	½ to 1 fl. dr.	2 to 4 Miis.
Liquor Calcis	1 to 4 fl. oz.	30 to 120 Mlls.
Liquor Calcis Saccharatus	20 to 60 min.	1 to 4 Mils.
Liquor Calumbæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Chiratæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
*Liquor Coscinii Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Cuspariæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Ethyl Nitritis	20 to 60 min.	1 to 4 Mils.
Liquor Ferri Acetatis	5 to 15 min.	3 to 10 Dml.
Liquor Ferri Perchloridi	5 to 15 min.	3 to 10 Dml.
Liquor Ferri Pernitratis	5 to 15 min.	3 to 10 Dml.
Liquor Hydrargyri Perchloridi	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Hydrogenii Peroxidi	½ to 2 fl. dr.	2 to 8 Mils.
Liquor Krameriæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Magnesii Carbonatis	1 to 2 fl. oz.	30 to 60 Mils.
Liquor Morphinæ Acetatis	10 to 60 min.	½ to 4 Mils.
Liquor Morphinæ Hydrochloridi	10 to 60 min.	½ to 4 Mils.
Liquor Morphinæ Tartratis	10 to 60 min.	½ to 4 Mils.
Liquor Potassæ	10 to 30 min.	½ to 2 Mils.
Liquor Potassii Permanganatis	2 to 4 fl. dr.	8 to 15 Mils.
Liquor Quassiæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Rhei Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Sarsæ Compositus Concentratus	2 to 8 fl. dr.	8 to 30 Mils.
Liquor Senegæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.

Name.	Official Dose.	Metric Dose.
Liquor Sennæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Serpentariæ Concentratus	½ to 2 fl. dr.	2 to 8 Mils.
Liquor Sodæ Chlorinatæ	10 to 20 min.	6 to 12 Dml.
Liquor Sodii Arsenatis	2 to 8 min.	1 to 5 Dml.
Liquor Strychninæ Hydrochloridi	2 to 8 min.	1 to 5 Dml.
Liquor Thyroidei	5 to 15 min.	3 to 10 Dml.
*Liquor Tinosporæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
*Liquor Toddaliæ Concentratus	½ to 1 fl. dr.	2 to 4 Mils.
Liquor Trinitrini	½ to 2 min.	3 to 12 Cml.
Lithii Carbonas	2 to 5 gr.	1 to 3 Dgm.
Lithii Citras	5 to 10 gr.	3 to 6 Dgm.
Lithii Citras Effervescens	60 to 120 gr.	4 to 8 Gm.
Lupulinum	2 to 5 gr.	1 to 3 Dgm.
Magnesia Levis	5 to 30 gr. (R.A.)	¼ to 2 Gm.
	30 to 60 gr. (S.A.)	2 to 4 Gm.
Magnesia Ponderosa	5 to 30 gr. (R.A.)	¼ to 2 Gm.
	30 to 60 gr. (S.A.)	2 to 4 Gm.
Magnesia Carbonas Levis	5 to 30 gr. (R.A.)	¼ to 2 Gm.
	30 to 60 gr. (S.A.)	2 to 4 Gm.
Magnesia Carbonas Ponderosus	5 to 30 gr. (R.A.)	¼ to 2 Gm.
	30 to 60 gr. (S.A.)	2 to 4 Gm.
Magnesii Sulphas	30 to 120 gr. (R.A.)	2 to 8 Gm.
	¼ to ½ oz. (S.A.)	7 to 14 Gm.
Magnesii Sulphas Effervescens	60 to 240 gr. (R.A.)	4 to 16 Gm.
	½ to 1 oz. (S.A.)	14 to 28 Gm.
Menthol	½ to 2 gr.	3 to 12 Cgm.
Mistura Ammoniaci	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Amygdalæ	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Creosoti	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Cretæ	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Ferri Composita	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Guaiaci	½ to 1 fl. oz.	15 to 30 Mils.
Mistura Olei Ricini	1 to 2 fl. oz.	30 to 60 Mils.
Mistura Sennæ Composita	1 to 2 fl. oz.	30 to 60 Mils.
Mistura Spiritus Vini Gallici	1 to 2 fl. oz.	30 to 60 Mils.
Morphinæ Acetas	⅛ to ½ gr.	8 to 30 Mgm.
Morphinæ Hydrochloridum	⅛ to ½ gr.	8 to 30 Mgm.
Morphinæ Tartras	⅛ to ½ gr.	8 to 30 Mgm.
Moschus	5 to 10 gr.	3 to 6 Dgm.
*Myrobalanum	30 to 60 gr.	2 to 4 Gm.
Naphthol (Beta-Naphthol)	3 to 10 gr.	2 to 6 Dgm.
Nux Vomica	1 to 4 gr.	½ to 2½ Dgm.
*Oleum Ajowan	½ to 3 min.	¼ to 2 Dml.
Oleum Anethi	½ to 3 min.	¼ to 2 Dml.
Oleum Anisi	½ to 3 min.	¼ to 2 Dml.
Oleum Anthemidis	½ to 3 min.	¼ to 2 Dml.
Oleum Cajuputi	½ to 3 min.	¼ to 2 Dml.
Oleum Carui	½ to 3 min.	¼ to 2 Dml.
Oleum Caryophylli	½ to 3 min.	¼ to 2 Dml.
Oleum Cinnamomi	½ to 3 min.	½ to 6 Cml.
Oleum Copaibæ	5 to 20 min.	3 to 12 Dml.
Oleum Coriandri	½ to 3 min.	¼ to 2 Dml.
Oleum Crotonis	½ to 1 min.	¼ to ½ Dml.
Oleum Cubebæ	5 to 20 min.	3 to 12 Dml.
Oleum Eucalypti	½ to 3 min.	¼ to 2 Dml.
*Oleum Gaultheriæ	3 to 10 min.	2 to 6 Dml.
*Oleum Graminis Citrati	½ to 3 min.	¼ to 2 Dml.
*Oleum Gynocardiæ	5 to 10 min., increasing to ½ to 1 fl. dr.	½ to 6 Dml., increasing to 2 to 4 Mils.

Name.	Official Dose.	Metric Dose.
Oleum Juniperi	½ to 3 min.	¼ to 2 Dml.
Oleum Lavandulæ	½ to 3 min.	¼ to 2 Dml.
Oleum Limonis	½ to 3 min.	¼ to 2 Dml.
Oleum Menthæ Piperitæ	½ to 3 min.	¼ to 2 Dml.
Oleum Menthæ Viridis	½ to 3 min.	¼ to 2 Dml.
Oleum Morrhuæ	1 to 4 fl. dr.	4 to 15 Mils.
Oleum Myristicæ	½ to 3 min.	¼ to 2 Dml.
Oleum Phosphoratum	1 to 5 min.	½ to 3 Dml.
Oleum Pimentæ	½ to 3 min.	¼ to 2 Dml.
Oleum Ricini	1 to 8 fl. dr.	4 to 30 Mils.
Oleum Rosmarini	½ to 3 min.	¼ to 2 Dml.
Oleum Santali	5 to 30 min.	¼ to 2 Dml.
Oleum Terebinthinæ	2 to 10 min. 3 to 4 fl. dr. (as anthelmintic)	1 to 6 Dml. 12 to 15 Mils.
Opium	½ to 2 gr.	3 to 12 Cgm.
Oxymel	1 to 2 fl. dr.	4 to 8 Mils.
Oxymel Scillæ	½ to 1 fl. dr.	2 to 4 Mils.
*Oxymel Urgineæ	½ to 1 fl. dr.	2 to 4 Mils.
Paraldehydum	½ to 2 fl. dr.	2 to 8 Mils.
Pepsinum	5 to 10 gr.	3 to 6 Dgm.
Phenacetinum	5 to 10 gr.	3 to 6 Dgm.
Phenazonum	5 to 20 gr.	3 to 12 Dgm
Phosphorus	$\frac{1}{100}$ to $\frac{1}{20}$ gr.	½ to 3 Mgm
Physostigminæ Sulphas	$\frac{1}{60}$ to $\frac{1}{20}$ gr.	1 to 3 Mgm.
*Picrorhiza	10 to 20 gr. (as tonic) 40 to 50 gr. (as antiperiodic)	6 to 12 Dgm. 2 to 3 Gm.
Picrotoxinum	$\frac{1}{100}$ to $\frac{1}{25}$ gr.	½ to 2½ Mgm.
Pilocarpinæ Nitras	$\frac{1}{20}$ to ½ gr.	3 to 30 Mgm.
Pilula Aloes Barbadensis	4 to 8 gr.	2½ to 5 Dgm.
Pilula Aloes et Asafetidæ	4 to 8 gr.	2½ to 5 Dgm.
Pilula Aloes et Ferri	4 to 8 gr.	2½ to 5 Dgm.
Pilula Aloes et Myrrhæ	4 to 8 gr.	2½ to 5 Dgm.
Pilula Aloes Socotrinæ	4 to 8 gr.	2½ to 5 Dgm.
Pilula Cambogiæ Composita	4 to 8 gr.	2½ to 5 Dgm.
Pilula Colocynthidis Composita	4 to 8 gr.	2½ to 5 Dgm.
Pilula Colocynthidis et Hyoscyami	4 to 8 gr.	2½ to 5 Dgm.
Pilula Ferri	5 to 15 gr.	3 to 10 Dgm.
Pilula Galbani Composita	4 to 8 gr.	2½ to 5 Dgm.
Pilula Hydrargyri	4 to 8 gr.	2½ to 5 Dgm.
Pilula Hydrargyri Subchloridi Co.	4 to 8 gr.	2½ to 5 Dgm.
Pilula Ipecacuanhæ cum Scillæ	4 to 8 gr.	2½ to 5 Dgm.
*Pilula Ipecacuanhæ cum Urginea	4 to 8 gr.	2½ to 5 Dgm.
Pilula Phosphori	1 to 2 gr.	6 to 12 Cgm.
Pilula Plumbi cum Opio	2 to 4 gr.	1 to 2½ Dgm.
Pilula Quininæ Sulphatis	2 to 8 gr.	1 to 5 Dgm.
Pilula Rhei Composita	4 to 8 gr.	2½ to 5 Dgm.
Pilula Saponis Composita	2 to 4 gr.	1 to 2½ Dgm.
Pilula Scammonii Composita	4 to 8 gr.	2½ to 5 Dgm.
Pilula Scillæ Composita	4 to 8 gr.	2½ to 5 Dgm.
*Pilula Urgineæ Composita	4 to 8 gr.	2½ to 5 Dgm.
Plumbi Acetas	1 to 5 gr.	½ to 3 Dgm.
*Podophylli Indici Resina	¼ to 1 gr.	15 to 60 Mgm.
Podophylli Resina	¼ to 1 gr.	15 to 60 Mgm.
Potassii Acetas	10 to 60 gr.	½ to 4 Gm.
Potassii Bicarbonas	5 to 30 gr.	¼ to 2 Gm.
Potassii Bichromas	$\frac{1}{10}$ to ⅛ gr.	6 to 12 Mgm.

Name.	Official Dose.	Metric Dose.
Potassii Bromidum	5 to 30 gr.	¼ to 2 Gm.
Potassii Carbonas	5 to 20 gr.	3 to 12 Dgm.
Potassii Chloras	5 to 15 gr.	3 to 10 Dgm.
Potassii Citras	10 to 40 gr.	½ to 2½ Gm.
Potassii Iodidum	5 to 20 gr.	3 to 12 Dgm.
Potassii Nitras	5 to 20 gr.	3 to 12 Dgm.
Potassii Permanganas	1 to 3 gr.	½ to 2 Dgm.
Potassii Sulphas	10 to 40 gr.	½ to 2½ Gm.
Potassii Tartras	30 to 240 gr.	2 to 16 Gm.
Potassii Tartras Acidus	20 to 60 gr.	1 to 4 Gm.
Pulvis Antimonialis	3 to 6 gr.	2 to 4 Dgm.
*Pulvis Buteæ Seminum	10 to 20 gr.	6 to 12 Dgm.
Pulvis Catechu Compositus	10 to 40 gr.	½ to 2½ Gm.
Pulvis Cinnamomi Compositus	10 to 40 gr.	½ to 2½ Gm.
Pulvis Cretæ Aromaticus	10 to 60 gr.	½ to 4 Gm.
Pulvis Cretæ Aromaticus cum Opio	10 to 40 gr.	½ to 2½ Gm.
Pulvis Elaterini Compositus	1 to 4 gr.	½ to 2½ Dgm.
Pulvis Glycyrrhizæ Compositus	60 to 120 gr.	4 to 8 Gm.
Pulvis Ipecacuanhæ Compositus	5 to 15 gr.	3 to 10 Dgm
Pulvis Jalapæ Compositus	20 to 60 gr.	1 to 4 Gm.
*Pulvis Kaladanæ Compositus	20 to 60 gr.	1 to 4 Gm.
Pulvis Kino Compositus	5 to 20 gr.	3 to 12 Dgm.
Pulvis Opii Compositus	2 to 10 gr.	1 to 6 Dgm.
Pulvis Rhei Compositus	20 to 60 gr.	1 to 4 Gm.
Pulvis Scammonii Compositus	10 to 20 gr.	6 to 12 Dgm.
Pulvis Tragacanthæ Compositus	20 to 60 gr.	1 to 4 Gm.
Quininæ Hydrochloridum	1 to 10 gr.	½ to 6 Dgm.
Quininæ Hydrochloridum Acidum	1 to 10 gr.	½ to 6 Dgm.
Quininæ Sulphas	1 to 10 gr.	½ to 6 Dgm.
Rhei Radix	3 to 10 gr. (R.A.) 15 to 30 gr. (S.A.)	2 to 6 Dgm. 1 to 2 Gm.
Salicinum	5 to 20 gr.	3 to 12 Dgm.
Salol	5 to 15 gr.	3 to 10 Dgm.
Santoninum	2 to 5 gr.	1 to 3 Dgm.
Scammoniæ Resina	3 to 8 gr.	2 to 5 Dgm.
Scammonium	5 to 10 gr.	3 to 6 Dgm.
Scilla	1 to 3 gr.	½ to 2 Dgm.
Soda Tartarata	120 to 240 gr.	8 to 16 Gm.
Sodii Arsenas	1/40 to 1/10 gr.	2 to 6 Mgm.
Sodii Benzoas	5 to 30 gr.	¼ to 2 Gm.
Sodii Bicarbonas	5 to 30 gr.	¼ to 2 Gm.
Sodii Bromidum	5 to 30 gr.	¼ to 2 Gm.
Sodii Carbonas	5 to 30 gr.	¼ to 2 Gm.
Sodii Carbonas Exsiccatus	3 to 10 gr.	2 to 6 Dgm.
Sodii Citro-Tartras Effervescens	60 to 120 gr.	4 to 8 Gm.
Sodii Hypophosphis	3 to 10 gr.	2 to 6 Dgm.
Sodii Iodidum	5 to 20 gr.	3 to 12 Dgm.
Sodii Nitris	1 to 2 gr.	6 to 12 Cgm.
Sodii Phosphas	30 to 120 gr. (R.A.) ¼ to ½ oz. (S.A.)	2 to 8 Gm. 7 to 14 Gm.
Sodii Phosphas Effervescens	60 to 120 gr. (R.A.) ¼ to ½ oz. (S.A.)	4 to 8 Gm. 7 to 14 Gm.
Sodii Salicylas	10 to 30 gr.	½ to 2 Gm.
Sodii Sulphas	30 to 120 gr. (S.A.) ¼ to ½ oz. (R.A.)	2 to 8 Gm. 7 to 14 Gm.
Sodii Sulphas Effervescens	60 to 120 gr. (R.A. ¼ to ½ oz. (S.A.)	4 to 8 Gm. 7 to 14 Gm.
Sodii Sulphis	5 to 20 gr.	3 to 12 Dgm.
Sodii Sulphocarbolas	5 to 15 gr.	3 to 10 Dgm.

Name.	Official Dose.	Metric Dose.
Spiritus Ætheris	20 to 40 min. (R.A.) 60 to 90 min. (S.A.)	1½ to 2½ Mils. 4 to 6 Mils.
Spiritus Ætheris Compositus	20 to 40 min. (R.A.) 60 to 90 min. (S.A.)	1½ to 2½ Mils. 4 to 6 Mils.
Spiritus Ætheris Nitrosi	20 to 40 min. (R.A.) 60 to 90 min. (S.A.)	1½ to 2½ Mils. 4 to 6 Mils.
Spiritus Ammoniæ Aromaticus	20 to 40 min. (R.A.) 60 to 90 min. (S.A.)	1½ to 2½ Mils. 4 to 6 Mils.
Spiritus Ammoniæ Fetidus	20 to 40 min. (R.A.) 60 to 90 min. (S.A.)	1½ to 2½ Mils. 4 to 6 Mils.
Spiritus Anisi	5 to 20 min.	3 to 12 Dml.
Spiritus Armoraciæ Compositus	1 to 2 fl. dr.	4 to 8 Mils.
Spiritus Cajuputi	5 to 20 min.	3 to 12 Dml.
Spiritus Camphoræ	5 to 20 min.	3 to 12 Dml.
Spiritus Chloroformi	5 to 20 min. (R.A.) 30 to 40 min. (S.A.)	3 to 12 Dml. 2 to 2½ Mils.
Spiritus Cinnamomi	5 to 20 min.	3 to 12 Dml.
Spiritus Juniperi	20 to 60 min.	1 to 4 Mils.
Spiritus Lavandulæ	5 to 20 min.	3 to 12 Dml.
Spiritus Menthæ Piperitæ	5 to 20 min.	3 to 12 Dml.
Spiritus Myristicæ	5 to 20 min.	3 to 12 Dml.
Strychnina	$\frac{1}{60}$ to $\frac{1}{15}$ gr.	1 to 4 Mgm.
Strychninæ Hydrochloridum	$\frac{1}{60}$ to $\frac{1}{15}$ gr.	1 to 4 Mgm.
*Succus Acalyphæ	1 to 4 fl. dr.	4 to 15 Mils.
*Succus Adhatodæ	1 to 4 fl. dr.	4 to 15 Mils.
Succus Belladonnæ	5 to 15 min.	3 to 10 Dml.
Succus Conii	1 to 2 fl. dr.	4 to 8 Mils.
Succus Hyoscyami	½ to 1 fl. dr.	2 to 4 Mils.
Succus Scoparii	1 to 2 fl. dr.	4 to 8 Mils.
Succus Taraxaci	1 to 2 fl. dr.	4 to 8 Mils.
Sulphonal	10 to 30 gr.	½ to 2 Gm.
Sulphur Præcipitatum	20 to 60 gr.	1½ to 4 Gm.
Sulphur Sublimatum	20 to 60 gr.	1½ to 4 Gm.
Syrupus Aromaticus	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Aurantii	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Aurantii Floris	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Calcii Lactophosphatis	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Cascaræ Aromaticus	½ to 2 fl. dr.	2 to 8 Mils.
Syrupus Chloral	½ to 2 fl. dr.	2 to 8 Mils.
Syrupus Codeinæ	½ to 2 fl. dr.	2 to 8 Mils.
Syrupus Ferri Iodidi	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Ferri Phosphatis	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Ferri Phosphatis cum Quinina et Strychnina	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Hemidesmi	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Limonis	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Pruni Virginianæ	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Rhei	½ to 2 fl. dr.	2 to 8 Mils.
Syrupus Rhœados	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Rosæ	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Scillæ	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Sennæ	½ to 2 fl. dr.	2 to 8 Mils.
Syrupus Tolutanus	½ to 1 fl. dr.	2 to 4 Mils.
*Syrupus Urgineæ	½ to 1 fl. dr.	2 to 4 Mils.
Syrupus Zingiberis	½ to 1 fl. dr.	2 to 4 Mils.
Tabellæ Trinitrini	1 or 2 tablets	1 or 2 tablets
Terebenum	5 to 15 min.	3 to 10 Dml.
Thymol	½ to 2 gr.	3 to 12 Cgm.
Thyroideum Siccum	3 to 10 gr.	2 to 6 Dgm.

Name.	Official Dose.	Metric Dose.
Tinctura Aconiti	2 to 5 min. (V.F.R.) 5-15 min.	1 to 3 Dml. 3 to 10 Dml.
*Tinctura Adhatoda	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Aloes	½ to 1 fl. dr. (R.A.) 1½ to 2 fl. dr. (S.A.)	2 to 4 Mils. 6 to 8 Mils.
*Tinctura Alstoniæ	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Andrographidis	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Aristolochiæ	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Arnicæ Florum	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Asafetidæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Aurantii	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Azadirachta Indicæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Belladonnæ	5 to 15 min.	3 to 10 Dml.
Tinctura Benzoini Composita	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Berberidis	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Buchu	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Calotropis	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Calumbæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Camphoræ Composita	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cannabis Indicæ	5 to 15 min.	3 to 10 Dml.
Tinctura Cantharidis	2 to 5 min. (R.A.) 5 to 15 min. (S.A.)	1 to 3 Dml. 3 to 10 Dml.
Tinctura Capsici	5 to 15 min.	3 to 10 Dml.
Tinctura Cardamomi Composita	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cascarillæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Catechu	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Chiratæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Chloroformi et Morphinæ Composita	5 to 15 min.	3 to 10 Dml.
Tinctura Cimicifugi	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cinchonæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cinchonæ Composita	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cinnamomi	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Cocci	5 to 15 min.	3 to 10 Dml.
Tinctura Colchici Seminum	5 to 15 min.	3 to 10 Dml.
Tinctura Conii	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Coscinii	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Croci	5 to 15 min.	3 to 10 Dml.
Tinctura Cubebæ	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Daturæ Seminum	5 to 15 min.	3 to 10 Dml.
Tinctura Digitalis	5 to 15 min.	3 to 10 Dml.
Tinctura Ergotæ Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Ferri Perchloridi	5 to 15 min.	3 to 10 Dml.
Tinctura Gelsemii	5 to 15 min.	3 to 10 Dml.
Tinctura Gentianæ Composita	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Guaiaci Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Hamamelidis	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Hydrastis	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Hyoscyami	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Iodi	2 to 5 min.	1 to 3 Dml.
Tinctura Jaborandi	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Jalapæ	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Jalapæ Composita	½ to 1 fl. dr.	2 to 4 Mils.
*Tinctura Kaladanæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Kino	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Krameriæ	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Lavandulæ Composita	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Limonis	½ to 1 fl. dr.	2 to 4 Mils.
Tinctura Lobeliæ Ætherea	5 to 15 min.	3 to 10 Dml.

Name.	Official Dose.	Metric Dose.
†Tinctura Lupuli	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Myrrhæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Nucis Vomicæ	5 to 15 min.	3 to 10 Dml.
**Tinctura Oliveri Corticis	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Opii	5 to 15 m. (R.A.)	3 to 10 Dml.
	20 to 30 m. (S.A.)	1 to 2 Mils.
†Tinctura Opii Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
**Tinctura Picrorhizæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Podophylli	5 to 15 min.	3 to 10 Dml.
**Tinctura Podophylli Indici	5 to 15 min.	3 to 10 Dml.
†Tinctura Pruni Virginianæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Quassiæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Quillaiæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Quininæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Quininæ Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Rhei Composita	½ to 1 dr. (R.A.)	2 to 4 Mils.
	2 to 4 dr. (S.A.)	8 to 15 Mils.
†Tinctura Scillæ	5 to 15 min.	3 to 10 Dml.
†Tinctura Senegæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Sennæ Composita	½ to 1 dr. (R.A.)	2 to 4 Mils.
	2 to 4 dr. (S.A.)	8 to 15 Mils.
†Tinctura Serpentariæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Stramonii	5 to 15 min.	3 to 10 Dml.
†Tinctura Strophanthi	5 to 15 min.	3 to 10 Dml.
†Tinctura Sumbul	½ to 1 fl. dr.	2 to 4 Mils.
**Tinctura Tinosporæ	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Tolutana	½ to 1 fl. dr.	2 to 4 Mils.
**Tinctura Urgineæ	5 to 15 min.	3 to 10 Dml.
†Tinctura Valerianæ Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
**Tinctura Valerianæ Indicæ Ammoniata	½ to 1 fl. dr.	2 to 4 Mils.
†Tinctura Zingiberis	½ to 1 fl. dr.	2 to 4 Mils.
**Turpethum	5 to 20 gr.	3 to 12 Dgm.
**Tylophoræ Folia	¼ to 2 gr. (as expectorant)	15 to 120 Mgm
	15 to 30 gr. (as emetic)	1 to 2 Gm.
†Vinum Antimoniale	10 to 30 min.	½ to 2 Mils.
	2 to 4 fl. dr. (as emetic)	8 to 15 Mils.
†Vinum Colchici	10 to 30 min.	½ to 2 Mils.
†Vinum Ferri	1 to 4 fl. dr.	4 to 15 Mils.
†Vinum Ferri Citratis	1 to 4 fl. dr.	4 to 15 Mils.
†Vinum Ipecacuanhæ	10 to 30 min. (as expectorant)	½ to 2 Mils.
	4 to 6 fl. dr. (as emetic)	15 to 23 Mils.
†Vinum Quininæ	½ to 1 fl. oz.	15 to 30 Mils.
†Zinci Acetas	1 to 2 gr.	6 to 12 Cgm.
†Zinci Oxidum	3 to 10 gr.	2 to 6 Dgm.
†Zinci Sulphas	1 to 3 gr. (as tonic)	½ to 2 Dgm.
	10 to 30 gr. (as emetic)	½ to 2 Gm.
†Zinci Valerianas	1 to 3 gr.	½ to 2 Dgm.

ABBREVIATIONS USED IN LATIN PRESCRIPTIONS.

A.C. : ante cibos, *before food.*
A.H. : alternis horis, *every other hour.*
A.J. : ante jentaculum, *before breakfast.*
A.M. : ante meridiem, *before noon.*
A.P. : ante prandium, *before dinner.*
Aa. : ana, *of each.*
Abd. : abdomen, *the belly.*
Abs. febr. : absente febri, *fever being absent.*
Acid. Hydroc. { Acidum Hydrochloricum, *or* Hydrocyanicum.
Ad alv. excitand. : ad alvum excitandam, *to stimulate the bowels.*
Ad defec. anim. : ad defectionem animi, *to fainting.*
Ad deliq. anim. : ad deliquium animi, *to fainting.*
Ad { 2 vic. : ad duas vices, *for two times (twice).* 3 vic. : ad tres vices, *for three times (thrice).*
Ad gr. acid. : ad gratum aciditatem, *to an agreeable acidity.*
Ad. lib. : at libitum, *at pleasure.*
Ad neutral. : ad neutralizandum, *to neutralization.*
Ad nuc. mosch. m. : ad nucis moschatæ magnitudinem, *a piece the size of a nutmeg.*
Ad recid. præc. : ad recidivum præcavendum, *to prevent a relapse.*
Ad sat. : ad saturandum, *to saturation.*
Ad { secund. / 3tiam. } vic. : ad { secundam / tertiam } vicem, *for the* { *2nd* / *3rd* } *time.*
Add. : adde, *add thou.*
Addend. : { addendus, a, um, *to be added.* addendo, *by adding* (gerund with Accusative).
Admov. : { admove, *apply thou.* admoveatur, *let it be applied.* admoveantur, *let them be applied,*
Ads. febr. : adstante febri, *while fever is present.*
Adv. : adversus *or* adversum (with Accus.), *against.*
Æg. : æger, ægra, *the patient.*
Aggr. febr. : aggrediente febri, *while fever is coming on.*
Alt. : altera (pars), *the remainder*; alternus, a, um, *alternate.*
Altern. d. : alterno die, / Altern. dieb. : alternis diebus, } *every other day.*
Altern. hor. : alterna hora, *or* alternis horis, / Altern. qq. hor. : alterna quaque hora, } *every other hour.*
Alv. adstrict. : alvo adstricta, *the bowels being confined.*
Alv. laxat. : alvo laxata, *the bowels being relaxed.*
Amp. : amplus, a, um, *full, large,* also ampulla, *ampoule, flask,* or *bottle.*
Ante, *before* { cœn. : cœnam, *supper* (often *dinner*). jentac. : jentaculum, *breakfast.* prand. : prandium, *dinner.*
Aper. : aperiens, *an aperient.*
Applic. : applicandus, a, um, *to be applied.*
Applicr. : applicetur, applicentur, *let it, let them, be applied.*
Aq. : aqua, *water.*
Aq. ad—— : Aquam ad——(governed by ℞).

Aquæ ad——(quantum sufficiat, *or* quantitatem sufficientem, *understood*) : *water up to*——
Aq. astr. : aqua astricta, *frozen water.*
Aq. bull. : aqua bulliens (entis), *boiling water.*
Aq. calid. : aqua calida, *hot water.*
Aq. chlor. : aqua chlori, *chlorine water.*
Aq. chlorof. : aqua chloroformi, *chloroform water.*
Aq. comm. : aqua communis, *common* or *plain water.*
Aq. dest. : aqua destillata, *distilled water.*
Aq. ferv. : aqua fervens (entis), *warm* or *hot water.*
Aq. fluv. : aqua fluvialis, *river water,*
Aq. font. : aqua fontana; *or* aqua fontis, *spring water.*
Aq. fort. : aqua fortis, *nitric acid.*
Aq. gel. : aqua gelida, *cold water.*
Aq. mar. : aqua marina, *sea water.*
Aq. niv. : aqua nivalis, *snow water.*
Aq. pluv. : aqua pluvialis, *rain water.*
Aq. pur. : aqua pura, *pure water* [*filtered, not distilled*].
Aur. dextr. *vel* læv. : auri dextræ, *or* lævæ, *to right* or *left ear.*
Ad. aur. : ad aurem, *to the ear.*
P. aur. : pone aurem, *behind the ear.*

B. : bis, *twice.*
B.A. : balneum arenæ, *a sand-bath.*
BB. *or* BBDS. : Barbadensis, *Barbados.*
B.M. : balneum Mariæ, *water bath*; b. maris, *sea-water bath.*
B.P. *or* B.Ph., *British Pharmacopœia.*
B.P.C. : *British Pharmaceutical Codex.*
B.T. : balneum tepidum, *a tepid bath.*
B.V. : balneum vaporis, *a vapour bath.*
Bals. : balsamum, *balsam.*
Bib. : bibe, *drink.*
Bid. : bidium, *two days.*
Bis { d. : bis die / d.d. : bis de die } *or* bis in d. : { bis in die / bis in dies } *twice a day.*
Brach. : brachium, *the arm.*
Brev. : brevis, e, *short.*
Bull. : bulliens, *boiling.*
But. : butyrum, *butter.*
But. ant. : butyrum antimonii, *butter of antimony.*

C. : congius, *a gallon.* C. : centum, 100. C. : cum, *with.*
C.C. : cornu cervi, *hartshorn.*
[C.C., *old style* : cucurbitula cruenta, *cupping glass with scarificator.*]
C.C.U. : cornu cervi ustum, *burnt hartshorn.*
C.c. : *cubic centimetre, millilitre.*
C. l. q. s. : cuilibet quantum sufficiat, *as you please, a sufficient quantity.*
C.M. : cras mane, *to-morrow morning*; C.M.S. : cras mane sumendus, a, um, *to be taken to-morrow morning.*
C.N. : cras nocte, *to-morrow night.*
C.V. : cras vespere, *to-morrow evening.*
C. vin. : cyathus vinosus *or* vinarius, *a wine-glass.*

Cal. : calomelas, *calomel.*
Calc. chlor. : calcis chlorinatæ (gen.), *chloride of lime.* / calcii chloridum, *calcium chloride.*
Cap. : capiat, *let him take, or* capsula, *a capsule.*
Capr. : capiatur, *let it be taken.* / capiantur, *let them be taken.*
Cib. . cibus, *food.*
Circ. : circa, *around* ; or circiter, *about.*
Cml. : *centimil.*
Co. *or* comp. : compositus, a, um, *compound.*
Coch. : cochleare, *spoonful* [*from* cochlea, *a snail's shell*].
Coch. amp. : cochleare amplum / Coch. mag. : cochleare magnum } *a tablespoonful.*
Coch. med. : cochleare medium / Coch. mod. : cochleare modicum } *a dessertspoonful.*
Coch. min. : cochleare minimum / Coch. parv. : cochleare parvum } *a teaspoonful.*
Cochleat. : cochleatim, *by spoonfuls.*
Col. : cola, *strain thou.* colatus, a, um, *strained.* / colaturus, a, um, *about to strain* ; i.e., *sufficient to strain* / colatura, æ (subs.), *the strained portion.* / coletur, *let it be strained.* colentur, *let them be strained.* / Colocynthis, *Colocynth.*
Collut. : collutorium, *a mouth-wash.*
Collyr. : collyrium, *an eye-lotion.*
Conc. : concisus, *sliced, or* concentratus, *concentrated.*
Conf. : confectio, *a confection.*
Cong. : congius, *a gallon.*
Conserv. : conserva, æ, *a conserve.* / conserva, *keep thou.*
Cont. : contusus, a, um, *bruised.* Contrit. : contritus, *pounded.*
Cont. rem. *vel.* med. : continuentur remedia, *vel* medicamenta, *let the remedies be continued.*
Coq. : coque, *boil thou.*
Coq. ad. med. consumpt. : coque ad medietatis consumptionem, *boil down to half.*
Coq. in S.A. : coque in sufficiente (quantitate) aquæ, *boil in a sufficient quantity of water.*
Coq. s. a. : coque secundum artem, *boil according to art.*
Cort. : cortex, icis, *bark.*
Crast. : crastinus, *for to-morrow.*
Cret. præcip. : creta præcipitata, *precipitated chalk.*
Cret. ppt. : creta preparata, *prepared chalk.*
Cryst. : crystallus, *a crystal.*
Cuj. : cujus, *of which.* Cujusl. : cujuslibet, *of any.*
Cyath. : cyathus, *glass.*
Cyath. vinos. : cyathus vinosus, *wine-glass.*

D. : dosis, *dose* ; die, *a day.*
D. in dup. : detur in duplo, *let twice as much be given.*
D. in p. æ. : divide in partes æquales, *divide into equal parts.*
D.D. : detur ad ——, *let it be given up to* ——
D.P. : directione propria, *with a proper direction.*

D.P.C. : dosi pedetentim crescente, *the dose gradually increasing.*
D.S. : { da, signa, *give and sign.*
{ detur, signetur, *let it be given and signed.*
D. seq. : die sequente, *on the following day.*
D. secund., tert., *etc.* : diebus secundis, tertiis, *etc., every second, third day, etc.*
D. spiss. : debita spissitudine, *with a proper consistence.*
D. t. d. : dentur tales doses, *let such doses be given.*
Deaur. pil : deaurentur pilulæ, *let the pills be gilt.*
Dec. : decoctum, *a decoction.*
Decub. : decubitus, *of lying down.*
D. d. in d. : de die in diem.
De d. : de die, *daily*, or *from day to day.*
Deglut. : deglutiatur, *let it be swallowed.*
Dej. alv. : dejectiones alvi, *motions.*
Dent. ad scat. : dentur ad scatulam, *let them be put in a box.*
Dest : destillatus, a, um, *distilled.*
Det. : detur, *let it be given.*
Dext. lat. : dextro lateri, *to the right side.*
Dieb. altern. : diebus alternis, *every other day.*
Dil. : dilutus, a, um, *diluted.*
Diluc. : diluculo, *at break of day.*
Dim. : dimidium (subs.), *the half;* dimidius, a, um, *half.*
Div. : divide, *divide.*
Dml. : *decimil.*
Donec alv. bene respond. : donec alvus bene responderit, *until the bowels have been well opened.*
Donec alv. bis dej. : donec alvus bis dejecerit, *until the bowels have acted twice.*
Donec alv. solut. fuer. : donec alvus soluta fuerit, *until the bowels have acted.*
Donec dol. exulav. : donec dolor exulaverit [also exsulaverit], *until the pain is relieved.*
Dos. : dosis, *a dose.*
Dr. : drachma, *a drachm.*
Dulc. : dulcis, e, *sweet.*
Dup. : } duplex, *double.*
Dx. : }
Dur. : durus, a, um, *hard.*

E gel. vit. : e gelatina vituli, *in calf's foot jelly.*
E paul. aq. : E paulo aqua, *in a little water.*
E quol. vehic. idon. : e quolibet vehiculo idoneo, *in any suitable vehicle.*
Ead. : eadem, *the same.*
Ed. : [*old*] edulcoratus, a, um, *purified.*
E.g. : exempli gratia, *for instance.*
Ejusd. : ejusdem, *of the same.*
Elect. : electuarium, *an electuary.*
Elect. : [*commercial*] electus, a, um, *picked, select, choice.*
Emet. : emeticum, *an emetic.*
Emp. : emplastrum, *a plaster.*
Emp. lyth. : emplastrum lythargyri, *lead plaster.*

Emp. lytt.: emplastrum lyttæ, *a blister.*
Enem.: enema, n., *an enema.*
Esur.: esuriens, *fasting*, i.e., *before food.*
Evac.: evacuatio, *a motion.*
Ex. aq.: Ex aqua, *in water.*
E. paul. aq.: e paulo aquæ, *in a little water.*
Ex. aq. { coch. ampl.: / cyath. vinos.: } ex. aquæ { cochleari amplo, / cyatho vinoso, } *in a tablespoonful / in a wine-glass of water*
Exhib.: exhibeatur, *let it be exhibited.*
Ex paul.: ex paulo [correctly, E paulo], *in a little.*
Exprim.: exprime, *express.*
Ext.: extractum, *an extract.*
Ext. Col. Co.: extractum colocynthidis compositum, *compound extract of colocynth.*
Ext. colch.: extractum colchici, *extract of colchicum.*
Ext. sup. alut. moll.: extende super alutam mollem, *spread it on soft leather.*
Extemp.: ex tempore, *extemporary, on the spur of the moment.*
Extempl.: extemplo, *immediately.*
Extend.: extende, *spread.*

F., Ft.: fiat, fiant, *let it (them) be made.*
F. L. A.: fiat lege artis, *let it be made according to rule.*
F. M. *or* ft. mist.: fiat mistura, *let a mixture be made.*
F. S. A.: fiat secundum artem, *let it be made according to art.*
F. V.: fiat venæsectio, *bleed.*
Feb. dur.: febri durante, *during the fever.*
Fem. intern.: femoribus internis, *to the inner part of the thighs.*
Filtr. filtra, *filter*; filtrum, a *filter.*
Fist. arm.: fistula armata, *clyster pipe and bladder fitted for use.*
Fl.: fluidus, *liquid.*
Flav.: flavus, a, um, *yellow.*
Fol.: folium, a *leaf*,
Fort.: fortis, e, *strong.*
Frigid.: frigidus, a, um, *cold.*
Frust.: frustum, *a little bit*; frustillatim, *little by little.*
Ft. haust.: fiat haustus, *let a draught be made.*
Ft. pil.: fiat pilula, *or* fiant pilulæ, *let a pill*, or *pills, be made.*
Ft. pulv.: fiat pulvis, *let a powder be made.*
Fusc.: fuscus, a, um, *brown.*

G. G. G.: Gummi guttæ Gambiæ, *Gamboge.*
Gall.: Gallicus, *French.*
Garg.: gargarisma, *a gargle.*
Gel. quav.: gelatina quavis, *in any kind of jelly.*
Gr.: granum, *a grain.*
Grad.: gradatim, *by degrees.*
Grm.: gramma, *a gram.* Fr. *gramme.*
Grms.: grammata, *grams.*
Gtt.: guttæ, "*drops*"; Guttat.: guttatim, *by drops.*
Guttur. appl.: gutturi applicandus, a, um, *to be applied to the throat.*

H.: hora, *at the hour of*—[Ablative.]
H. d.: h. s.: hora decubitus; hora somni, *at bedtime.*
H. f.: hujus formæ, *of this shape* (emplast.).
H. p. n.: haustus purgans noster, "*our*" *aperient draught.*
Hab.: habeat, *let him have* (*or take*).
Habr.: habeantur, *let them be taken.*
Har. pil. iij. s.: harum pilulæ tres sumantur, *let three of these pills be taken.*
Hebdom.: hebdomada (Acc.), *for a week.*
Hirud.: hirudines, *leeches.*
Hora decubitus, *at bedtime.*
Hor. un. spat.: horæ unius spatio, *at the expiration of one hour.*
Hor. interm.: horis intermediis, *in the intermediate hours.*
Hst.: haustus, *a draught.*
Ht. t. d. d. s.: haustus ter de die sumendus, *the draught to be taken three times a day.*

Id.: idem, *the same.*
Impet. efferv.: impetu effervescentiæ, *during effervescence.*
Imprans.: impransus, a, um, *fasting.*
In d.: in dies, *from day to day.*
In decoct. hord.: in decocto hordei, *in barley water.*
In p. æq.: in partes æquales, *in* (i.e., *into*) *equal parts.*
In pulm.: in pulmento, *in gruel.*
Incis.: incisus, a, um, *cut, sliced.*
Inf.: infusum, *an infusion.*
Infric.: { infricetur, *let it be rubbed in.*
{ infricandus, a, um, *to be rubbed in.*
Infund.: infunde, *pour in.*
Infus.: infusa, *infuse.*
Inj.: injectio, *an injection.*
Inj. enem.: injiciatur enema, *let an enema be administered.*
Inj. hyp.: injectio hypodermica, *an hypodermic injection.*
Insip.: insipidus, a, um, *tasteless.*
Insp.: inspissare, *to thicken.*
Int.: inter, *between.*
Intim.: intime, *intimately.*
Involv.: involvere, *to roll in.*

Jentac.: jentaculum, *breakfast.*
Jul.: julepus, julepum, *or* julapium, *a julep.*
Jusc.: jusculum, *broth.*
Jusc. aven.: jusculum avenaceum, *gruel.*

Kal. ppt.: kali præparatum, *prepared kali* (*potassium carbonate*).

L.: Lac, tis, *milk.*
L. A.: lac asinarium *or* asinarum, *asses' milk.*
L. bov.: lac bovinum, *cows' milk.*
L. cap.: lac capræ, capreæ, *or* capellæ, *goats' milk.*
L. ov.: lac ovillum *or* ovinum, *ewes' milk.*
L. vac.: lac vaccæ, *cows' milk.*
Lat. dol.: lateri dolenti, *to the affected side.*
Lb., lib.: libra, *a pound.*
Lig.: lignum, *wood.*

Lin. p. a. infr.: linimentum parti affectæ infricandum, *the liniment to be rubbed on the affected part.*
Liq.: liquor, *a solution.*
Lot.: lotio, *a lotion.*
Luc. p.: luce prima, *early in the morning (at the first light)*

M.: minimum, *a minim.*
M.: misce, *mix* (bene), *well*; (intime), *thoroughly.* (S.A.: secundum artem), *pharmaceutically.*
M. d.: more dicto, *as directed.*
M. D. S.: misce, da, signa, *mix, give, and sign.*
M. D. U. (Hibern.): more dicto utendus, *to be used as directed.*
M. et v.: mane et vespere, *morning and evening.*
M. ft. Mist.: misce, fiat mistura, *mix, and let a mixture be made.*
M. p.: mane primo, *early in the morning*; or, mica panis, *a crumb of bread*; or, massa pilularum, *a pill-mass.*
M. q. dx.: mitte quantitatem duplicem, *send double quantity.*
M. S.: more solito, *in the usual manner.*
Man.: manipulus, *a handful.*
Mass.: massa, *a pill-mass.*
Mil.: millitre (*cubic centimetre*).
Mic. pan: mica panis, *a crumb of bread.*
Min.: minimum, *a minim.*
Mist.: mistura, *a mixture.*
Mitt.: mitte, *send.*
Mittr.: mittatur, mittantur, *let it (let them) be sent.*
Mittr. in phial.: mittantur in phialam, *let them be put into a phial.*
Mod. *or* Mor. { dict.: / præs.: } modo *or* more { dicto / præscripto, } *as prescribed.*
Moll.: mollis, e, *soft.*
Mr.: mistura, *a mixture.*

N.: nocte, *at night.*
N. M.: nux moschato, *the nutmeg.*
Ne tr. s. num: ne tradas sine nummo, *do not deliver unless paid.*
Neb.: nebula, *a spray.*
Nig.: niger, ra, rum, *black.*
Nim.: nimis, *too much.*
No.: numero, *in number.*
9bris: Novembris, *of November.*
Noct.: nocte, *at night.*
Nov.: novus, a, um, *new.*

O.: octarius, *a pint.*
O. alt. hor.: omnibus alternis horis, *every other hour.*
O. M.: omni mane, *every morning*; *or*, oleum morrhuæ, *cod liver oil.*
O. N.: omni nocte, *every night.*
O. O. O.: oleum olivæ optimum, *best olive oil.*
Ol.: oleum, *oil.*
Omn. bid.: omni biduo, *every two days.*
Op.: ope, *by means of*; alcoholis, *spirit*; luti, *luting.*
Ope penicilli. *with a camel-hair pencil.*

)pt. : optimus, *best.*
)v. : ovum, *an egg.*
)v. vitell. sol. : ovi vitello solutum, *dissolved, i.e., suspended, in yolk of egg.*
)z. : uncia, *an ounce* (avoirdupois).

'. : pondere, *by weight.*
'. a. a. : parti affectæ applicandus, a, um, *to be applied to the affected part.*
'. Æ. : partes æquales, *equal parts.*
'. B. *or* Ph. B. : *Pharmacopœia Britannica.*
'. C. : per centum, *per cent.*
'. d. : { per deliquium [old], *by deliquescence.* / pro dosi, *for a dose.*
'. M. : post meridiem, *afternoon*; primo mane, *early in the morning.*
'. P. : partes, *parts*; pulvis patrum [old], *Jesuits' Bark.*
'. p. a. : phiala prius agitata, *the bottle having been previously shaken.*
'. R. N. : pro re nata, *occasionally.*
art. { affect. : / dolent. : } parti { affectæ, / dolenti, } *to the* { *affected* / *painful* } *part.*
art. vic. : partitis vicibus, *in divided doses.*
arv. : parvus, a, um, *small.*
ast. : pasta, *a paste* : pastillus, *a pastille.*
ed. : pedetentim, *gradually.*
er bid., trid. : per biduum, triduum, *for a period of two* or *three days.*
er salt. : per saltum, *at a bound, by leaps.*
eract. op. emet. : peracta operatione emetici (*or*, emetica), *when the operation of the emetic is finished.*
ess. : pessus, *a pessary.*
n., *Pharmacopœia.* Continental, *Pharmacopœa.*
n. B. : *Britannica (British).*
n. Boruss. : Pharmacopœa Borussica (*Prussian*).
n. D. : *Dublinensis* (*Dublin*).
n. E. : Edinburgensis, Edinensis (*Edinburgh*).
n. G. or Germ. : Pharmacopœa Germanica (*German*)
n. Gall. : Pharmacopœa Gallica, *or*,
(Codex Medicamentarius (*Paris*).
n. Helv. : Pharmacopœa Helvetica *(Swiss).*
n. L. : *Londinensis* (*London*). Ph. U.S. : (*United States*).
nial : phiala, *a phial.*
g. : pigmentum, *a paint.*
oc. : poculum, *a cup.*
ond. : ponderosus, a, um, *heavy.*
ost qq. evac. : post quamque evacuationem, *after each motion.*
ost prand. : post prandium, *after dinner.*
ost sing. sed. liq. : post singulas sedes liquidas, *after each liquid motion.*
pt. : præparatus, a, um, *prepared.*
ro pot. s. : pro potu sumendus, a, um, *to be taken as a drink.*
ro. rat. æt. : pro ratione ætatis, *according to age.*

Prox. luc.: proxima luce [old], *on the next day.*
Pulv.: pulvis, *a powder.*
Pulv.: Hum.: pulvinar humuli, *a hop pillow.*
Pv.: parvus, a, um, small.

Q. dx.: quantitas duplex.
Q. l.: quantum libet,
Q. p.: quantum placet, } *as much as you please.*
QQ.: quaque, *every.*
4ta qq. hor.: quarta quaque hora, *every fourth hour.*
Q. S.: quantum sufficiat; quantitas sufficiens; quantum satis, *sufficient.*
Q. v.: quantum volueris, *as much as you please.*
Q. v.: quod vide, *which see.*
Quant. fab.: quantitas fabæ, *a piece the size of a bean.*
Quant. nuc.: quantitas nucis, *a piece the size of a nut.*
Quant. nuc. avell.: quantitas nucis avellanæ, *a piece the size of a filbert.*
Quant. nuc. jugl.: quantitas nucis juglandis, *a piece the size of a walnut.*
Quart.: quartus, a, um, *the fourth.*
Quat.: quater, *four times.*
Quot. mane: quolibet mane, *any morning.*

℞: recipe, *take.*
R. in pulv.: redactus in pulverem, *reduced to powder.*
Rad.: radix, *a root.*
Ras.: rasuræ, *shavings.*
Rect.: rectificatus, a, um, *rectified.*
Redig. in pulv.: redigatur in pulverem, *let it be reduced to powder.*
Reg.: regioni, *to the region.*

Reg.	cor.:	Regioni	cordis, *of the heart.*
	epigast.:		epigastricæ, *pit of the stomach.*
	hepat.:		hepatis, *of the liver.*
	umbilic.:		umbilici, *of the navel.*

Rep., Repet.: repetat, *let him repeat.*
Repr.: repetatur, *or*
Repetr.: repetantur, } *let* { *it* / *them* } *be repeated.*

S.: sumat, *let the patient take,* or, sine, *without.*
S.A.: secundum artem, *according to art,* i.e., *with pharmaceutical skill.*
S. d.: sic dicta, *so called.*
S.G.: *specific gravity* (or better Sp. Gr.).
S.I.: sine igne, *cold drawn.*
S.O.S.: si opus sit, *if there is need; if occasion require.*
S.s.: semisse (abl.), from semis, semissis (gen.), *the half.*
Also, s.s. sine sale, *without salt* [adeps].
S.S.S.: stratum super stratum, *layer upon layer.*
S.V.R.: spiritus vini rectificatus, *rectified spirit.*
S.V.T.: spiritus vini tenuior, *proof spirit.*
Sanguisug. vj.: Sanguisugæ sex, *six leeches.*
Scat.: scatula, *a box.*
Scrob. cord.: scrobiculo cordis, *to the pit of the stomach.*

Semidr.: semidrachma, *half a drachm.*
Semih.: semihora, *half an hour.*
Sbris: Septembris, *of September.*
Seq. luc.: sequenti luce, *the following day.*
Serv.: serva, *keep.*
Sesquih: sesquihora, *an hour and a half.*
Sesunc.: sesuncia, *an ounce and a half.*
Si n. val.: si non valeat, *if it does not answer.*
Si vir. perm.: si vires permittant, *if the strength permit.*
Sig.: Signa, signetur, signentur, *sign, let it (them) be signed.*
Sing.: singulorum, *of each.*
Sing. auror.: singulis auroris, *every morning.*
Sing. hor. quad.: singulis horæ quadrantibus, *every quarter of an hour.*
Solv.: solve, *dissolve*; also solvellæ, *soluble tablets.*
Sp.: spiritus, *spirit* (of any kind).
St.: stet, stent, *let it (them) stand.*
Stat.: statim, *immediately.*
Stat. eff.: statu effervescentiæ, *whilst effervescing.*
Sub fin. coct.: sub finem coctionis, *when sufficiently boiled down [at the end of the boiling].*
Suff.: sufficiens, tis, *sufficient.*
Sum.: sumat, *let the patient take.*
Sum. tal.: sumat talem, tales, *let the patient take one (or more) such.*
Sumend.: sumendus, a, um, *to be taken.*
Sumr.: sumatur, sumantur, *let it (them) be taken.*
Supp.: suppositorium, *a suppository.*
Syr.: syrupus, *syrup.*

Ter., ter, *thrice.*
Ter. d. d.: ter de die, *thrice a day.*
Ter. d. s.: ter die sumendus, a, um, *to be taken three times a day.*
Ter. i. d.: ter in die, *three times a day.*
Ter. O.: tinctura opii, *tincture of opium.*
Tab.: tabletta, *or* tabella, *a tablet.*
Temp. dext.: tempori dextro, *to the right temple.*
Ter sim.: tere simul, *rub together.*
Tr.: tinctura, *a tincture.*
Trit.: tritura, *triturate.*
Troch.: trochisci, *lozenges.*
Tuss.: tussis, *a cough.*

U.S.P.: *Pharmacopœia of the United States.*
Ult. præscrip: ultimo præscriptus, a, um, etc., *the last ordered.*
Ung.: unguentum, *an ointment.*
Ut dict.: ut dictum, *as directed.*
Ut supr.: ut supra, *as above.*

V.: vespere, *in the evening.*
V.O.S.: vitello ovi solutus, a, um, *dissolved in yolk of egg.*
Vit.: vitellus, *the yolk.*
Vs.: venæsectio, *bleeding.*

Z.Z.: zingiber, *ginger.*
Z.Z.: [mediæval] *myrrh.*

MATERIA MEDICA OF

A tabular statement—based on the British Pharmacopœia, 1898, 'Materia Medica'—giving the chief particulars concerning

Name of Drug.	Natural Origin.	Family or Order.
Acaciæ Cortex	*Acacia Arabica* or *Acacia decurrens*	Leguminosæ
Acaciæ Gummi	*Acacia Senegal*, and other species	Leguminosæ
Acalypha	*Acalypha Indica*	Euphorbiaceæ
Aconiti Folia (Herba)	*Aconitum Napellus*	Ranunculaceæ
Aconiti Radix	*Aconitum Napellus*	Ranunculaceæ
Acori Calami Rhizoma	*Acorus Calamus*	Aroideæ
Adeps	*Sus scrofa*	Ungulata
Adeps Lanæ	*Ovis Aries*	Ungulata
Adhatoda	*Adhatoda Vasica*	Acanthaceæ
Agropyrum	*Agropyrum repens*	Gramineæ
Ajowan Oleum	*Carum copticum*	Umbelliferæ
Aloe Barbadensis	*Aloe Chinensis*, *A. vera*, and other species	Liliaceæ
Aloe Capensis	*Aloe ferox*, and other species	Liliaceæ
Aloe Natalensis	*Aloe ferox*, and other species	Liliaceæ
Aloe Socotrina	*Aloe Perryi*, and other species	Liliaceæ
Aloinum	Aloes (various)	Liliaceæ
Alstonia	*Alstonia scholaris* and *Alstonia constricta*	Apocynaceæ
Althæa	*Althæa officinalis*	Malvaceæ
Ammoniacum	*Dorema Ammoniacum*, and other species	Umbelliferæ
Amygdala Amara	*Prunus Amygdalus*, var. *amara*	Rosaceæ
Amygdala Dulcis	*Prunus Amygdalus*, var. *dulcis*	Rosaceæ
Amygdalæ Oleum	*Prunus Amygdalus*, vars. *amara* and *dulcis*	Rosaceæ
Amylum	*Triticum sativum*, *Zea Mays*, and *Oryza sativa*	Gramineæ
Anchusæ Radix	*Alkanna tinctoria*	Borragineæ
Andrographis	*Andrographis paniculata*	Acanthaceæ
Anethi Fructus	*Peucedanum graveolens*	Umbelliferæ
Anethi Oleum	*Peucedanum graveolens*	Umbelliferæ
Anisi Fructus	*Pimpinella Anisum*	Umbelliferæ
Anisi Oleum	*Pimpinella Anisum* or *Illicium verum*	Umbelliferæ / Magnoliaceæ

VEGETABLE AND ANIMAL ORIGIN.

the Indian and Colonial Addendum, 1900, and Humphrey's
the drugs included in the Minor Examination Syllabus.

Geographical Source.	Brief Description.	Chief Constituents.
Arabia, Africa, India, and Australia	Dried bark	Tannic and gallic acids.
Kordofan, Senegambia, etc.	Dried gummy exudation	Calcium arabate (Arabin).
India	Fresh or dried herb....	Acalyphine and resin.
Britain	Fresh leaves and flowering tops	Aconitine.
Britain	Dried root	Aconitine.
Holland and Germany	Dried rhizome	Volatile oil, and acorin
Domesticated everywhere	Purified abdominal fat	Stearin, palmitin, and olein.
Domesticated everywhere	Purified cholesterin-fat of sheep's wool	Cholesterin and iso-cholesterin.
India	Fresh or dried leaves ..	Vasicine.
Europe, Asia, America, etc.	Dried rhizome	Triticin.
India, Persia, Africa, etc.	Volatile oil	Thymol.
Dutch West Indian Islands (Curaçao, etc.).	Inspissated juice of leaves	Barbaloin, iso-barbaloin and emodin.
Cape Colony	Inspissated juice of leaves	Barbaloin, β-barbaloin, and emodin.
Natal	Inspissated juice of leaves	Nataloin and homo-nataloin.
Socotra and Eastern Africa	Inspissated juice of leaves	Barbaloin, iso-barbaloin, and emodin.
West Indies, Africa, etc.	Bitter principle.....	Barbaloin.
India, Philippine Islands, and Australia	Dried bark	Ditamine and other alkaloids.
England, Germany, Belgium, and France	Decorticated or peeled and dried root	Mucilage.
Central Persia	Gum-resinous exudation from stem	Resin, gum, and volatile oil.
South of France, Sicily, and Northern Africa	Ripe seeds	Fixed oil and amygdalin.
Spain, Portugal, South of France, Sicily and Northern Africa	Ripe seeds	Fixed oil.
Spain, Portugal, Sicily, etc.	Fixed oil from seeds ..	Olein and other glycerides
Temperate and subtropical climates	Carbohydrate	Granulose and cellulose.
Hungary, Greece, and Asia Minor	Dried root	Alchusic and alkannic acids, and alkannin
India	Dried plant	Bitter principle.
England, Germany, and India	Dried ripe fruit.....	Volatile oil.
England and Germany	Volatile oil from fruits	Carvone.
Russia, Germany, Spain, Italy, etc.	Dried ripe fruit	Volatile oil.
China, Tonkin, and Europe	Volatile oil from fruits	Anethol.

Name of Drug.	Natural Origin.	Family or Order.
Anisi Stellati Fructus	*Illicium verum*	Magnoliaceæ
Anthemidis Flores	*Anthemis nobilis*	Compositæ
Anthemidis Oleum	*Anthemis nobilis*	Compositæ
Arachis Oleum	*Arachis hypogæa*	Leguminosæ
Araroba	*Andira Araroba*	Leguminosæ
Arecæ Semina	*Areca Catechu*	Palmeæ
Aristolochia	*Aristolochia Indica*	Aristolochiaceæ
Armoraciæ Radix	*Cochlearia Armoracia*	Cruciferæ
Arnicæ Flores	*Arnica montana*	Compositæ
Arnicæ Rhizoma	*Arnica montana*	Compositæ
Asafetida	*Ferula fœtida*, and other species	Umbelliferæ
Aurantii Floris Aqua	*Citrus Aurantium*, var. *Bigaradia*	Rutaceæ
Aurantii Cortex	*Citrus Aurantium*, var. *Bigaradia*	Rutaceæ
Aurantii Cortex Indicus	*Citrus Aurantium*, varieties grown in India and Ceylon	Rutaceæ
Azadirachta Indica	*Melia Azadirachta*	Meliaceæ
Balsamum Peruvianum	*Myroxylon Pereiræ*	Leguminosæ
Balsamum Tolutanum	*Myroxylon Toluifera*	Leguminosæ
Bebeeru Cortex	*Nectrandra Rodiæi*	Laurineæ
Belæ Fructus	*Ægle Marmelos*	Rutaceæ
Belladonnæ Folia	*Atropa Belladonna*	Solanaceæ
Belladonnæ Radix	*Atropa Belladonna*	Solanaceæ
Benzoinum	*Styrax Benzoin*, and other species	Styraceæ
Berberidis Cortex	*Berberis vulgaris*	Berberideæ
Berberis	*Berberis aristata*	Berberideæ
Betel	*Piper Betle*	Piperaceæ
Bryoniæ Radix	*Bryonia dioica*	Cucurbitaceæ
Buchu Folia	*Barosma betulina*	Rutaceæ
Buteæ Gummi	*Butea frondosa*	Leguminosæ
Buteæ Semina	*Butea frondosa*	Leguminosæ
Cadinum Oleum	*Juniperus Oxycedrus*, and other species	Coniferæ
Cajuputi Oleum	*Melaleuca leucadendron*	Myrtaceæ
Calendula	*Calendula officinalis*	Compositæ
Calotropis	*Calotropis procera* and *Calotropis gigantea*	Asclepiadeæ
Calumbæ Radix	*Jateorrhiza Columba*	Menispermaceæ
Cambogia	*Garcinia Hanburii*	Guttiferæ

Geographical Source.	Brief Description.	Chief Constituents.
China	Dried ripe fruit	Volatile oil.
Britain, Belgium, France, etc.	Dried expanded flower-heads	Volatile oil.
England and Germany	Volatile oil	Alcohols and esters
India, China, and America	Fixed oil	Olein and other glycerides.
Bahia (Brazil)	Crude chrysarobin	Chrysarobin and dichrysarobin.
India and the Philippine Islands	Ripe seeds	Arecoline and other alkaloids.
India and the Eastern Colonies	Dried stem and root	Aristolochine and volatile oil.
Britain	Fresh root	Sinigrin and myrosin
Central and Southern Europe	Dried flowers	Arnicin, volatile oil, resin, and arnisterin.
Central and Southern Europe	Dried rhizome and rootlets	Arnicin, volatile oil, and arnisterin.
Persia and Afghanistan	Gum-resinous exudation from stem and root	Resin, gum, and volatile oil.
Southern Europe	Water distilled from flowers	Volatile oil.
Spain and Sicily	Fresh or dried outer part of rind	Volatile oil.
India and Ceylon	Fresh or dried outer part of rind	Volatile oil
Southern India, Ceylon, etc.	Dried stem bark	Resin and margosine.
San Salvador	Balsam from trunk	Cinnamein.
New Granada	Balsam from trunk	Cinnamic acid and cinnamein.
Guiana	Dried bark	Beberine and other alkaloids.
India	Fresh half-ripe fruit	Mucilage and pectin.
Britain and Germany	Fresh leaves and branches	Hyoscyamine and atropine .
Britain and Germany	Dried root	Hyoscyamine and atropine
Siam and Sumatra	Balsamic resin	Benzoic and cinnamic acids.
Britain	Dried bark	Berberine and other alkaloids.
India and Ceylon	Dried stem	Berberine and other alkaloids.
India, Ceylon, etc.	Dried leaves	Volatile oil.
England and Central and Southern Europe	Fresh and dried root	Bryonin and bryoresin.
Cape Colony	Dried leaves	Volatile oil and mucilage.
India	Inspissated juice	Tannic and gallic acids.
India	Ripe seeds	Fixed oil.
South of France	Empyreumatic oily liquid	Cadinene.
East and West Indies	Volatile oil from leaves	Cineol.
Levant and Southern Europe	Dried ray-florets	Calendulin, volatile oil, and resin.
India	Dried root-bark	Bitter and acid resins.
Eastern Africa	Dried slices of root	Calumbamine, palmatine, and jateorhizine.
Siam	Gum-resin	Resin and gum.

Name of Drug.	Natural Origin.	Family or Order.
Cambogia Indica	*Garcinia Morella*	Guttiferæ
Camphora	*Cinnamomum Camphora*	Laurineæ
Canellæ Cortex	*Canella alba*	Canellaceæ
Cannabis Indica	*Cannabis sativa*	Urticaceæ
Cantharis	*Cantharis vesicatoria*	Coleoptera
Caoutchouc	*Hevea Brasiliensis*	Euphorbiaceæ
Capsici Fructus	*Capsicum minimum*	Solanaceæ
Carbo Animalis	Bones	Various
Carbo Ligni	Wood	Various
Cardamomi Semina	*Elettaria Cardamomum*	Scitamineæ
Carui Fructus	*Carum Carvi*	Umbelliferæ
Carui Oleum	*Carum Carvi*	Umbelliferæ
Caryophylli Oleum	*Eugenia caryophyllata*	Myrtaceæ
Carophyllum	*Eugenia caryophyllata*	Myrtaceæ
Cascara Sagrada	*Rhamnus purshianus*	Rhamneæ
Cascarilla	*Croton Eluteria*	Euphorbiaceæ
Cassiæ Cortex	*Cinnamomum Cassia*	Laurineæ
Cassiæ Flores	*Cinnamomum Cassia*, and other species	Laurineæ
Cassiæ Pulpa	*Cassia Fistula*	Leguminosæ
Castoreum	*Castor Fiber*	Rodentia
Catechu	*Uncaria Gambier*	Rubiaceæ
Catechu Nigrum	*Acacia Catechu*	Leguminosæ
Cera Alba	*Apis mellifica*	Hymenoptera
Cera Flava	*Apis mellifica*	Hymenoptera
Cetaceum	*Physeter macrocephalus*	Cetacea
Cetraria	*Cetraria islandica*	Discomycetes or Discolichenes
Cevadilla	*Schœnocaulon officinalis*	Liliaceæ
Chenopodium	*Chenopodium ambrosioides* and *C. ambrosioides*, var. *anthelminticum*	Chenopodiaceæ
Chirata	*Swertia Chirata*	Gentianeæ
Chondrus	*Chondrus Crispus*	Gigartinaceæ
Chrysarobinum	Araroba	Leguminosæ
Cimicifugæ Rhizoma	*Cimicifuga racemosa*	Ranunculaceæ
Cinchonæ Flavæ Cortex	*Cinchona Calisaya*	Rubiaceæ

Geographical Source.	Brief Description.	Chief Constituents.
India	Gum-resin	Resin and gum.
China, Formosa, and Japan	White crystalline solid distilled from the wood	It is a ketone or a keto-tetrahydro-cymene.
West Indies	Dried bark	Volatile oil and bitter principle.
India	Dried flowering or fruiting tops of pistillate plants	Cannabin (cannabinone).
Spain, France, Sicily, Hungary, and Southern Russia	Dried beetle	Cantharidin.
Brazil	Prepared latex	Pure caoutchouc.
Zanzibar, Sierra Leone, etc.	Dried ripe fruit	Capsaicin.
Britain	Carbonaceous residue of bones	Calcium phosphate and carbon.
Britain	Carbonaceous residue of wood	Carbon.
India and Ceylon	Dried ripe seeds	Volatile oil.
Europe	Dried fruit	Volatile oil.
Central and Northern Europe	Volatile oil from fruit	Carvone.
Britain and Germany	Volatile oil from flower-buds	Eugenol.
Zanzibar, Pemba, etc.	Dried flower-buds	Volatile oil.
North California	Dried bark	Bitter substance and emodin.
Bahama Islands	Dried bark	Cascarillin, cascarilline and volatile oil.
Southern China	Dried bark	Volatile oil.
Southern China	Immature fruits	Volatile oil.
India	Pulp from the pods	Sugar, mucilage, and pectin
Hudson's Bay Territory, etc.	Dried preputial follicles	Resin and volatile oil.
Malay Archipelago	Extract of leaves and young shoots	Catechin and catechu-tannic acid.
India and Burmah	Extract of heartwood	Catechu-tannic acid and acacatechin.
Britain, etc.	Bleached wax from honeycomb	Myricin and cerotic acid.
Britain, etc.	Wax from honeycomb	Myricin and cerotic acid.
Pacific and Indian Oceans	Concrete fatty substance from head	Cetyl palmitate (Cetin)
Britain, etc.	Dried lichen	Lichenin and isolichenin.
Mexico, Guatemala, and Venezuela	Dried ripe seeds	Cevadine.
United States	Dried fruit	Volatile oil.
Northern India	Dried plant	Ophelic acid and chiratin.
Ireland and Massachusetts	Dried plant	Carageenin and proteids.
Britain	Purified araroba	Chrysarobin and dichrysarobin.
Canada and United States	Dried rhizome and roots	Cimicifugin and racemosin.
Bolivia and Southern Peru	Dried bark	Quinine and other alkaloids.

Name of Drug.	Natural Origin.	Family or Order.
Cinchonæ Lancifoliæ Cortex	*Cinchona lancifolia*	Rubiaceæ
Cinchonæ Rubræ Cortex	*Cinchona succirubra*	Rubiaceæ
Cinnamodendron	*Cinnamodendron corticosum*	Canellaceæ
Cinnamomi Cortex	*Cinnamomum Zeylanicum*	Laurineæ
Cinnamomi Oleum	*Cinnamomum Zeylanicum*	Laurineæ
Cissampelos	*Cissampelos Pareira*	Menispermaceæ
Cocæ Folia	*Erythroxylum Coca*	Linaceæ
Cocculi Fructus	*Anamirta paniculata*	Menispermaceæ
Coccus	*Coccus Cacti*	Hemiptera
Cocos Oleum	*Cocos nucifera* and *C. butyracea.*	Palmeæ
Colchici Cormus	*Colchicum autumnale*	Liliaceæ
Colchici Semina	*Colchicum autumnale*	Liliaceæ
Colocynthidis Pulpa	*Citrullus Colocynthis*	Cucurbitaceæ
Condurango Cortex	*Gonolobus Condurango*	Asclepiadeæ
Conii Folia	*Conium maculatum*	Umbelliferæ
Conii Fructus	*Conium maculatum*	Umbelliferæ
Convallariæ Flores (Herba)	*Convallaria majalis*	Liliaceæ
Copaiba	*Copaifera Lansdorfii* and other species	Leguminosæ
Copaibæ Oleum	*Copaifera Lansdorfii* and other species	Leguminosæ
Coriandri Fructus	*Coriandrum sativum*	Umbelliferæ
Coriandri Oleum	*Coriandrum sativum*	Umbelliferæ
Coscinium	*Coscinium fenestratum*	Menispermaceæ
Coto	Species of *Cryptocarya*	Laurineæ
Crocus	*Crocus sativus*	Irideæ
Crotonis Oleum	*Croton Tiglium*	Euphorbiaceæ
Cubebæ Fructus	*Piper Cubeba*	Piperaceæ
Cubebæ Oleum	*Piper Cubeba*	Piperaceæ
Cucurbitæ Semina Præparata	*Cucurbitæ maxima*	Cucurbitaceæ
Cumini Fructus	*Cuminum Cyminum*	Umbelliferæ
Curara	*Strychnos toxifera*	Loganiaceæ
Curcumæ Rhizoma	*Curcuma longa*	Scitamineæ
Cuspariæ Cortex	*Galipea officinalis.*	Rutaceæ
Cusso	*Brayera anthelmintica*	Rosaceæ
Cydoniæ Semina	*Pyrus Cydonia*	Rosaceæ
Damiana	*Turnera diffusa*, var. *aphrodisaica* and other species	Turneraceæ

Geographical Source.	Brief Description.	Chief Constituents.
New Granada.....	Dried bark	Quinine and other alkaloids.
India, Jamaica Ceylon, etc.	Dried bark of stem and branches of cultivated plants	Quinine, cinchonidine, cinchonine, quinidine, and other alkaloids.
Jamaica	Dried bark	Volatile oil and tannin.
Ceylon	Dried inner bark of shoots from truncated stocks	Volatile oil.
Ceylon and England ..	Volatile oil from bark..	Cinnamic aldehyde and eugenol.
India	Dried root	Beberine (Pelosine).
Bolivia and Peru	Dried leaves	Cocaine and other alkaloids.
India and Malay Archipelago	Dried fruit	Picrotoxin.
Mexico and Canary Islands	Dried fecundated female insects	Carminic acid.
India, Ceylon, etc.	Solid white fat	Various glycerides.
England, Ireland, etc...	Fresh and dried corms	Colchicine.
England, Ireland, etc...	Dried ripe seeds	Colchicine.
Northern Africa, Syria, Spain, Cyprus, etc.	Dried pulp of fruit, freed from seeds	Citrullol, and an active alkaloid.
Ecuador	Dried bark	Condurangin.
Britain and Central Europe	Fresh leaves and young branches	Coniine and conhydrine.
Britain and Central Europe	Dried full-grown unripe fruits	Coniine and conhydrine.
England	Dried inflorescence or entire plant	Convallamarin and convallarin.
Central and South America	Oleo-resin from trunk..	Volatile oil and resin.
Britain and Germany..	Volatile oil from oleo-resin	Caryophyllene.
Russia, Thuringia, etc.	Dried ripe fruit	Volatile oil.
Britain and Germany..	Volatile oil from fruit..	d-Linalool (Coriandrol).
India and Ceylon	Dried stem	Berberine and saponin.
Bolivia	Dried bark	Cotoin.
Spain, France, Austria, and Italy	Dried stigmas and tops of styles	Volatile oil, picrocrocin, and crocin.
India and England	Expressed oil from seeds	Crotonoleic acid and croton-resin.
Java, Sumatra and Borneo	Dried full-grown unripe fruit	Volatile oil and cubebin.
England and Germany.	Volatile oil from fruit..	Cadinene.
Levant and India.....	Prepared fresh ripe seeds	Acrid resin.
Northern Africa, Sicily, Malta, and India	Dried fruit	Volatile oil.
South America	Extract from bark	Curarine and curine.
India, China, Java, etc.	Dried rhizome	Curcumin and volatile oil.
Venezuela	Dried bark	Volatile oil, angosturin, and various alkaloids.
Abyssinia.....	Dried panicles of pistillate flowers	Kosotoxin, protokosin, and kosidin.
Persia and Central Europe	Dried ripe seeds	Mucilage, amygdalin, and emulsin.
South America and West Indies	Dried leaves	Volatile oil and damianin.

Name of Drug.	Natural Origin.	Family or Order.
Daturæ Folia	*Datura fastuosa*, var. *alba*, and *D. Metel*	Solanaceæ
Daturæ Semina	*Datura fastuosa*, var. *alba*	Solanaceæ
Digitalis Folia	*Digitalis purpurea*	Scrophularineæ
Dulcamara	*Solanum Dulcamara*	Solanaceæ
Elaterium	*Ecballium Elaterium*	Cucurbitaceæ
Elemi	*Canarium commune* and other species	Burseraceæ
Embelia	*Embelia Ribes and E.robusta*	Myrsineæ
Ergota	*Claviceps purpurea* on *Secale cereale*	Pyrenomycetes Gramineæ
Erythrophlœi Cortex	*Erythrophlœum guineense*	Leguminosæ
Eucalypti Gummi	*Eucalytus rostrata* and other species	Myrtaceæ
Eucalypti Oleum	*Eucalyptus Globulus* and other species	Myrtaceæ
Euonymi Cortex	*Euonymus atropurpureus*	Celastrineæ
Euphorbiæ Herba	*Euphorbia pilulifera*	Euphorbiaceæ
Euphorbium	*Euphorbia resinifera*	Euphorbiaceæ
Fel Bovinum Purificatum	*Bos Taurus*	Ungulata
Ficus	*Ficus Carica*	Urticaceæ
Filix Mas	*Aspidium Filix-mas*	Filicineæ
Fœniculi Fructus	*Fœniculum capillaceum*	Umbelliferæ
Fœni-græci Semina	*Trigonella Fœnum-græcum*	Leguminosæ
Frangulæ Cortex	*Rhamnus Frangula*	Rhamneæ
Fucus	*Fucus vesiculosis*	Fucaceæ
Galangæ Rhizoma	*Alpinia officinarum*	Scitamineæ
Galbanum	*Ferula galbaniflua* and other species	Umbelliferæ
Galla	*Cynips Gallæ tinctoriæ* on *Quercus infectoria*	Hymenoptera, Cupuliferæ
Gaultheriæ Oleum	*Gaultheria procumbens*	Ericaceæ
Gelatinum	Skin and cartilage	Various
Gelsemii Radix	*Gelsemium nitidum*	Loganiaceæ
Gentianæ Radix	*Gentiana lutea*	Gentianeæ
Glucosum Liquidum	Starch	Various
Glycyrrhizæ Radix	*Glycyrrhiza glabra* and other species	Leguminosæ
Gossypii Radicis Cortex	*Gossypium herbaceum*	Malvaceæ
Gossypium	*Gossypium Barbadense* and other species	Malvaceæ
Graminis Citrati Oleum	*Andropogon citratis*	Gramineæ
Granati Cortex	*Punica Granatum*	Lythrarieæ
Granati Fructi Cortex	*Punica Granatum*	Lythrarieæ
Grindelia	*Grindelia squarrosa*, *G. camporum*, and *G. robusta*	Compositæ

Geographical Source.	Brief Description.	Chief Constituents.
India	Dried leaves	Hyoscine.
India	Dried seeds	Hyoscine.
England and Germany.	Dried leaves	Digitoxin and digitalin.
England	Stems and branches	Dulcamarin, and solanine.
England and Malta	Dried sediment from juice of fruit	Elaterin.
Philippine Islands	Oleo-resin	Volatile oil and resins.
East Indies	Dried ruit	Embelic acid.
Russia, Spain, Germany, etc.	Dried sclerotium of the fungus	Ergotamine, ergotoxine, and ergotinine.
Upper Guinea and Senegambia	Dried bark	Erythrophlœine.
Australia	Ruby-coloured exudation from bark	Kinotannic acid.
Australia and Tasmania	Volatile oil from fresh leaves	Cineol.
United States	Dried root-bark	Euonymin.
India, Australia, etc.	Aerial portion of plant.	Glucosidal matter.
Morocco	Gum-resin	Acrid resin.
Domesticated everywhere	Purified contents of gall-bladder	Sodium salts of glycocholic and taurocholic acids.
Smyrna and Greece	Dried fleshy receptacles	Grape sugar.
Britain	Dried rhizome	Filmarone, filicic acid, and aspidinol.
France, Germany, Russia, etc.	Dried ripe fruit	Volatile oil.
India, Egypt, and Morocco	Dried seeds	Mucilage, fixed oil, and proteids.
Britain	Dried bark	Frangulin, emodin, and iso-emodin.
Britain	Dried seaweed	Algin and various salts.
China and Siam	Dried rhizome	Volatile oil and galangol.
Persia	Gum resin	Resin, gum, and volatile oil.
Asia Minor, Persia, and Greece	Excrescences on bark caused by development of eggs	Gallotannic and gallic acids.
United States and Canada	Volatile oil from leaves or bark	Methyl salicylate.
Britain, France, etc.	Horny sheets	Glutin.
Southern United States	Dried rhizome and roots	Gelseminine and gelsemine.
Germany, Switzerland, France, and Spain	Dried rhizome and roots	Gentiopicrin.
United States	Syrupy liquid	Dextrose.
England, France, Spain, Russia, and Persia	Peeled root and subterranean stem	Glycyrrhizin.
India, Persia, and Southern Europe	Dried root-bark	Acid resin.
Tropical and subtropical countries	Hairs of seed	Cellulose.
India	Volatile oil	Citral.
Southern Europe and Central Asia	Dried bark of stem and root	Pelletierine and other alkaloids.
Southern Europe and Central Asia	Dried rind of fruit	Gum, sugar, and tannic acid.
North America	Dried leaves and flowering-tops	Resin and volatile oil.

Name of Drug.	Natural Origin.	Family or Order.
Guaiaci Lignum	*Guaiacum officinale* or *G. sanctum*	Zygophylleæ
Guaiaci Resina	*Guaiacum officinale* or *G. sanctum*	Zygophylleæ
Guarana	*Paullinia Cupana*	Sapindaceæ
Gummi Indicum	*Anogeissus latifolia*	Combretaceæ
Gutta Percha	*Palaquium oblongifolium* and other species	Sapotaceæ
Gynocardiæ Oleum	*Taraktogenos Kurzii*	Bixineæ
Hæmatoxyli Lignum	*Hæmatoxylon campechianum*	Leguminosæ
Hamamelidis Cortex	*Hamamelis virginiana*	Hamamelideæ
Hamamelidis Folia	*Hamamelis virginiana*	Hamamelideæ
Hellebori Nigri Rhizoma	*Helleborus niger*	Ranunculaceæ
Hemidesmi Radix	*Hemidesmus Indicus*	Asclepiadeæ
Hirudo	*Sanguisuga medicinalis* and *S. officinalis*	Gnathobdellida
Hirudo Australis	*Hirudo quinquestriata*	Gnathobdellida
Hordeum Decorticatum	*Hordeum distichon*	Gramineæ
Hydrastis Rhizoma	*Hydrastis Canadensis*	Ranunculaceæ
Hygrophila	*Hygrophila spinosa*	Acanthaceæ
Hyoscyami Folia	*Hyoscyamus niger*	Solanaceæ
Hyoscyami Semina	*Hyoscyamus niger*	Solanaceæ
Ichthyocolla	*Acipenser Huso* and other species	Chondrostei
Ignatii Semina	*Strychnos Ignatii*	Loganiaceæ
Indigo	*Indigofera tinctoria* and *I. Anil*	Leguminosæ
Inula	*Inula Helenium*	Compositæ
Ipecacuanhæ Radix	*Psychotria Ipecacuanha*	Rubiaceæ
Iridis Rhizoma	*Iris germanica*, *I. pallida*, and *I. florentina*	Irideæ
Ispaghula	*Plantago ovata*	Plantagineæ
Jaborandi Folia	*Pilocarpus Jaborandi*	Rutaceæ
Jalapa	*Ipomæa Purga*	Convolvulaceæ
Juniperi Oleum	*Juniperus communis*	Coniferæ
Kaladana	*Ipomæa hederacea*	Convolvulaceæ
Kamala	*Mallotus Philippinensis*	Euphorbiaceæ
Kavæ Rhizoma	*Piper methysticum*	Piperaceæ
Kino	*Pterocarpus Marsupium*	Leguminosæ
Kino Eucalypt	*Eucalyptus* species	Myrtaceæ
Kolæ Semina	*Cola vera*, *C. acuminata* and other species	Sterculiaceæ

Geographical Source.	Brief Description.	Chief Constituents.
West Indies and South America	Heart-wood.....	Resin.
West Indies and South America	Resin from stem	Guaiaconic, guaiaretic, and guaiacic acids.
Brazil and Uruguay....	Prepared seeds	Caffeine.
India and Ceylon	Gummy exudation	Arabic acid, and its salts.
Malay Archipelago	Dried and purified latex	Gutta.
Burmah	Fixed oil from seeds ..	Chaulmoogric acid.
Campeachy, Honduras, Jamaica, etc.	Heart-wood.....	Hæmatoxylin.
United States and Canada	Dried bark	Tannin.
United States and Canada	Fresh or dried leaves ..	Tannin.
Central and Southern Europe	Dried rhizome and rootlets	Helleborin and helleborein.
India and Ceylon	Dried root	Coumarin.
Germany, France, Hungary, etc.	Aquatic worm	Buccal secretion, contains hirudin.
Australia	Aquatic worm	
Britain	Fruit divested of integuments	Starch and albuminoids.
United States and Canada	Dried rhizome and roots	Berberine, hydrastine, and canadine.
India	Dried herb	Mucilage.
Britain and Germany..	Fresh or dried leaves and flowers, with or without branches	Hyoscyamine and hyoscine
Britain and Germany..	Dried seeds.....	Hyoscyamine and hyoscine
Caspian and Black Seas	Whitish shreds or horny sheets	Gelatin.
Philippine Islands	Dried seeds.....	Strychnine and brucine.
East and West Indies..	Blue pigment.....	Indigotin.
Holland, Switzerland, and Thuringia	Dried root and rhizome	Acrid resin and volatile oil
Brazil and Johore	Dried root	Emetine, cephaeline, and psychotrine.
Italy and Morocco	Dried rhizome	Myristic acid, irone and iridin.
India and Persia	Dried seeds.....	Mucilage.
Pernambuco and Ceara	Dried leaflets	Pilocarpine, isopilocarpine, and pilocarpidine
Mexico, Jamaica, and India	Dried tubercules	Jalapin and scammonin.
Northern Europe	Volatile oil from full-grown unripe fruit	Pinene and cadinene.
India	Dried seeds.....	Jalapin (Pharbitisin).
India, China, Ceylon, etc.	Glands and hairs from fruit	Rottlerin, iso-rottlerin, and resins.
Sandwich Islands.....	Dried decorticated rhizome	Acrid resin.
Malabar	Dried exudation from stem	Kinotannic acid.
Australia	Dried exudation from stem	Kinotannic acid.
West Indies, Brazil, Java, etc.	Dried kernels of seeds	Caffeine.

Name of Drug.	Natural Origin.	Family or Order.
Krameriæ Radix	*Krameria triandra* and *K. argentea*	Polygaleæ
Lacca	*Coccus Lacca*	Hemiptera
Lactuca	*Lactuca virosa*	Compositæ
Lactucarium	*Lactuca virosa*	Compositæ
Laricis Cortex	*Larix Europæa*	Coniferæ
Lauri Fructus	*Lauris nobilis*	Laurineæ
Laurocerasi Folia	*Prunus Laurocerasus*	Rosaceæ
Lavandulæ Oleum	*Lavandula vera*	Labiatæ
Limonis Cortex	*Citrus Medica*, var. β. *Limonum*	Rutaceæ
Limonis Oleum	*Citrus Medica*, var. β. *Limonum*	Rutaceæ
Limonis Succus	*Citrus Medica*, var. β. *Limonum*	Rutaceæ
Lini Oleum	*Linum usitatissimum*	Lineæ
Linum	*Linum usitatissimum*	Lineæ
Litmus	*Roccella tinctoria* and other species	Discomycetes
Lobelia	*Lobelia inflata*	Lobeliaceæ
Lupulinum	*Humulus Lupulus*	Urticaceæ
Lupulus	*Humulus Lupulus*	Urticaceæ
Lycopodium	*Lycopodium clavatum*, and other species	Lycopodiaceæ
Manna	*Fraxinus Ornus*	Oleaceæ
Marrubium	*Marrubium vulgare*	Labiatæ
Mastiche	*Pistacia Lentiscus*	Anacardiaceæ
Maté Folia	*Ilex paraguayensis*	Ilicineæ
Maticæ Folia	*Piper angustifolium*	Piperaceæ
Mel Depuratum	*Apis mellifica*	Hymenoptera
Menthæ Piperitæ Oleum	*Mentha piperita*	Labiatæ
Menthæ Viridis Oleum	*Mentha viridis*	Labiatæ
Mentho	*Mentha arvensis*, vars. *piperascens* and *glabrata*, and *Mentha piperita*	Labiatæ
Mezerei Cortex	*Daphne Mezereum*, *D. Laureola*, and *D. Gnidium*	Thymelaceæ
Morrhuæ Oleum	*Gadus Morrhua*	Teleostei

Geographical Source.	Brief Description.	Chief Constituents.
Brazil, Peru and Bolivia	Dried root	Krameria - tannic (Ratanhia-tannic) acid.
East Indies and Ceylon	Resinous exudation in flakes	Resin and laccinic acid.
Britain, France, Germany, etc.	Fresh herb	Lactucarium.
Britain, France, Germany, etc.	Dried exudation from stem	Lactucone, lactucin, lactucic acid and lactucopicrin.
England, Central and Southern Europe	Dried bark	Tannic acid and larixin.
Southern Europe and Syria	Ripe fruit	Fixed oil, volatile oil, and bitter principle
Britain and other temperate regions	Fresh leaves	Laurocerasin and emulsin
England, Southern Europe, and Northern Africa	Distilled oil from flowers	Linalool and linalyl acetate
Southern Europe	Fresh outer part of pericarp of fruit	Volatile oil.
Southern Europe	Volatile oil from outer part of pericarp of fruit	Citral, d-limonene, and l-limonene.
Southern Europe and West Indies	Freshly expressed juice of ripe fruit	Citric acid.
Britain	Fixed oil from seeds ..	Linolein.
Britain, Holland, Russia, etc.	Dried ripe seeds, entire or in coarse powder	Fixed oil and mucilage.
European and African Coasts	Blue pigment	Azolitmin and erythrolitmin.
North America	Dried flowering herb ..	Lobeline.
England, Germany, etc.	Glands from strobiles..	Volatile oil and lupamaric acid.
England, Germany, Russia, California, etc.	Dried strobiles	Lupulin.
Russia, Germany, and Switzerland	Pale yellowish spores..	Fixed oil.
Calabria and Sicily....	Concrete saccharine exudation	Mannite.
England and Southern France	Leaves and flowering tops	Marrubiin and volatile oil.
Grecian Archipelago ..	Concrete resinous exudation	Resin and volatile oil.
Brazil and Argentina ..	Dried leaves	Caffeine.
Peru, Bolivia, Brazil, etc.	Dried leaves	Volatile oil and tannin.
Domesticated everywhere	Clarified saccharine secretion	Dextrose and levulose.
England, France, Germany, and United States	Volatile oil from fresh plants	Menthol.
England and United States	Volatile oil from fresh plants	Carvone.
Japan, China, and United States	Crystalline substance from peppermint oil	Pure menthol.
Britain, Thuringia, France, etc.	Dried bark	Mezerein.
Northern Atlantic Ocean; off Norway, Newfoundland, etc.	Fixed oil from fresh livers	Jecolein and therapin.

Name of Drug.	Natural Origin.	Family or Order.
Moschus	*Moschus moschiferus*	Ungulata
Mucuna	*Mucuna pruriens*	Leguminosæ
Mylabris	*Mylabris phalerata*	Coleoptera
Myristica	*Myristica fragrans*	Myristicaceæ
Myristicæ Oleum	*Myristica fragrans*	Myristicaceæ
Myrobalanum	*Terminalia Chebula*	Combretaceæ
Myrrha	*Balsamodendron Myrrha*, and other species	Burseraceæ
Nux Vomica	*Strychnos Nux-vomica*	Loganiaceæ
Olibanum	*Boswellia Carterii*, and other species	Burseraceæ
Olivæ Oleum	*Olea europæa*	Oleaceæ
Oliveri Cortex	*Cinnamomum Oliveri*	Laurineæ
Opium	*Papaver somniferum*	Papaveraceæ
Os Sepiæ	*Sepia officinalis*	Cephalopoda
Ovum	*Gallus Bankiva*, var. *domesticus*	Gallinæ
Pancreatinum	*Sus scrofa*	Ungulata
Papaveris Capsulæ	*Papaver somniferum*	Papaveraceæ
Para Coto	Species of *Cryptocarya*.	Laurineæ
Paradisi Grana	*Amomum melegueta*	Scitamineæ
Pareiræ Radix	*Chondrodendron tomentosum*	Menispermaceæ
Pepsinum	*Sus scrofa*, *Ovis Aries*, or *Bos Taurus*	Ungulata
Physostigmatis Semina	*Physostigma venenosum*	Leguminosæ
Picrorhiza	*Picrorhiza Kurroa*	Scrophularineæ
Pimenta	*Pimenta officinalis*	Myrtaceæ
Pimentæ Oleum	*Pimenta officinalis*	Myrtaceæ
Pini Oleum	*Pinus Pumilio*	Coniferæ
Piper Longum	*Piper officinarum*, or *P. Longum*	Piperaceæ
Piper Nigrum	*Piper nigrum*	Piperaceæ
Pix Burgundica	*Picea excelsa*	Coniferæ
Pix Carbonis	Coal	Various
Pix Liquida	*Pinus sylvestris* and other species	Coniferæ
Podophylli Indica Resina	*Podophyllum Emodi*	Berberideæ
Podophylli Indica Rhizoma	*Podophyllum Emodi*	Berberideæ

Geographical Source.	Brief Description.	Chief Constituents.
Central Asia	Dried secretion from preputial follicles	Odorous principle.
Africa, India, and America	Hairs of fruit	Tannin and resin.
China, India, etc.....	Dried beetle	Cantharidin.
Moluccas, Banda Islands, etc.	Dried seed divested of testa	Volatile and fixed oils.
Moluccas, Banda Islands, etc.	Volatile oil from seed..	Camphene, pinene, dipentene, and myristicol.
India	Dried immature fruit ..	Tannic acid.
North-Eastern Africa and Southern Arabia	Gum-resin from stem..	Resin, gum, and volatile oil.
Bengal, Madras, Ceylon, Siam, etc.	Dried ripe seeds	Strychnine and brucine.
Southern Arabia and Somaliland	Gum-resin	Resin and volatile oil.
Spain, France, Italy, California, etc.	Expressed oil from ripe fruit	Olein, palmitin, and arachin.
New South Wales and Queensland	Dried bark	Volatile oil.
Asia Minor, Persia, India, etc.	Inspissated juice from unripe capsules	Morphine, codeine, and other alkaloids.
Mediterranean and Atlantic Oceans	Internal shell	Calcium carbonate.
Domesticated everywhere	Egg.....	Albumin, proteids, and fats.
Domesticated everywhere	Mixture of enzymes.....	Trypsin, amylopsin, and steapsin.
Britain and Asia Minor	Nearly ripe dried fruit	Morphine.
Bolivia.....	Dried bark	Paracotoin.
Western Africa.....	Dried seeds.....	Volatile oil and paradol.
Brazil and Peru	Dried root	Beberine (Pelosine).
Domesticated everywhere	Enzyme from mucous lining of fresh and healthy stomach	A soluble enzyme.
Western Africa.....	Ripe seeds	Physostigmine (Eserine).
Alpine Himalaya	Dried rhizome	Picrorhizin.
West Indies, Mexico, Jamaica, etc.	Dried full-grown unripe fruit	Volatile oil.
West Indies, Mexico, Jamaica, etc.	Volatile oil from unripe fruit	Eugenol.
Central Europe.....	Volatile oil from fresh leaves and shoots	Bornyl acetate, pinene, and other terpenes.
Malay Archipelago, or Bengal and Philippine Islands	Dried unripe fruit-spike	Volatile oil and piperine.
East Indies.....	Dried unripe fruit	Volatile oil, piperine, and chavacin.
Finland, Black Forest, and Jura Mountains	Resinous exudation from stem	Resin and volatile oils.
Britain	Nearly black viscid liquid	Phenol and its homologues.
Scotland, Denmark, Norway, and Russia..	Bituminous liquid from wood	Guaiacol and its homologues.
Northern India	Precipitated resin	Podophyllotoxin and picropodophyllin.
Northern India	Dried rhizome and roots	Podophyllin.

Name of Drug.	Natural Origin.	Family or Order.
Podophylli Resina	*Podophyllum peltatum*	Berberideæ .....
Podophylli Rhizoma ..	*Podophyllum peltatum*	Berberideæ .....
Populi Cortex.....	*Populus* species	Salicineæ .....
PruniVirginianæCortex	*Prunus serotina*	Rosaceæ .....
Prunum	*Prunus domestica*.....	Rosaceæ .....
terocarpi Lignum	*Pterocarpus santalinus*	Leguminosæ .....
Pyrethri Flores.....	*Pyrethrum cinerariæfolium*, and other species	Compositæ .....
Pyrethri Radix	*Anacyclus Pyrethrum*.....	Compositæ .....
Quassiæ Lignum	*Picræna excelsa*	Simarubeæ .....
Quercus Cortex.....	*Quercus Robur*	Cupuliferæ .....
Quillaiæ Cortex	*Quillaja saponaria*	Rosaceæ .....
Resina	*Pinus* species	Coniferæ .....
Rhei Radix.....	*Rheum palmatum. R. officinale*, and other species	Polygonaceæ .....
Rhœados Petala	*Papaver Rhœas*.....	Papaveraceæ .....
Ricini Oleum.....	*Ricinus communis*	Euphorbiaceæ .....
Rosæ Caninæ Fructus	*Rosa canina*	Rosaceæ .....
Rosæ Centifoliæ Petala	*Rosa centifolia*	Rosaceæ .....
Rosæ Gallicæ Petala ..	*Rosa gallica*	Rosaceæ .....
Rosæ Oleum	*Rosa damascena*	Rosaceæ .....
Rosmarini Oleum.....	*Rosmarinus officinalis*.....	Labiatæ .....
Rutæ Herba	*Ruta graveolens*	Rutaceæ .....
Sabinæ Cacumina.....	*Juniperus Sabina*.....	Coniferæ .....
Saccharum Lactis	*Bos Taurus*	Ungulata .....
Saccharum Purificatum	*Saccharum officinarum*	Gramineæ .....
Salicis Cortex.....	*Salix alba* and other species	Salicineæ .....
Sambuci Flores.....	*Sambucus nigra*.....	Caprifoliaceæ.....
Sandaraca	*Callitris quadrivalvis*.....	Coniferæ .....
Sanguinariæ Rhizoma..	*Sanguinaria Canadensis* ..	Papaveraceæ .....
Sanguis Draconis.....	*Calamus Draco*.....	Palmeæ.....
Santali Oleum	*Santalum album*	Santalaceæ .....

Geographical Source.	Brief Description.	Chief Constituents.
United States and Canada	Precipitated resin	Podophyllotoxin and picropodophyllin.
United States and Canada	Dried rhizome and roots	Podophyllin.
Britain, Central and Southern Europe	Dried bark	Salicin.
North America	Dried bark	Amygdalin and emulsin.
South of France	Dried ripe fruit.....	Sugar and various acids.
India, Ceylon and Southern Philippines	Reddish heart-wood ..	Santalin.
Dalmatia, Persia, and California	Dried unexpanded flower-heads	Pyrethrotoxic acid and volatile oil
Northern Africa, Levant, and Southern Europe	Dried root	Pyrethrine, resin, and fixed oils.
Jamaica and Caribbean Islands	Wood of trunk and branches	Picrasmin.
Europe	Dried young bark.....	Quercitannic acid.
Chili and Peru	Inner part of bark	Sapotoxin and quillajic acid.
North America	Residue left after distillation of oil of turpentine	Abietic acids.
China and Thibet.....	Dried rhizome, deprived of cortex	Rheopurgarin, catechin, emodin, glucogallin, and tetrarin.
Britain	Fresh petals	Rhœadic and papaveric acids.
India	Fixed oil from seeds ..	Ricinolein.
Britain	Dried ripe fruit	Citric and malic acids, sugar, and gum.
Western Asia and Europe	Fresh petals	Malic and tartaric acids, and volatile oil.
Southern Europe	Fresh and dried unexpanded petals	Red colouring matter and volatile oil.
Bulgaria, Persia, Cashmere, etc	Volatile oil from fresh flowers	Geraniol, citronellol, and their esters.
England, Southern France, and Dalmatian Islands	Volatile oil from flowering tops	Borneol and its esters
England and Southern Europe	Dried stem, leaves, and fruit	Volatile oil.
Britain and Southern Europe	Dried young shoots	Volatile oil.
Domesticated everywhere	Crystallised sugar from whey of milk	Pure lactose.
West Indies, British Guiana, etc.	Crystallised sugar from juice of sugar-cane	Pure sucrose.
Britain, Central and Southern Europe	Dried bark	Salicin and tannin.
Britain	Fresh or dried flowers, separated from stalks	Volatile oil.
North-West Africa	Resinous tears	Resin acids and volatile oil.
Canada and United States	Dried rhizome	Sanguinarine, other alkaloids, and resins.
Borneo, Sumatra, etc.	Dried resinous secretion	Draco - resinotannol and dracoresene.
Southern India	Volatile oil from wood	Santalol, santalal and esters.

Name of Drug.	Natural Origin.	Family or Order.
Santonica	*Artemisia maritima*, var. *Stechmanniana*	Compositæ
Sappan	*Cæsalpinia sappan*	Leguminosæ
Sarsæ Radix	*Smilax ornata*	Smilaceæ
Sassafras Radix	*Sassafras officinale*	Laurineæ
Scammoniæ Radix	*Convolvulus Scammonia*	Convolvulaceæ
Scammoniæ Resina	*Convolvulus Scammonia*	Convolvulaceæ
Scammonium	*Convolvulus Scammonia*	Convolvulaceæ
Scilla	*Urginea Scilla*	Liliaceæ
Scoparii Cacumina	*Cytisus scoparius*	Leguminosæ
Senegæ Radix	*Polygala Senega*	Polygaleæ
Senna Alexandrina	*Cassia acutifolia*	Leguminosæ
Senna Indica	*Cassia angustifolia*	Leguminosæ
Serpentariæ Rhizoma	*Aristolochia Serpentaria* or *A. reticulata*	Aristolochiaceæ
Sesami Oleum	*Sesamum Indicum*	Pedalineæ
Sevum Præparatum	*Ovis Aries*	Ungulata
Simarubæ Cortex	*Simaruba amara*, and *S. glauca*	Simarubeæ
Sinapis	*Brassica sinapioides* and *B. alba*	Cruciferæ
Sinapis Albæ Semina	*Brassica alba*	Cruciferæ
Sinapis Nigræ Semina	*Brassica sinapioides*	Cruciferæ
Sinapis (Volatile) Oleum	*Brassica sinapioides*	Cruciferæ
Spigelia	*Spigelia marilandica*	Loganiaceæ
Staphisagriæ Semina	*Delphinium Staphisagria*	Ranunculaceæ
Stramonii Folia	*Datura Stramonium*	Solanaceæ
Stramonii Semina	*Datura Stramonium*	Solanaceæ
Strophanthi Semina	*Strophanthus Kombé*	Apocynaceæ
Styrax Præparatus	*Liquidambar orientalis*	Hamamelideæ
Succinum	*Pinus succinifer*, and other species	Coniferæ
Sumbul Radix	*Ferula Sumbul*	Umbelliferæ
Tabaci Folia	*Nicotiana Tabacum*	Solanaceæ
Tamarindus	*Tamarindus Indica*	Leguminosæ
Taraxaci Radix	*Taraxacum officinale*	Compositæ

Geographical Source.	Brief Description.	Chief Constituents.
Northern Turkestan ..	Dried unexpanded flower-heads	Santonin, artemsin, and volatile oil.
India	Orange-red heart-wood	Sappanin.
South America, Costa Rica, etc.	Dried root	Parillin, sarsasaponin, and smilasaponin.
North America	Dried root	Volatile oil and tannin.
Syria and Asia Minor..	Dried root	Scammonin, resin, sugar, and starch.
Syria and Asia Minor..	Glucosidal resin from root	Scammonin.
Syria and Asia Mihor ..	Gum-resin from living root	Scammonin and gum.
Mediterranean Coasts	Dried bulb in slices....	Scillitoxin, scillipierin, and scillin.
England	Frrsh and dried tops ..	Sparteine and scoparin.
United States and British North America	Dried root	Senegin and polygalic acid.
Middle and Upper Nile Territories Southern Arabia and India	Dried leaflets	Senna-emodin, senna-isoemodin, senna-chrysophanic acid, mucilage, and sugar.
United States	Dried rhizome and root-	Aristolochine and volatile oil.
India, China, and Japan	Fixed oil from seeds ..	Olein and other glycerides.
Domesticated everywhere	Internal fat of abdomen	Stearin, palmitin, and olein.
Guiana and Northern Brazil, West Indies, and Florida	Dried bark	Quassin, or picrasmin.
England, Holland, Germany, etc.	Powdered ripe seeds ..	Fixed oil, sinigrin, sinalbin, and myrosin.
England, Holland, Germany, etc.	Dried ripe seeds	Fixed oil, sinalbin, and myrosin.
England, Holland, Germany, etc.	Dried ripe seeds	Fixed oil, sinigrin, and myrosin.
England, Holland, Germany, etc.	Volatile oil from seeds	Allyl isothiocyanate.
United States.....	Dried rhizome and rootlets, or entire plant	Spigeline, acrid bitter substance, and volatile oil
Asia Minor and Southern Europe	Dried ripe seeds	Delphinine, delphinoidine and delphisine.
England, Germany, France, and Hungary	Dried leaves	Hyoscyamine, atropine, and hyoscine.
England, Germany, France, and Hungary	Dried ripe seeds	Hyoscyamine, atropine. and hyoscine.
East Africa	Dried ripe seeds freed from awns	Strophanthin.
Asia Minor	Purified balsam from trunk	Cinnamic acid, storesinol, and esters.
Baltic Coast (Prussia)..	Fossil resin.....	Succino-abietic acid and succinin.
Turkestan	Dried transverse slices of root	Volatile oil and resin.
America	Dried leaves..	Nicotine.
East and West Indies..	Preserved fruits freed from brittle outer part of pericarp	Tartaric acid, acid potassium tartrate, and sugar.
Britain..	Fresh and dried roots..	Taraxacin, pectin, and inulin.

Name of Drug.	Natural Origin.	Family or Order.
Terebinthina Canadensis	*Abies balsamea*	Coniferæ
Terebinthinæ Oleum	*Pinus sylvestris*, and other species	Coniferæ
Thea	*Camellia Thea*	Ternstrœmiaceæ
Thcobromatis Oleum	*Theobroma Cacao*	Sterculiaceæ
Theobromatis Semina	*Theobroma Cacao*	Sterculiaceæ
Thus Americanum	*Pinus palustris* and *P. Tæda*	Coniferæ
Thymi Oleum	*Thymus vulgaris*	Labiatæ
Thymol	*Thymus vulgaris*, *Monardæ punctata*, and *Carum copticum*	Labiatæ Labiatæ Umbelliferæ
Thyroideum	*Ovis Aries*	Ungulata
Tinospora	*Tinospora cordifolia*	Menispermaceæ
Toddalia	*Toddalia aculeata*	Rutaceæ
Tonco Semina	*Dipteryx odorata* and *D. oppositifolia*	Leguminosæ
Tragacantha	*Astragalus gummifer*, and other species	Leguminosæ
Turpethum	*Ipomœa Turpethum*	Convolvulaceæ
Tussilago	*Tussilago Farfara*	Compositæ
Tylophoræ Folia	*Tylophora asthmatica*	Asclepiadeæ
Ulmi Cortex	*Ulmus campestris*	Urticaceæ
Ulmi Fulvi Cortex	*Ulmus fulva*	Urticaceæ
Urginea	*Urginea Indica* or *Scilla Indica*	Liliaceæ
Uvæ	*Vitis vinifera*	Ampelideæ
Uvæ Ursi Folia	*Arctostaphylos Uva-Ursi*	Ericaceæ
Valerianæ Indicæ Rhizoma	*Valeriana Wallichii*	Valerianeæ
Valerianæ Rhizoma	*Valeriana officinalis*	Valerianeæ
Vanillæ Fructus	*Vanilla planifolia*	Orchideæ
Veratri Alba Rhizoma	*Veratrum album*	Liliaceæ
Veratri Viridis Rhizoma	*Veratrum viride*	Liliaceæ
Viburnum	*Viburnum prunifolium*	Caprifoliaceæ
Wintera	*Drimys Winteri*	Magnoliaceæ
Zingiber	*Zingiber officinale*	Scitamineæ

Geographical Source.	Brief Description.	Chief Constituents.
Canada, Nova Scotia, and United States	Oleo-resin from bark ..	Resins and volatile oil.
United States and France	Volatile oil from oleo-resin	Dextro-pinene and lævo-pinene.
China, Japan, India, Ceylon, etc.	Dried leaves and leaf-buds	Caseine and tannin.
Central and South America, West Indies, Ceylon, etc.	Concrete fixed oil from seeds	Stearin, palmitin, and olein.
Central and South America, West Indies, Ceylon, etc.	Prepared seeds	Theobromine and fixed oil.
Southern United States	Concrete oleo-resin	Abietic and pimaric acids and volatile oil.
France and Germany ..	Fresh herb	Thymol and carvacrol.
Southern France, America, and India	Crystalline phenol from volatile oils	Isopropyl-meta-cresol.
Domesticated everywhere	Fresh and healthy thyroid gland	Thyroglobulin.
India	Dried stem	Berberine and bitter glucoside.
India and Ceylon	Dried root-bark	Bitter principle, resin, and volatile oil.
Guiana and Brazil	Dried seeds	Coumarin.
Southern and Eastern Europe, Asia Minor and Persia	Ribbon-shaped gummy flakes	Bassorin and oxybassorin.
India and Ceylon	Dried root and stem ..	Turpethin (Jalapin).
Britain	Dried leaves or flowering stems	Mucilage and bitter glucoside.
India, Ceylon, and Moluccas	Dried leaves	Tylophorine.
England, Central and Southern Europe	Dried bark	Mucilage, tannin, and bitter principle.
United States.....	Dried bark	Mucilage and tannin.
India	Dried young bulbs	Scillitoxin, scillipicrin, and scillin.
Central and Southern Europe, California, and Australia	Dried ripe fruit.....	Sugar and acid potassium tartrate.
Britain, Central and Northern Europe, and North America	Dried leaves	Arbutin, methyl-arbutin, and ursone.
India	Dried rhizome and rootlets	Volatile oil and valerianic acid.
England, Holland, and Germany	Dried erect rhizome and roots	Volatile oil and valerianic acid.
Mexico, Mauritius, Java, etc.	Dried fruit	Vanillin and fixed oil.
Central and Southern Europe	Dried rhizome and rootlets	Jervine, protoveratrine, and other alkaloids.
United States.....	Dried rhizome and rootlets	Jervine, veratrine, and other alkaloids.
United States.....	Dried bark	Viburnin, tannin, and valerianic acid.
South America	Dried bark	Volatile oil and tannin.
West Indies, Cochin China, Africa, etc.	Dried scraped rhizome	Volatile oil and gingerol.

METRIC WEIGHTS AND MEASURES.

Measures of Length.

The metric system of weights and measures is a decimal system, based upon the metre (M.), which equals 39·370113 inches, and was originally supposed to represent the ten-millionth part of the quadrant of a meridian. The actual standard, at the present time, is the distance determined at 0° C., between two points on a bar of iridio-platinum, kept in Paris, a copy of which is in the possession of the Board of Trade. The chief subdivisions of the metre are the decimetre (Dm.), centimetre (Cm.), and millimetre (Mm.), being respectively the tenth, hundredth, and thousandth parts of the metre. The thousandth part of a millimetre is termed a micron (μ), and is largely used for minute measurements, while the chief multiple of the metre is the kilometre (Km.), a length of one thousand metres, equal to rather more than six-tenths of a mile.

Metric Measures of Length.

1 Micromillimetre ($\mu\mu$) =	0·000001 Mm. =	0·00000004 Inch.
1 Micron (μ) ..... =	0·001 Mm. .. =	0·0000394 Inch.
1 Millimetre (Mm.) .. =	0·001 M. .... =	0·0393701 Inch.
1 Centimetre (Cm.) .. =	0·010 M. .... =	0·3937011 Inch.
1 Decimetre (Dm.) .. =	0·100 M. .... =	3·9370113 Inches.
1 Metre (M.) ..... =	1·0 M. ..... =	39·370113 Inches. 3·280843 Feet. 1·0936143 Yards.
1 Dekametre (Dkm.) .. =	10·0 M. .. =	10·93614 Yards.
1 Hectometre (Hm.) .. =	100·0 M. .. =	109·36143 Yards.
1 Kilometre (Km.) .. =	1,000·0 M. .. =	0·62137 Mile.
1 Myriametre (Mym.) =	10,000·0 M. .. =	6·21371 Miles.

Conversion of Metric to Imperial Units.

Millimetres × 0·0394 = Inches.	Decimetres ÷ 0·2539 = Inches.
Millimetres ÷ 25·3999 = Inches.	Metres × 39·3701 = Inches.
Centimetres × 0·3937 = Inches.	Metres ÷ 0·0254 = Inches.
Centimetres ÷ 2·5399 = Inches.	Kilometres × 0·6214 = Miles.
Decimetres × 3·9370 = Inches.	Kilometres ÷ 1·6093 = Miles.

Measures of Mass.

The chief metric weight, or measure of mass, is the gramme (Gm.), which equals 15·4324 grains, and was originally the mass of one-thousandth part of a cubic decimetre of distilled water at 4° C. its point of greatest density. The gramme is now more correctly described as the mass of one-thousandth part of a solid cylinder of iridio-platinum 39 millimetres high and the same in diameter, which is kept in Paris, and of which a copy is in the possession of the Board of Trade. The chief subdivisions of the gramme are the decigram (Dgm.), centigram (Cgm.), and

milligram (Mgm.), being respectively the tenth, hundredth, and thousandth part of the gramme. The only multiple of the gramme which is much used is the kilogram (Kilo.), a weight of one thousand grammes, equal to two and one-fifth pounds.

Metric Weights or Measures of Mass.

1 Microgram (γ)	=	0·001 Mgm.	=	0·000015 Gr.
1 Milligram (Mgm.)....	=	0·001 Gm.	=	0·015 Grain.
1 Centigram (Cgm.)	=	0·010 Gm.	=	0·154 Grain.
1 Decigram (Dgm.)	=	0·100 Gm.	=	1·543 Grain.
1 Gramme (Gm.)	=	1·0 Gm.	=	15·4324 Grains. 0·7716 Scruple. 0·2572 Drachm 0·03215 Oz. Tr. 0·03527 Oz. Av.
1 Dekagram (Dkgm.) ..	=	10·0 Gm.	=	0·3527 Oz. Av.
1 Hectogram (Hgm.) ..	=	100·0 Gm.	=	3·5274 Oz. Av.
1 Kilogram (Kilo.)	=	1000·0 Gm.	=	2·2046 Lbs.
1 Myriagram (Mygm.)..	=	10·0 Kilo.	=	22·0462 Lbs.
1 Quintal (Q.)	=	100·0 Kilo.	=	1·9684 Cwt.
1 Millier or Tonne (T.)..	=	1000·0 Kilo.	=	0·9842 Ton.

Conversion of Metric to Imperial Units.

Grammes × 15·4324 = Grains.	Grammes ÷ 31·1035 = Oz. (Tr.)
Grammes ÷ 0·0648 = Grains.	Grammes × 0·0353 = Oz. (Av.)
Grammes ÷ 1·2959 = Scruples.	Grammes ÷ 28·3495 = Oz. (Av.)
Grammes ÷ 3·8879 = Drachms.	Kilogrm. × 2·2046 = Pounds.
Grammes × 0·0322 = Oz.(Troy)	Kilogrm. ÷ 0·4536 = Pounds.

Measures of Capacity.

The chief metric fluid measure, or measure of capacity, is the litre (L.), which equals 1·7598 pints, and was originally the volume of a cubic decimetre of water at 4° C., its point of greatest density. At that temperature the weight of a cubic decimetre of water at normal pressure is 999·547 grammes, and it should be noted that the weight of water in a cubic decimetre is always less than a kilogram, at all temperatures, except under a pressure of four atmospheres, when the weight is exactly 1000 grammes. The present standard litre is the volume of a kilogram weight of distilled water at 4° C., and is equal to 1·00016 cubic decimetres at 15° C. The chief subdivision of the litre is its one-thousandth part, the "mil" or millilitre (Ml.), which is the volume of a gramme weight of distilled water at 4° C., and is equal to 1·00016 cubic centimetres at 15° C. The tenth part of a "mil" or millilitre is termed the "decimil," and is a useful measure of capacity for dispensing purposes, while the "centimil," or hundredth part of a "mil" or millilitre, though much too small a quantity to be measured, will sometimes be found useful in calculations. It should be noted that half a decimil is equivalent to one standard drop from a pipette

made to deliver twenty drops to one gramme of distilled water at 15° C.

Metric Measures of Capacity.

1 Microl or Microlitre (λ)	= 0·001 Ml.	=	0·0169 Minim.
1 Centimil (C. or Cml.)	= 0·010 Ml.	=	0·1689 Minim.
1 Decimil (D. or Dml.)	= 0·100 Ml.	=	1·6894 Minims.
1 Mil or Millilitre (Ml.)	= 0·001 L.	=	16·8941 Minims. 0·2816 Fl. Drachm. 0·0352 Fl. Ounce.
1 Centilitre (Cl.)	= 0·010 L.	=	2·8157 Fl. Drachm. 0·35196 Fl. Ounce. 0·0176 Pint.
1 Decilitre (Dl.)	= 0·100 L.	=	3·5196 Fl. Ounces. 0·1759 Pint.
1 Litre (L.)	= 1·0 L.	=	35·1960 Fl. Ounce. 1·7598 Pints. 0·2199 Gallon.
1 Dekalitre (Dkl.)	= 10·0 L.	=	2·19975 Gallons.
1 Hectolitre (Hl.)	= 100·0 L.	=	2·74969 Bushels.
1 Kilolitre (Kl.)	= 1000·0 L.	=	3·43712 Quarters.

Conversion of Metric to Imperial Units.

Millilitres × 16·8941 = Minims.	Litres × 35·1960 = Fl. Oz.
Millilitres ÷ 0·0592 = Minim.	Litres ÷ 0·0284 = Fl. Oz.
Millilitres × 0·2816 = Fl. Dr.	Litres × 1·7598 = Pints.
Millilitres ÷ 3·5515 = Fl. Dr.	Litres ÷ 0·5682 = Pints.
Millilitres × 0·0352 = Fl. Oz.	Litres × 0·2199 = Gallons.
Millilitres ÷ 28·4123 = Fl. Oz.	Litres ÷ 4·5459 = Gallons.

THE WEIGHT OF A LITRE.

It should be noted, by the way, that there are two different litres in use, the standard litre already referred to, which is the volume of a kilogram weight of distilled water at 4° C., its point of greatest density, and Mohr's litre, which is the volume of a kilogram weight of distilled water at 15° C. The one-thousandth part of a standard litre, at 4° C., weighs one gramme, but necessarily weighs less than a gramme at 15° C., whereas the one-thousandth part of a Mohr's litre weighs exactly one gramme at 15° C. In other words, the volume of distilled water contained in a standard litre weighs 1,000 grammes at 4° C., and 998·979 grammes at 15° C., while the volume of water contained in a Mohr's litre weighs 1,000 grammes at the higher temperature. Burettes and other apparatus for volumetric analysis are graduated usually according to Mohr's system, but measuring instruments graduated according to the standard litre can also be obtained, and should be used by pharmacists in preference to the others, as all metric measures for pharmaceutical purposes, though graduated at 15·5° C., are based on the standard litre.

IMPERIAL WEIGHTS AND MEASURES.

IMPERIAL MEASURES OF LENGTH.

1 Inch	=	25·3999 Millimetres.
1 Foot (12 in.).....	=	304·7997 Millimetres. 0·3047997 Metre.
1 Yard (3 ft.)	=	914·3992 Millimetres. 0·9143992 Metre.
1 Mile (1,760 yds.)	=	1,609,342·5920 Millimetres 1·6093426 Kilom.

Conversion o Imperial to Metric Units.

Inches ÷ 0·0394 = Millimetre .	Inches × 0·2539 = Decimetres.
Inches × 25·3999 = Millimetres.	Inches ÷ 39·3701 = Metres.
Inches ÷ 0·3937 = Centimetres.	Inches × 0·0254 = Metres.
Inches × 2·5399 = Centimetres.	Miles ÷ 0·6214 = Kilometres.
Inches ÷ 3·9370 = Decimetres.	Miles × 1·6093 = Kilometres.

IMPERIAL WEIGHTS OR MEASURES OF MASS.

1 Grain	=	0·0648 Gramme. 64·7989 Milligrammes.
1 Scruple (20 grains).....	=	1·2959 Grammes.
1 Drachm (60 grains)	=	3·8879 Grammes.
1 Troy or Apothecaries' Ounce (480 grains).....	=	31·1035 Grammes.
1 Avoirdupois Ounce (437·5 gr.)..	=	28·3495 Grammes.
1 Pound (7,000 grains)	=	453·5924 Grammes. 0·4536 Kilogramme.

Conversion of Imperial to Metric Units.

Grains ÷ 15·4324 = Gms.	Ounces (Troy) × 31·1035 = Gms.
Grains × 0·0648 = Gms.	Ounces (Av.) ÷ 0·0353 = Gms.
Scruples (Ap.) × 1·2959 = Gms.	Ounces (Av.) × 28·3459 = Gms.
Drachms (Ap.) × 3·8879 = Gms.	Pounds (Av.) ÷ 2·2046 = Kilo.
Ounces (Troy) ÷ 0·0311 = Gms.	Pounds (Av.) × 0·4536 = Kilo.

IMPERIAL MEASURES OF CAPACITY.

1 Minim (0·9114583 grain of water)	=	0·0592 Millilitre.
1 Fluid Drachm (60 m. or 54·6875 gr.)	=	3·5515 Millilitres.
1 Fluid Ounce (8 fl. dr. or 437·5 gr.)	=	28·4123 Millilitres. 0·0284 Litre.
1 Pint (20 fl. oz. or 8750 grains) ..	=	568·2454 Millilitres. 0·5682 Litre.
1 Gallon (8 pints or 70,000 grains)	=	4545·9631 Millilitres. 4·5459 Litres.

Conversion of Imperial to Metric Units.

Minims	÷ 16·8941	= Millilitres.	Fl. Oz.	÷ 35·1960	= Litres.
Minims	× 0·0592	= Millilitres.	Fl. Oz.	× 0·0284	= Litres.
Fl. Dr.	÷ 0·2816	= Millilitres.	Pints	÷ 1·7598	= Litres.
Fl. Dr.	× 3·5515	= Millilitres.	Pints	× 0·5682	= Litres.
Fl. Oz.	÷ 0·0352	= Millilitres.	Gallons	÷ 0·2199	= Litres.
Fl. Oz.	× 28·4123	= Millilitres.	Gallons	× 4·5459	= Litres.

METRIC AND IMPERIAL EQUIVALENTS FOR TRADE PURPOSES.

Based on Board of Trade Standards.

METRIC TO IMPERIAL.

Linear Measure.

1 Millimetre (Mm.) (1/1000th M.)	=	0·03937 Inch.
1 Centimetre (1/100th M.)	=	0·3937 Inch.
1 Decimetre (1/10th M.)	=	3·937 Inches.
1 Metre (M.)	=	**39·370113 Inches.** **3·280843 Feet.** **1·0936143 Yards.**
1 Decametre (10 M.)	=	10·936 Yards.
1 Hectometre (100 M.)	=	109·36 Yards.
1 Kilometre (1000 M.)	=	0·62137 Mile.

Square Measure.

1 Square Centimetre	=	0·15500 Square Inch.
1 Square Decimetre (100 Square Centimetres)	=	15·500 Square Inches.
1 Square Metre (100 Square Decimetres)	=	10·7639 Square Feet. 1·1960 Square Yards.
1 Are (100 Sq. Metres)	=	119·60 Square Yards.
1 Hectare (100 Ares or 10,000 Sq. Metres)	=	2·4711 Acres.

Cubic Measure.

1 Cubic Centimetre	=	0·0610 Cubic Inch.
1 Cubic Decimetre (C.d.) (1000 Cubic Centimetres)	=	61·024 Cubic Inches.
1 Cubic Metre (1000 Cubic Decimetres)	=	35·3148 Cubic Feet. 1·307954 Cubic Yards.

Measure of Capacity.

1 Centilitre (1/100th Litre)	=	0·070 Gill.
1 Decilitre (1/10th Litre)	=	0·176 Pint.
1 Litre	=	**1·75980 Pints.**
1 Dekalitre (10 Litres)	=	2·200 Gallons.
1 Hectolitre (100 Litres)	=	2·75 Bushels.

Apothecaries Measure.

1 Centimil (1/100th Millilitre) ..	=	0·1689 Minim.
1 Decimil (1/10th Millilitre)	=	1·6894 Minims.
1 **Mil** or Millilitre (1/1000th Litre)	=	16·8941 Minims, or 0·2816 Fl. Drachm.
1 Centilitre (1/100th Litre)	=	2·8157 Fl. Drachms, or 0·35196 Fl. Ounce.
1 Decilitre (1/10th Litre)	=	3·5196 Fl. Ounces.
1 Litre	=	1·7598 Pints.

Avoirdupois Weight.

1 Milligram (1/1000th Grm.)....	=	0·015 Grain.
1 Centigram (1/100th Grm.)	=	0·154 Grain.
1 Decigram (1/10th Grm.).....	=	1·543 Grains.
1 Gramme (1 Grm.).....	=	15·432 Grains.
1 Dekagram (10 Grm.).....	=	5·644 Drachms.
1 Hectogram (100 Grm.)	=	3·527 Oz.
1 Kilogram (1000 Grm.)	=	**2·2046223 Lbs. or 15432·3564 Grains.**
1 Myriagram (10 Kilog.).....	=	22·046 Lbs.
1 Quintal (100 Kilog.)	=	1·968 Cwt.
1 Tonne (1000 Kilog.)	=	0·9842 Ton.

Troy Weight.

1 Gramme (1 Grm.)	=	0·03215 Oz. Troy. 15·432 Grains.

Apothecaries Weight.

1 Gramme (1 Grm.)	=	0·2572 Drachm. 0·7716 Scruple. 15·432 Grains.

IMPERIAL TO METRIC.

Linear Measure.

1 Inch	=	25·400 Millimetres.
1 Foot (12 inches)	=	0·30480 Metre.
1 Yard (3 Feet)	=	**0·914399 Metre.**
1 Fathom (6 Feet)	=	1·8288 Metres.
1 Pole (5½ Yards)	=	5·0292 Metres.
1 Chain (22 Yards)	=	20·1168 Metres.
1 Furlong (220 Yards)	=	201·168 Metres.
1 Mile (8 Furlongs)	=	1·6093 Kilometres.

Square Measure.

1 Square Inch	=	6·4516 Sq. Centimetres.
1 Square Foot (144 Square Inches)	=	9·2903 Sq. Decimetres.
1 Square Yard (9 Square Feet)	=	0·836126 Square Metre.
1 Perch (30¼ Square Yards)	=	25·293 Square Metres.
1 Rood (40 Perches)	=	10·117 Ares.
1 Acre (4,840 Square Yards)	=	0·40468 Hectare.
1 Square Mile (640 Acres)	=	259·00 Hectares.

Cubic Measure.

1 Cubic Inch	=	16·387 Cubic Centimetres
1 Cubic Foot (1,728 Cubic Inches)	=	0·028317 Cubic Metre.
1 Cubic Yard (27 Cubic Feet)	=	0·764553 Cubic Metre.

Measures of Capacity.

1 Gill	=	1·42 Decilitres.
1 Pint (4 Gills)	=	0·568 Litre.
1 Quart (2 Pints)	=	1·136 Litres,
1 Gallon (4 Quarts)	=	**4·5459631 Litres.**
1 Peck (2 Gallons)	=	9·092 Litres.
1 Bushel (8 Gallons)	=	3 637 Dekalitres.
1 Quarter (8 Bushels)	=	2·909 Hectolitres.

Apothecaries Measure.

1 Minim	=	5·919 Centimils. 0·059 Mil or Millilitre.
1 Fluid Scruple	=	1·184 Mils or Millilitres.
1 Fluid Drachm (60 Minims)	=	3·552 Mils or Millilitres.
1 Fluid Ounce (8 Drachms)	=	2·84123 Centilitres.
1 Pint (20 Fluid Ounces)	=	0·568 Litre.
1 Gallon (8 Pints or 160 Fluid Ounces)	=	**4·5459631 Litres.**

Avoirdupois Weight.

1 Grain	=	0·0648 Gramme.
1 Drachm	=	1·772 Grammes.
1 Ounce (16 Drachms)	=	28·350 Grammes.
1 Pound (16 Ozs., or 7,000 Grains)	=	**0·45359243 Kilogram.**
1 Stone (14 Lbs.)	=	6·350 Kilograms.
1 Quarter (28 Lbs.)	=	12·70 Kilograms.
1 Hundredweight (Cwt.) (112 Lbs.)	=	50·80 Kilograms. 0·5080 Quintal.
1 Ton (20 Cwt.)	=	1·0160 Tonnes or 1016 Kilograms.

Troy Weight.

1 Grain	=	0·0648 Gramme.
1 Pennyweight (24 Grains)	=	1·5552 Grammes.
1 Troy Ounce (20 Pennyweights)	=	31·1035 Grammes.

Apothecaries Weight.

1 Grain	=	0·0648 Gramme.
1 Scruple (20 Grains)	=	1·296 Grammes.
1 Drachm (3 Scruples)	=	3·888 Grammes.
1 Ounce (8 Drachms)	=	31·1035 Grammes.

SPECIFIC GRAVITIES OF SOME COMMON SUBSTANCES.

Aluminium	2·7	Zinc	7·2
Brass	8·0	Ice	0·9
Copper	8·9	Glass	2·6 to 3·3
Gold	19·3	Ivory	1·9
Iron (cast)	7·2	Bone	1·8 to 2·0
Iron (wrought)	7·8	Marble	2·7
Lead	11·4	Slate	2·8
Mercury	13·6	Cedar wood	0·49 to 0·66
Platinum	21·5	Deal	0·49 to 0·60
Silver	10·6	Mahogany	0·50 to 0·86
Steel	7·8	Oak	0 61 to 1·17
Tin	7·3	Cork-bark	0·24

Weight in lbs. avoirdupois of 1 sq. foot of sheet metal, one-eighth of an inch thick.

	Lb.		Lb.
Iron, cast	4·72	Brass	5·39
Iron, wrought	5·06	Lead	7·37
Steel	5·11	Zinc	4·69
Copper	5·80		

EQUIVALENTS OF MEASURES OF LENGTH (METRIC AND IMPERIAL).

Metric.	Imperial.	Metric.	Imperial.	Metric.	Imperial.
Millimetres.	Inches.	Millimetres.	Inches.	Millimetres.	Inches.
1524	60	533	21	19	0·75
1500	59·06	508	20	18	0·71
1450	57·09	500	19·69	17·5	0·69
1400	55·12	483	19	17	0·67
1397	55	457	18	16	0·63
1350	53·15	450	17·72	15	0·59
1300	51·18	432	17	14	0·55
1270	50	406	16	13	0·51
1250	49·21	400	15·75	12·5	0·49
1200	47·24	381	15	12	0·47
1150	45·28	356	14	11	0·43
1143	45	350	13·78	10 (1 Cm.)	0·39
1100	43·31	330	13	9·5	0·37
1050	41·34	305	12 (1 Foot)	9	0·35
1016	40	300	11·81	8·5	0·33
1000 (1 M.)	39·37	279	11	8	0·31
990	39	254	10	7·5	0·29

965	38	250	9·84	7	0 28
950	37·40	229	9	6·5	0·25
939	37	203	8	6	0·24
914	36 (1 Yard)	200	7·87	5·5	0·22
900	35·43	178	7	5	0·20
889	35	152	6	4·5	0·18
864	34	150	5·91	4	0·16
850	33·46	127	5	3·5	0·14
838	33	102	4	3	0·12
813	32	100 (1 Dcm.)	3·94	2·5	0·10
800	31·50	90	3·54	2	0·08
787	31	80	3·15	1·75	0·07
762	30	76	3	1·5	0·06
750	29·53	70	2·76	1·25	0·05
736	29	60	2·36	1	0·04
711	28	51	2	0·9	0·035
700	27·56	50	1·97	0·8	0·031
686	27	40	1·57	0·75	0·029
660	26	30	1·18	0·7	0·027
650	25·59	25·4	1 (1 Inch)	0·6	0·023
635	25	25	0·98	0·5	0·019
610	24	24	0·94	0·4	0·015
600	23·62	23	0·90	0·3	0·012
584	23	22	0·87	0·25	0·0097
559	22	21	0·83	0·2	0·0078
550	21·65	20	0·79	0·1	0·0039

FRACTIONS OF INCHES, WITH EQUIVALENTS OF THE SAME IN MILLIMETRES.

Imperial.		Metric.	Imperial.		Metric.
Inches.		Millimetres.	Inches.		Millimetres.
In decimal fractions.	In 32ds.		In decimal fractions.	In 32ds.	
1	32	25·4	0·37	12	9·5
0·94	30	23·8	0·34	11	8·7
0·90	29	23	0·31	10	7·9
0·87	28	22·2	0·28	9	7·1
0·81	26	20·6	0·25	8	6·4
0·75	24	19·1	0·22	7	5·6
0·69	22	17·5	0·19	6	4·8
0·62	20	15·9	0·13	4	3·2
0·56	18	14·3	0·09	3	2·4
0·50	16	12·7	0·06	2	1·6
0·44	14	11·1	0·03	1	0·8

INCHES TO MICRA AND MILLIMETRES, FEET TO CENTIMETRES, YARDS TO METRES.

Inches, Feet, or Yards.	Inches to Micra (μ).	Inches to Millimetres (Mm.).	Feet to Centimetres (Cm.).	Yards to Metres (M.).
1	25399·9	25·4	30·5	0·9
2	50799·9	50·8	60·9	1·8
3	76199·9	76·2	91·4	2·7
4	101599·9	101·6	121·9	3·6
5	126999·9	127·0	152·4	4·6
6	152399·9	152·4	182·9	5·5
7	177799·9	177·8	213·4	6·4
8	203199·8	203·2	243·8	7·3
9	228599·8	228·6	274·3	8·2

Explanation of Table.—The first column represents the number of inches, feet, or yards to be converted.

Thus:

4 in. = 101599·9μ or 101·6 Mm.; 4 ft. = 121·9 Cm.; 4 yds. = 3·6 M.

EQUIVALENTS OF WEIGHTS OR MEASURES OF MASS (Metric and Imperial).

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
1000	15432·4	800	12345·9	623·689	9625 [22 oz.
995·312	15360	793·787	12250 [28 oz.	622·070	9600
975	15046·6	777·587	12000		
971·984	15000	775	11960·1	600	9259·4
964·208	14880	765·437	11812·5 [27 oz.	595·340	9187·5 [21 oz.
950	14660·7	750	11574·3	590·966	9120
933·105	14400	746·484	11520 [2 troy lb.	583·191	9000
925	14274·9	737·087	11375 [26 oz.	575	8873·6
907·185	14000 [2 av. lb.	725	11188·5	566·990	8750 [20 oz.
902·000	13920	715·380	11040	559·863	8640
		712·788	11000	550	8487·8
900	13889·1	708·738	10937·5 [25 oz.	538·641	8312·5 [19 oz.
878·635	13562·5 [31 oz.			528·759	8160
875	13503·3	700	10802·6	525	8102
870·898	13440	684·277	10560	518·392	8000
850·486	13125 [30 oz.	680·388	10500 [24 oz.	510·291	7875 [18 oz.
850	13117·5	675	10416·8		
842·386	13000	653·173	10080	500	7716·2
839·794	12960	652·039	10062·5 [23 oz.	497·656	7680
825	12731·7	650	10031·0	481·942	7437·5 [17 oz.
822·136	12687·5 [29 oz.	647·989	10000	475	7330·4
808·691	12480	625	9645·2	466·552	7200

EQUIVALENTS OF WEIGHTS OR MEASURES OF MASS—*continued.*

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
453·592	7000 [1 av. lb.	85·049	1312·5 [3 oz.	22·5	347·2
450	6944·6	80	1234·6	22·032	340
435·449	6720	75	1157·4	22	339·5
425·243	6562·5 [15 oz.	70	1080·3	21·5	331·8
425	6558·8	64·799	1000	21·383	330
404·345	6240	62·207	960	21	324·1
400	6172·9	60	925·9	20·736	320
396·893	6125 [14 oz.	58·319	900	20·5	316·4
388·794	6000	56·699	875 [2 oz.	20·088	310
375	5787·1	51·839	800	20	308·6
373·242	5760 [1 troy lb.	50	771·6	19·5	300·9
368·544	5687·5 [13 oz.	45·359	700	19·439	300 [5⅓
350	5401·3	40	617·3	19	293·2
342·138	5280	39·879	600	18·792	290
340·194	5250 [12 oz.	32·399	500	18·5	285·5
325	5015·5	31·1035	480 [1⅓	18·144	280
323·995	5000	31	478·4	18	277·8
311·845	4812·5 [11 oz.	30·455	470	17·5	270·1
311·035	4800	30·5	470·7	17·495	270
300	4629·7	30	463·0	17	262·3
283·495	4375 [10 oz.	29·807	460	16·848	260

279·930	4320		29·5	433·5	16·5	254·5	
275	4244		29·159	450	16·199	250	
259·196	4000		29	447·5	16	246·9	
255·146	3937·5	[9 oz.	28·512	440	15·878	245	
250	3858·1		28·5	439·8			
248·828	3840		28·350	437·5	[1 av. oz.	15·551	240 [4⅓
226·796	3500	[8 oz.	28	431·1		15·5	239·2
225	3472·3		27·864	430		15·228	235
217·724	3360		27·5	423·4		15	231·5
						14·904	230
200	3086·5		27·215	420	[7⅓	14·580	225
198·447	3062·5	[7 oz.	27	416·7		14·5	223·8
194·397	3000		26·568	410		14·256	220
186·621	2880		26·5	408·3		14·175	218·75 [½ av. oz.
175	2700·7		26	401·2		14	216·1
170·097	2625	[6 oz.	25·919	400		13·932	215
161·997	2500		25·5	393·5		13·607	210
155·517	2400		25·271	390		13·5	208·4
150	2314·9		24·624	380		13·284	205
141·748	2187·5	[5 oz.	25	385·8		13	200·6
129·598	2000			378·1		12·690	200
125	1929		24	370·4		12·636	195
124·414	1920		23·976	370		12·5	192·9
113·398	1750	[4 oz.	23·5	362·7		12·312	190
						12	185·2
100	1543·2		23·327	360	[6⅓	11·988	185
97·198	1500		23	354·9		11·663	180 [3⅓
93·310	1440		22·679	350		11·5	177·5
90	1388·9						

EQUIVALENTS OF WEIGHTS OR MEASURES OF MASS—*continued.*

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
11·340	175	2·5	38·6	0·389	6
11·016	170	2·268	35	0·35	5·4
11	169·8	2	30·9		
10·692	165			0·324	5
10·5	162·1	1·944	30	0·3	4·6
10·368	160	1·9	29·3	0·291	4·5
10	154·3	1·8	27·8	0·259	4
10·044	155	1·75	27·0	0·25	3·9
9·719	150	1·7	26·2	0·226	3·5
9·5	146 6	1·620	25	0·2	3·1
9·396	145	1·6	24·7	0·194	3
9·072	140	1·555	24	0·162	2·5
9	138·9	1·5	23·2	0·15	2·3
8·748	135	1·490	23	0·129	2
8·5	132·2	1·426	22	0·125	1·9
8·424	130	1·4	21·6	0·10	1·55
8·100	125	1·361	21	0·097	1·5
8	123·5	1·3	20·1	0·06479	1 grain
		1·296	20		
7·775	120	1·25	19·3	0·061	0·94
7·5	115·8	1·232	19	0·060	0·93
		1·2	18·5	0·057	0·88

7·452	115	1·166	18	0·053	0·82
7·128	110	1·102	17	0·052	0·77
7·088	109·375 [$\frac{1}{4}$ av. oz.	1·1	16·9	0·049	0·76 [$\frac{3}{4}$ grain
7	108·0	1·037	16	0·046	0·7
6·804	105	1	15·4324	0·045	0·69
6·5	100·3			0·044	0·66
6·480	100	0·972	15	0·040	0·62
6·156	95	0·95	14·7	0·039	0·6
6	92·6	0·907	14	0·036	0·56
5·832	90	0·9	13·9	0·032	0·5 [$\frac{1}{2}$ grain
5·505	85	0·85	13·1		
5·5	84·9	0·842	13	0·029	0·45
5·184	80	0·8	12·4	0·028	0·43
5	77·2	0·775	12	0·026	0·4
4·860	75	0·75	11·6	0·024	0·37
4·536	70	0·713	11	0·023	0·35
4·5	69·5	0·7	10·8	0·022	0·33
4·212	65	0·65	10·1	0·020	0·31
4	61·7			0·019	0·3
		0·648	10 [$\frac{1}{2}$	0·016	0·25 [$\frac{1}{4}$ grain
3·888	60	0·6	9·1	0·01	0·2
3·564	55	0·583	9	0·012	0·18
3·544	54·6875 [$\frac{1}{8}$ av. oz.	0·55	8·5	0·011	0·166
3·5	54·0	0·518	8	0·0097	0·15
3·240	50	0·5	7·7		
3	46·3	0·454	7	0·0090	0·143
2·916	45	0·45	6·9	0·0080	0·125 [$\frac{1}{8}$ grain
2·592	40	0·4	6·2	0·0070	0·11
				0·0065	0·1

EQUIVALENTS OF WEIGHTS OR MEASURES OF MASS—*continued.*

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains,
0·0055	0·08	0·0018	0·028	0·0007	0·0104
0·0040	0·06	0·0016	0·025	0·0006	0·01
0·0032	0·05	0·0014	0·021	0·0005	0·008
0·0028	0·042			0·0004	0·006
0·0026	0·04	0·0013	0·02	0·0003	0·005
0·0022	0·033	0·0011	0·017	0·0002	0·003
0·0020	0·032	0·0009	0·015	0·0001	0·0015

EQUIVALENTS OF MEASURES OF CAPACITY (Metric and Imperial).

Metric Measure.	Imperial Measure.		Metric Measure.	Imperial Measure.	
Mils. (= C.c.'s.)	Minims.	Fluid Grains.	Mils. (= C.c.'s.)	Minims.	Fluid Grains.
1000 (1 litre)	16894·1	15398·3	675	11403·5	10393·8
994·429	16800 [35 fl. oz.	15312·5	653·482	11040 [23 fl. oz.	10062·5
975	16471·7	15013·3	651·114	11000	10026
966·017	16320 [34 fl. oz.	14875	650	10981·2	10008·0
950	16049·4	14628·3	625·070	10560 [22 fl. oz.	9625

947·072	16000	14583·4
937·605	15840 [33 fl. oz.	14437·5
925	15627	12243·4
909·193	15360 [32 fl. oz.	14000
900	15204·7	13858·4
887·883	15·000	13671·9
880·780	14880 [31 fl. oz.	13562·5
875	14782·3	13473·5
852·368	14400 [30 fl. oz.	13125
850	14349·9	13088·5
828·690	14000	12760·5
825	13937·6	12703·6
823·956	13920 [29 fl. oz.	12687·5
800	13515·3	12319
795·544	13440 [28 fl. oz.	12250
775	13092·9	11934
769·498	13000	11849
767·131	12960 [27 fl. oz.	11812·5
750	12670·6	11548·7
738·719	12480 [26 fl. oz.	11375
725	12248·2	11153·7
710·307	12000 [25 fl. oz.	10937·5
700	11825·8	10478·8
681·895	11520 [24 fl. oz.	10500
625	10558·8	9622·9
600	10136·4	9238·9
596·658	10080 [21 fl. oz.	9187·5
591·922	10000	9114·6
575	9714·1	8854
568·245	9600 [1 pint.	8750
550	9291·7	8469
539·833	9120 [19 fl. oz.	8312·5
732·730	9000	8203·2
525	8869·4	8004
511·421	8640 [18 fl. oz.	7875
500	8447	7699·1
483·009	8160 [17 fl. oz.	7437·5
475	8024·7	7314·2
473·536	8000	7291·7
454·596	7680 [16 fl. oz.	7000
450	7602·4	6929·2
426·184	7200 [15 fl. oz.	6562·5
425	7179	6544·3
414·344	7000	6380·2
400	6757·6	6159·5
397·772	6720 [14 fl. oz.	6125
375	6335·3	5774·3
369·360	6240 [13 fl. oz.	5687·5
355·152	6000	5468·8
350	5912·9	5389·4

EQUIVALENTS OF MEASURES OF CAPACITY—*continued.*

Metric Measure.	Imperial Measure.		Metric Measure.	Imperial Measure.	
Mils. (= C.c.'s.)	Minims.	Fluid Grains.	Mils. (= C.c.'s.)	Minims.	Fluid Grains.
340·947	5760 [12 fl. oz.	5250	50	844·7	769·9
325	5490·6	5004·4	47·354	800	729·2
312·535	5280 [11 fl. oz.	4812·5	45	760·2	692·9
			44·394	750	683·6
300	5068·2	4619·5	42·618	720	656·3
295·961	5000	4557·3	41·434	700	638
284·123	4800 [10 fl. oz.	4375	40	675·8	615·9
275	4645·9	4234·5	35·515	600	546·9
255·711	4320 [9 fl. oz.	3937·5	35	591·3	538·9
250	4223·5	3849·6	30	506·8	461·9
236·678	4000	3645·9	29·596	500	455·7
227·298	3840 [8 fl. oz.	3500	28·412	480 [1 fl. oz.	437·5
225	3801·2	3464·6	28	473	431·1
			27·821	470	428·4
200	3378·8	3079·7	27·5	464·6	423·5
198·886	3360 [7 fl. oz.	3062·5	27·228	460	419·3
177·577	3000	2734·4	27	456·1	415·7
175	2956·5	2694·7	26·637	450	410·2
170·474	2880 [6 fl. oz.	2625	26·5	447·7	408·1
150	2534·1	2309·7	26·045	440	401
147·980	2500	2278·7	26	439·2	400·3

142	2400 [5 fl. oz.	2187·5
125	2111·8	1924·8
118·384	2000	1823·9
113·649	1920 [4 fl. oz.	1750
112·565	1900	1731·8
106·646	1800	1640·6
100·727	1700	1549·5
100	1689·4	1539·8
95	1604·9	1462·8
94·707	1600	1458·3
90	1520·5	1385·1
88·788	1500	1367·2
85·238	1440 [3 fl. oz.	1312·5
85	1435·9	1308·9
82·869	1400	1276·1
80	1351·6	1231·86
76·950	1300	1184·9
75	1267	1154·9
71	1200	1093·75
70	1182·6	1077·9
65·111	1100	1002·6
65	1098·1	1000·9
60	1013·6	923·9
59·192	1000	911·5
56·825	960 [2 fl. oz.	875
55	929·2	846·9
53·273	900	820·3
25·977	438·9	400
25·5	430·8	392·7
25·453	430	391·9
25	422·4	384·9
24·861	420 [7 fl. drm.	382·8
24·5	413·9	377·3
24·269	410	373·7
24	405·5	369·6
23·677	400	364·6
23·5	397	361·9
23·085	390	355·5
23	388·6	354·2
22·730	383·9	350
22·5	380·1	346·5
22·494	380	346·4
22	371·7	338·8
21·902	370	337·2
21·5	363·2	331·2
21·309	360 [6 fl. drm.	328·1
21	354·8	323·4
20·718	350	319
20·5	346·3	315·7
20·126	340	309·9
20	337·9	307·9
19·534	330	300·8
19·5	329·4	300·2

EQUIVALENTS OF MEASURES OF CAPACITY—*continued.*

Metric Measure.	Imperial Measure.		Metric Measure	Imperial Measure.	
Mils. (= C.c.'s.)	Minims.	Fluid Grains.	Mils. (= C.c.'s.)	Minims.	Fluid Grains.
19·482	329·1	300	9·767	165	150·4
19	320·9	292·5	9·5	160·4	146·3
18·942	320	291·7	9·471	160	145·8
18·5	312·5	284·8	9·175	155	141·3
18·350	310	282·6	9	152	138·5
18	304·1	277·1	8·879	150	136·7
			8·683	145	131·6
17·758	300 [5 fl. drm.	273·4	8·5	143·6	130·9
17·5	295·6	269·4	8·287	140	127·6
17·166	290	264·3	8	135·2	123·2
17	287·2	261·7	7·990	135	123
16·574	280	255·2	7·695	130	118·7
16·5	278·8	254	7·5	126·7	115·5
16·235	274·3	250	7·399	125	114·1
16	270·3	246·3	7·251	122·5	111·6
15·982	270	246·1			
15·5	261·9	208·6	7·103	120 [2 fl. drm.	109·4
15·390	260	236·9	7	118·3	107·8
15	253·4	230·9	6·807	115	104·8
14·798	250	227·9	6·511	110	100·3
14·5	244·9	223·2	6·5	109·8	100·1

14·302	245	223·3
14·206	240 [4 fl. drm.	218·8
14	236·5	215·5
13·910	235	214·2
13·614	230	209·6
13·5	228·1	207·8
13·318	225	205·1
13·022	220	200·5
13	219·6	200·1
12·988	219·4	200
12·726	215	195·9
12·5	211·2	192·4
12·430	210	191·4
12·134	205	186·8
12	202·7	184·7
11·838	200	182·3
11·542	195	177·7
11·5	194·3	177·1
11·247	190	173·2
11	185·8	169·3
10·951	185	168·6
10·655	180 [3 fl. drm.	164·1
10·5	177·4	161·6
10·359	175	159·5
10·063	170	154·9
10	168·9	153·9
9·741	164·6	150
6·494	109·7	100
6·215	105	95·7
6	101·4	92·4
5·919	100	91·1
5·845	98·7	90
5·624	95	86·6
5·5	92·9	84·7
5·328	90	82
5·195	87·8	80
5·031	85	77·5
5	84·5	76·9
4·736	80	72·9
4·546	76·8	70
4·5	76	69·3
4·439	75	68·4
4·143	70	63·8
4	67·6	61·6
3·896	65·8	60
3·847	65	59·2
3·552	60 [1 fl. drm.	54·7
3·5	59·1	53·9
3·256	55	50·1
3·247	54·9	50
3	50·7	46·2
2·959	50	45·6
2·922	49·4	45
2·664	45	41·1
2·597	43·8	40

EQUIVALENTS OF MEASURES OF CAPACITY—*continued.*

Metric Measure.	Imperial Measure.		Metric Measure.	Imperial Measure.	
Mils. (= C.c.'s.)	Minims.	Fluid Grains.	Mils. (= C.c.'s.)	Minims.	Fluid Grains.
2·5	42·2	38·5	0·839	14·2	13
2·368	40	36·5	0·829	14	12·8
2·273	38·4	35	0·8	13·5	12·3
2·072	35	31·9	0·779	13·2	12
2	33·8	30·8	0·770	13	11·9
1·948	32·9	30	0·75	12·7	11·6
1·9	32·1	29·3	0·710	12	11
1·8	30·4	27·7	0·7	11·8	10·7
			0·65	11	10·1
			0·649	10·9	10
1·776	30 [½ fl. drm.	27·3	0·6	10·1	9·2
1·75	29·6	26·9			
1·7	28·7	26·2			
1·624	27·4	25	0·592	10	9·1
1·6	27	24·6	0·585	9·9	9
1·5	25·3	23·1	0·55	9·3	8·5
1·479	25	22·8	0·533	9	8·2
1·421	24	21·9	0·520	8·8	8
1·4	23·7	21·6	0·5	8·5	7·7
1·361	23	20·9	0·474	8	7·3

1·3	22	20·1
1·299	21·9	20
1·25	21·1	19·2
1·243	21	19
1·2	20·3	18·5
1·184	20	18·2
1·179	19·8	18
1·15	19·4	17·7
1·125	19	17·3
1·1	18·6	17
1·066	18	16·4
1·039	17·7	16
1·006	17	15·5
1	16·9	15·4
0·974	16·5	15
0·95	16·1	14·6
0·947	16	14·5
0·918	15·5	14
0·9	15·2	13·9
0·888	15	13·7
0·85	14·4	13·1

0·45	7·7	7
0·414	7	6·4
0·4	6·8	6·1
0·390	6·7	6
0·355	6	5·5
0·35	5·9	5·4
0·325	5·5	5
0·3	5·1	4·7
0·296	5	4·5
0·260	4·4	4
0·25	4·2	3·9
0·237	4	3·7
0·2	3·4	3·1
0·195	3·3	3
0·178	3	2·7
0·15	2·5	2·3
0·130	2·2	2
0·125	2·1	1·9
0·118		1·8
0·1	1·7	1·5
0·065	1·1	1
0·059	1	0·9
0·010	0·17	0·15

TABLE OF THERMOMETRIC EQUIVALENTS.

CENTIGRADE (CELSIUS) AND FAHRENHEIT SCALES.

C.°	F.°	C.°	F.°	C°	F°	C.°	F.°
—40	—40	—21·1	—6	—3	26·6	15·6	60
—39·4	—39	—21	—5·8	—2·8	27	16	60·8
—39	—38·2	—20·6	—5	—2·2	28	16·1	61
—38·9	—38	—20	—4	—2	28·4	16·7	62
—38·3	—37			—1·7	29	17	62·6
—38	—36·4	—19·4	—3	—1·1	30	17·2	63
—37·8	—36	—19	—2·2	—1	30·2	17·8	64
—37·2	—35	—18·9	—2	—0·6	31	18	64·4
—37	—34·6	—18·3	—1	0	32	18·3	65
—36·7	—34	—18	—0·4			18·9	66
—36·1	—33	—17·8	0	0·5	32·9	19	66·2
—36	—32·8	—17·5	0·5	0·6	33	19·4	67
—35·6	—32	—17·2	1	1	33·8	20	68
—35	—31	—17	1·4	1·1	34		
		—16·7	2	1·7	35	20·6	69
—34·4	—30	—16·1	3	2	35·6	21	69·8
—34	—29·2	—16	3·2	2·2	36	21·1	70
—33·9	—29	—15·6	4	2·8	37	21·7	71
—33·3	—28	—15	5	3	37·4	22	71·6
—33	—27·4			3·3	38	22·2	72
—32·8	—27	—14·4	6	3·9	39	22·8	73
—32·2	—26	—14	6·8	4	39·2	23	7·34
—32	—25·6	—13·9	7	4·4	40	23·3	74

—31·7	—25	—13·3	8	5	41	23·9	75
—31·1	—24	—13	8·6			24	75·2
—31	—23·8	—12·8	9	5·6	42	24·4	76
—30·6	—23	—12·2	10	6	42·8	25	77
—30	—22	—12	10·4	6·1	43		
		—11·7	11	6·7	44	25·6	78
—29	—21	—11·1	12	7	44·6	26	78·8
—29	20·2	—11	12·2	7·2	45	26·1	79
—28·9	—20	—10·6	13	7·	46	26·7	80
—28·3	—19	—10	14	8	46·4	27	80·6
—28	—18·4			8·3	47	27·2	81
—27·8	—18	—9·4	15	8·9	48	27·8	82
—27·2	—17	—9	15·8	9	48·2	28	82·4
—27	16·6	—8·9	16	9·4	49	28·3	83
—26·7	—16	—8·3	17	10	50	28·9	84
—26·1	—15	—8	17·6			29	84·2
—26	—14·8	—7·8	18	10·6	51	29·4	85
—25·6	—14	—7·2	19	11	51·8	30	86
—25	—13	—7	19·4	11·1	52		
		—6·7	20	11·7	53	30·6	87
—24·4	—12	—6·1	21	12	53·6	31	87·8
—24	—11·2	—6	21·2	12·2	54	31·1	88
—23·9	—11	—5·6	22	12·8	55	31·7	89
—23·3	—10	—5	23	13	55·4	32	89·6
—23	—9·4			13·3	56	32·2	90
—22·8	—9	—4·4	24	13·9	57	32·8	91
—22·2	—8	—4	24·8	14	57·2	33	91·4
—22	—7·6	—3·9	25	14·4	58	33·3	92
—21·7	—7	—3·3	26	15	59	33·9	93

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
34	93·2	53·9	129	73·3	164	93	199·4
34·4	94	54	129·2	73·9	165	93·3	200
35	95	54·4	130	74	165·2	93·9	201
35·6	96	55	131	74·4	166	94	201·2
36	96·8	55·6	132	75	167	94·4	202
36·1	97	56	132·8	75·6	168	95	203
36·7	98	56·1	133	76	168·8	95·6	204
37	98·6	56·7	134	76·1	169	96	204·8
37·2	99	57	134·6	76·7	170	96·1	205
37·8	100	57·2	135	77	170·6	96·7	206
38	100·4	57·8	136	77·2	171	97	206·6
38·3	101	58	136·4	77·8	172	97·2	207
38·9	102	58·3	137	78	172·4	97·8	208
39	102·2	58·9	138	78·3	173	98	208·4
39·4	103	59	138·2	78·9	174	98·3	209
40	104	59·4	139	79	174·2	98·9	210
40·6	105	60	140	79·4	175	99	210·2
41	105·8	60·6	141	80	176	99·4	211
41·1	106	61	141·8	80·6	177	100	212
41·7	107	61·1	142	81	177·8	100·6	213
42	107·6	61·7	143	81·1	178	101	213·8
42·2	108	62	143·6	81·7	179	101·1	214
42·8	109	62·2	144	82	179·6	101·7	215
43	109·4	62·8	145	82·2	180	102	215·6

43·3	110	63	145·4	82·8	181	102·2	216
43·9	111	63·3	146	83	181·4	102·8	217
44	111·2	63·9	147	83·3	182	103	217·4
44·4	112	64	147·2	83·9	183	103·3	218
45	113	64·4	148	84	183·2	103·9	219
45·6	114	65	149	84·4	184	104	219·2
46	114·8	65·6	150	85	185	104·4	220
46·1	115	66	150·8	85·6	186	105	221
46·7	116	66·1	151	86	186·8	105·6	222
47	116·6	66·7	152	86·1	187	106	222·8
47·2	117	67	152·6	86·7	188	106·1	223
47·8	118	67·2	153	87	188·6	106·7	224
48	118·4	67·8	154	87·2	189	107	224·6
48·3	119	68	154·4	87·8	190	107·2	225
48·9	120	68·3	155	88	190·4	107·8	226
49	120·2	68·9	156	88·3	191	108	226·4
49·4	121	69	156·2	88·9	192	108·3	227
50	122	69·4	157	89	192·2	108·9	228
50·6	123	70	158	89·4	193	109	228·2
51	123·8	70·6	159	90	194	109·4	229
51·1	124	71	159·8	90·6	135	110	230
51·7	125	71·1	160	91	195·8	110·6	231
52	125·6	71·7	161	91·1	196	111	231·8
52·2	126	72	161·6	91·7	197	111·1	232
52·8	127	72·2	162	92	197·6	111·7	233
53	127·4	72·8	163	92·2	198	112	233·6
53·3	128	73	163·4	92·8	199	112·2	234

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
112·8	235	132·2	270	152	305·6	171·7	341
113	235·4	132·8	271	152·2	306	172	341·6
113·3	236	133	271·4	152·8	307	172·2	342
113·9	237	133·3	272	153	307·4	172·8	343
114	237·2	133·9	273	153·3	308	173	343·4
114·4	238	134	273·2	153·9	309	173·3	344
115	239	134·4	274	154	309·2	173·9	345
		135	275	154·4	310	174	345·2
115·6	240			155	311	174·4	346
116	240·8	135·6	276			175	347
116·1	241	136	276·8	155·6	312		
116·7	242	136·1	277	156	312·8	175·6	348
117	242·6	136·7	278	156·1	313	176	348·8
117·2	243	137	278·6	156·7	314	176·1	349
117·8	244	137·2	279	157	314·6	176·7	350
118	244·4	137·8	280	157·2	315	177	350·6
118·3	245	138	280·4	157·8	316	177·2	351
118·9	246	138·3	281	158	316·4	177·8	352
119	246·2	138·9	282	158·3	317	178	352·4
119·4	247	139	282·2	158·9	318	178·3	353
120	248	139·4	283	159	318·2	178·9	354
		140	284	159·4	319	179	354·2
120·6	249			160	320	179·4	355
121	249·8	140·6	285			180	356
121·1	250	141	285·8	160·6	321		
121·7	251	141·1	286	161	321·8	180·6	357

122	251·6	141·7	287	161·1	322	181	357·8
122·2	252	142	287·6	161·7	323	181·1	358
122·8	253	142·2	288	162	323·6	181·7	359
123	253·4	142·8	289	162·2	324	182	359·6
123·3	254	143	289·4	162·8	325	182·2	360
123·9	255	143·3	290	163	325·4	182·8	361
124	255·2	143·9	291	163·3	326	183	361·4
124·4	256	144	291·2	163·9	327	183·3	362
125	257	144·4	292	164	327·2	183·9	363
125·6	258	145	293	164·4	328	184	363·2
126	258·8	145·6	294	165	329	184·4	364
126·1	259	146	294·8	165·6	330	185	365
126·7	260	146·1	295	166	330·8	185·6	366
127	260·6	146·7	296	166·1	331	186	366·8
127·2	261	147	296·6	166·7	332	186·1	367
127·8	262	147·2	297	167	332·6	186·7	368
128	262·4	147·8	298	167·2	333	187	368·6
128·3	263	148	298·4	167·8	334	187·2	369
128·9	264	148·3	299	168	334·4	187·8	370
129	264·2	148·9	300	168·3	335	188	370·4
129·4	265	149	300·2	168·9	336	188·3	371
130	266	149·4	301	169	336·2	188·9	372
130·6	267	150	302	169·4	337	189	372·2
131	267·8	150·6	303	170	338	189·4	373
131·1	268	151	303·8	170·6	339	190	374
131·7	269	151·1	304	171	339·8	190·6	375
132	269·6	151·7	305	171·1	340	191	375·8

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
191·1	376	210	410	228·3	443	246·7	476
191·7	377			228·9	444	247	476·6
192	377·6	210·6	411	229	444·2	247·2	477
192·2	378	211	411·8	229·4	445	247·8	478
192·8	379	211·1	412	230	446	248	478·4
193	379·4	211·7	413			248·3	479
193·3	380	212	413·6	230·6	447	248·9	480
193·9	381	212·2	414	231	447·8	249	480·2
194	381·2	212·8	415	231·1	448	249·4	481
194·4	382	213	415·4	231·7	449	250	482
195	383	213·3	416	232	449·6		
		213·9	417	232·2	450	250·6	483
195·6	384	214	417·2	232·8	451	251	483·8
196	384·8	214·4	418	233	451·4	251·1	484
196·1	385	215	419	233·3	452	251·7	485
196·7	386			233·9	453	252	485·6
197	388·6	215·6	420	234	453·2	252·2	486
197·2	387	216	420·8	234·4	454	252·8	487
197·8	388	216·1	421	235	455	253	487·4
198	388·4	216·7	422			253·3	488
198·3	389	217	422·6	235·6	456	253·9	489
198·9	390	217·2	423	236	456·8	254	489·2
199	390·2	217·8	424	236·1	457	254·4	490
199·4	391	218	424·4	236·7	458	255	491

200	392
200·6	393
201	393·8
201·1	394
201·7	395
202	395·6
202·2	396
202·8	397
203	397·4
203·3	398
203·9	399
204	399·2
204·4	400
205	401
205·6	402
206	402·8
206·1	403
206·7	404
207	404·6
207·2	405
207·8	406
208	406·4
208·3	407
208·9	408
209	408·2
209·4	409

218·3	425
218·9	426
219	426·2
219·4	427
220	428
220·6	429
221	429·8
221·1	430
221·7	431
222	431·6
222·2	432
222·8	433
223	433·4
223·3	434
223·9	435
224	435·2
224·4	436
225	437
225·6	438
226	438·8
226·1	439
226·7	440
227	440·6
227·2	441
227·8	442
228	442·4

237	458·6
237·2	459
237·8	460
238	460·4
238·3	461
238·9	462
239	462·2
239·4	463
240	464
240·6	465
241	465·8
241·1	466
241·7	467
242	467·6
242·2	468
242·8	469
243	469·4
243·3	470
243·9	471
244	471·2
244·4	472
245	473
245·6	474
246	474·8
246·1	475

255·6	492
256	492·8
256·1	493
256·7	494
257	494·6
257·2	495
257·8	496
258	496·4
258·3	497
258·9	498
259	498·2
259·4	499
260	500
260·6	501
261	501·8
261·1	502
261·7	503
262	503·6
262·2	504
262·8	505
263	505·4
263·3	506
263·9	507
264	507·2
264·4	508
265	509

THERMOMETRIC MEMORANDA.

Reprinted from the British Pharmacopœia.

Thermometers employed in taking specific gravities, melting points, or boiling points, should have been compared with a standard thermometer, and their errors recorded in a table, by means of which the readings of the instruments used are to be corrected. The zero point of the instruments should be verified from time to time.

To determine the melting point of a substance, a minute fragment of it should be placed in a thin-walled glass tube having an internal diameter of about one millimetre (1/25 inch), and sealed at the lower end. This tube should be attached to the thermometer so that the substance is near the middle of the bulb, and the thermometer with the attached tube should be immersed in a suitable liquid, contained in a beaker placed over a small lamp flame. Water is suitable for substances melting below 212° F. (100° C sulphuric acid, hard paraffin, or glycerin for substances melting at higher temperatures. The liquid should be continually stirred by means of a glass ring moved up and down till the substance is seen to melt. The temperature is noted, the tube cooled till the substance solidfies, and the operation then repeated. The latter reading of the thermometer should be taken as the melting point. To obtain accurate results, the whole of the mercury column of the thermometer should be immersed in the heated liquid; but as this is seldom practicable, the mean temperature of the emergent column—that is, of that portion above the surface of the heated liquid—should be ascertained and the necessary correction applied. To obtain the mean temperature of the emergent column, a small thermometer is fixed by india-rubber bands in such a position that its bulb is about the middle of the emergent column. The corrected temperature may be calculated with approximate accuracy from the formula:—

Corrected temperature $= T + 0{\cdot}000143\ (T - t)\ N$, in which

T = observed, *i.e.*, uncorrected, temperature;

t = mean temperature of the emergent column;

N = the length of the emergent column in scale degrees.

To determine the boiling point of a substance, the liquid under examination should be placed in a distilling flask having a side tube for conveying the vapour to a condenser, while the thermometer passes through a cork inserted in the neck. The bulb of the thermometer should be near to, but not immersed in, the liquid, and the whole of the thread of mercury should, if possible, be surrounded by the vapour; the temperature is read off as soon as the liquid is distilling freely. If any considerable length of the mercurial column be not surrounded by the vapour, the temperature of the emergent column should be ascertained as directed under melting points, and the necessary correction applied

WATER ANALYSIS.

CHEMICAL AND MICROSCOPICAL EXAMINATION.

IN the majority of cases in which water is submitted to chemical examination the object of the examination is to determine its fitness, or otherwise, for drinking and general domestic use. While an exhaustive analysis requires the use of expensive apparatus and special methods of examination, which practically necessitate its being done by an expert in this special branch of work, sufficient information for the purpose just mentioned can be obtained by any careful chemist possessed of ordinary laboratory apparatus. In the present article those processes are described which furnish the requisite data on which to base an opinion as to the utility of the water examined. While care and ordinary chemical knowledge suffice for the carrying out of the actual analysis, the formation of a sound opinion from the analytical results requires experience. General rules as to the inferences to be drawn from the results are given below; but it is not possible to furnish any such rules which shall be suitable to all cases. In forming a judgment on any given water, attention must be paid to the nature of the source, its geographical position, and the geological formations of the locality. By far the larger number of waters submitted for analysis are from wells, and in these cases information should be obtained as to the depth of the well, and its position with regard to cesspools, sewers, stables or cowhouses, etc., in the vicinity. Such information is rarely supplied unless asked for; its importance should, therefore, be pointed out, and the fullest possible details be obtained from a competent person having access to the source of supply.

It is not, as a rule, the business of the chemist to collect the sample for analysis, but he can often furnish instructions to the person who will do so. A clean, stoppered Winchester quart should be used. This should be rinsed out once or twice with the water; or, better, it should be completely filled and emptied again before collecting the sample to be used for analysis. If the source is a river or well, the whole bottle should be plunged some inches below the surface and there filled, but without stirring up sediment from the bottom. If a supply from a tap or pump is to be examined, the water should be allowed to run to waste long enough to empty the pipes of the water that has stood in them before beginning to collect the sample. The water having been collected, the bottle should be at once tied down and labelled.

Before proceeding to the analysis the physical characters of the water should be noted. These include colour, for which

a considerable depth of the water is examined in a white glass vessel; taste; smell, when warmed; and brightness, carefully noting any turbidity or sediment. The reaction of the water to litmus paper should also be ascertained.

The Chemical Examination may include the following tests, but it is not necessary to apply all of them in every case. This is referred to more fully below:—

(1) TOTAL SOLIDS.—50 or 100 Ml. of the water is evaporated to dryness on a water-bath in a tared platinum or nickel dish; when completely dry the dish, with residue, is cooled in a desiccator and weighed. If a little suspended matter or sediment exists in the water it should be first shaken up, so that the total solids will include undissolved, as well as dissolved, matter; but if much is present it may be filtered out and determined separately by drying and weighing.

(2) OXYGEN ABSORBED.—Two determinations are made, one of the amount of oxygen absorbed in fifteen minutes, the other of the amount absorbed in four hours; the temperature employed is 27° C.

The following solutions are required:—

Potassium Permanganate.—0·3954 Gm. in 1 litre; 1 Ml. contains 0·0001 Gm. of available oxygen.

Potassium Iodide.—About 1 in 10.

Dilute Sulphuric Acid.—One fluid part of strong acid is added to 3 of water; after cooling to 27° it must be kept at this temperature for four hours, after adding enough permanganate to leave a very faint pink tint at the end of that time.

Sodium Thiosulphate.—1 Gm. in 1 litre.

To perform the test, two stoppered flasks are taken of 250 Ml. capacity, and 200 Ml. of the water put in each; these are placed in a water-bath at 27° until the contained water is at that temperature, then 10 Ml. each of the dilute sulphuric acid and the permanganate solution are added to each flask. At the end of fifteen minutes one flask is taken out of the bath, potassium iodide solution dropped in until the pink colour is replaced by a yellow, and the iodine then determined by titration with the thiosulphate solution, using starch as indicator. At the end of four hours the other flask is treated in the same way; if the pink colour in this flask disappears in less than four hours a further measured quantity of permanganate is added, so that at the end of the time a marked pink colour remains. The exact strength of the thiosulphate solution is determined by a control experiment with *pure* distilled water for four hours. From the data obtained from these determinations the amounts of oxygen absorbed respectively in fifteen minutes and four hours are found by simple calculations. The strength of

the thiosulphate solution will not remain constant for more than three or four days, and it should therefore be determined afresh each time.

(3) "FREE" AND "ALBUMINOID" AMMONIA.—For these most important determinations the following solutions are required:—

Standard Ammonium Chloride.—Dissolve 3·14 Gm. of pure ammonium chloride in ammonia-free distilled water and make up to 1 litre; dilute 10 Ml. of this solution with more of the water to 1 litre. This diluted solution contains 0·01 milligram of ammonia (NH_3) in 1 Ml.

Nessler Solution.—Dissolve 17 Gm. of mercuric chloride in 300 Ml. of water, and add this to a previously made solution of 35 Gm. of potassium iodide in 100 Ml. of water; dilute the mixed liquid with a 20 per cent. solution of caustic potash to 1 litre; add more mercuric chloride solution until the precipitate that forms just ceases to redissolve on shaking. Then set aside for the precipitate to settle, and decant the clear liquid. The sensitiveness of this solution is increased by keeping, and should be such that 2 Ml. dropped into a mixture of 5 Ml. of the dilute ammonium chloride solution with 45 Ml. of water will *at once* give a yellowish-brown colour.

Alkaline Permanganate Solution.—Dissolve 8 Gm. of potassium permanganate and 200 Gm. of caustic potash in 1,100 Ml. of water and boil rapidly till concentrated to 1 litre.

Ammonia-free Distilled Water.—The purest water available is distilled, and the distillate rejected until 50 Ml. of it does not give a yellow tint with 2 Ml. of Nessler solution after five minutes' standing; it is then collected, but distillation must not be carried to dryness.

The test is carried out in the following manner:—A stoppered glass retort of about 1 litre capacity is connected to a large Liebig condenser; the tube of the retort must pass several inches into the tube of the condenser, and the joint may be packed by wrapping a little writing paper round the tube of the retort, or it may be covered with a broad india-rubber band. Ammonia-free water (300 Ml. or so) is put into the retort, and distilled until 50 Ml. of the distillate gives no colour with 2 Ml. of Nessler solution, showing the apparatus to be free from ammonia; distillation is then stopped, and the water remaining in the retort siphoned out through the tubulure, without dismantling the apparatus, and 500 Ml. of the water for examination is put in. About 0·5 Gm. of recently ignited sodium carbonate is added, the stopper replaced, and distillation commenced. The retort should not be placed on wire gauze, but heated by means of a naked flame, and dis-

tillation should proceed briskly. The distillate is collected in portions of 50 Ml., conveniently in cylinders of white glass with a mark at 50 Ml. (known as Nessler glasses). These cylinders must all be of uniform diameter, so that 50 Ml. of liquid forms a column of the same height in all. The first 50 Ml. of distillate is set aside; the second is Nesslerised—that is, 2 Ml. of Nessler solution is dropped into it and the mixture stirred. If any colour is produced, the depth of colour is imitated by dropping into another Nessler glass from a burette a known quantity of the dilute standard ammonium chloride solution, adding ammonia-free water to 50 Ml., and then 2 Ml. of Nessler solution, and stirring. If the colour so produced is not identical in depth with that obtained with the distillate, a fresh trial is made with more or less of the ammonium chloride until a liquid of exactly the same depth of colour is obtained. The amount of ammonia in the distillate that has been Nesslerised is, of course, equal to the known amount that has been used to match it. The comparison is made by placing the Nessler tubes side by side on a white porcelain tile or a sheet of white paper, and looking obliquely through the column of liquid from above in a good light; daylight is greatly to be preferred to any artificial light. If this second 50 Ml. of distillate gives a colour with Nessler solution, further portions of 50 Ml. each are collected until no more ammonia is obtained; if less than a total of 200 Ml. has been collected, distillation is continued until this quantity has passed over, throwing away the later portions of distillate, and the burner is then removed from under the retort. The first 50 Ml. of distillate is Nesslerised in the manner that has just been described; the reason for setting it aside until after the second portion has been treated is that it is not possible to accurately compare the depth of colour in two liquids if very much ammonia is present. If, therefore, the second distillate has been found to contain much ammonia, the first, which will contain considerably more, should be suitably diluted before Nesslerising, and calculation made accordingly. The total of the quantities of ammonia found in all the distillates constitutes the "free ammonia" of the sample. While this distillation of the sample of water is proceeding, 50 Ml. of the alkaline permanganate solution and 200 Ml. of ammonia-free water are kept gently boiling in a flask, so that the volume is not reduced below about 200 Ml. by the time the water in the retort is reduced to 300 Ml.; having then temporarily stopped the distillation, the stopper of the retort is removed and the 200 Ml. of diluted permanganate poured in. Distillation is then re-commenced, and successive portions of distillate of 50 Ml. each

are collected and Nesslerised as before. When no more ammonia is contained in the distillate, the operation is at an end. Usually three portions of 50 Ml. will be sufficient. In the distillation with permanganate it is often necessary to keep the retort gently shaken to prevent bumping. The total ammonia obtained in this second distillation, as found by Nesslerising the fractions, constitutes the "albuminoid ammonia" of the sample. Half a litre of water having been employed, a simple calculation gives the result as parts of ammonia per 100,000 of water. In the case of very bad waters, less than half a litre should be taken, and diluted to this volume with ammonia-free water; a corresponding difference must, of course, be made in calculating the results. It is, of course, obvious that every part of the process of determining ammonia by this method must be carried out in a room in which no ammoniacal vapour is present in the atmosphere. If this precaution is not observed enough ammonia may be dissolved from the air by the distillates to vitiate the results. When practicable, it is a good plan to leave the retort and condenser always standing ready, and use them for no other purpose.

(4) NITRITE.—The following solutions are required:—

Meta-phenylene-Diamine.—Dissolve 0·5 Gm. in very dilute sulphuric acid, and dilute the solution to 100 Ml. with water.

Sulphuric Acid.—Diluted with twice its volume of water.

Sodium Nitrite.—Dissolve 0·4047 Gm. of silver nitrite in boiling water, and add sodium chloride until no further precipitate is formed; dilute to 1 litre, let the silver chloride settle, and then dilute 100 Ml. of the clear liquid to 1 litre. This solution contains 0·01 milligram of nitrous anhydride (N_2O_3) in 1 Ml.

To carry out the test, 100 Ml. of the water is put into a 100 Ml. Nessler glass, and 1 Ml. each of the meta-phenylene-diamine solution and the sulphuric acid are added. If a brown colour appears in less than one minute a new test must be made with a less quantity of the water, made up to 100 Ml. with pure distilled water. The colour produced is matched by trying measured quantities of the sodium nitrite solution, diluted to 100 Ml., and treated with meta-phenylene-diamine and acid in the same way as the water. Since the colour gradually deepens for some time, the final comparison must be between liquids that have stood for twenty minutes. The comparison and the calculation are made in the same way as in Nesslerising for ammonia. Since nitrite is easily oxidised on keeping the water, it should be determined as soon as possible after the water is received.

(5) NITRATE.—Nitrate and nitrite are determined together by reducing to ammonia; the nitrite found as above is then deducted, and the difference is nitrate. One molecule of ammonia represents one molecule of nitrite or nitrate, or half a molecule of the respective anhydrides (N_2O_3 and N_2O_5). Dissolve 100 Gm. of caustic soda in 1 litre of water, add about 100 square centimetres of thin aluminium foil, keeping it at the bottom by a glass rod; when it is dissolved, boil the solution briskly to about two-thirds of its volume, cool, and dilute to 1 litre. (This is to ensure freedom from nitrate and ammonia formed by its reduction.) 100 Ml. of this solution, and 100 Ml. of the water are then put into a retort, and a piece of aluminium foil added. The retort is stoppered, a plug of glass wool, moistened with very dilute hydrochloric acid (free from ammonia), is put into the tube of it, and the open end closed with a cork. The whole is set aside for a few hours, the plug of glass wool then washed down into the retort with ammonia-free water, and the whole distilled until reduced to about one-half. The distillate is collected, and an aliquot part diluted to 50 Ml. and Nesslerised; if much ammonia is found, ammonia-free water is added to the retort and distillation is continued until a distillate free from ammonia is obtained. From the total amount of ammonia found, the amount of "free ammonia" in 100 Ml. of the water must be deducted; the remainder represents nitrite and nitrate.

(6) CHLORINE.—Prepare a solution of silver nitrate, containing 4·7946 Gm. per litre; 1 Ml. of this is equivalent to 1 milligram of chlorine. Titrate 100 Ml. of the water with this solution, using potassium chromate as indicator in the usual way.

(7) POISONOUS METALS.—The chief metal to be looked for is lead, which may be present from the water having acted on the lead pipes through which it is conveyed. Copper and iron can be tested for at the same time; the latter metal, although not poisonous, is objectionable if present in drinking water in more than traces. 100 Ml. of the water is placed in a porcelain dish and stirred with a glass rod which has been dipped in ammonium sulphide solution. If any darkening is produced, the liquid is just acidified with a drop or two of hydrochloric acid; if the darkening disappears, it is due to iron; if it persists, it is due to lead or copper. The test may be made approximately quantitative by comparing the depth of colour with that produced in a very dilute solution of a salt of the metal in question, of known strength. For more accurate results, and for the detection of arsenic or other metallic impurities, a large quantity of the water must be

concentrated in a porcelain dish and examined by the usual analytical methods.

(8) HARDNESS.—The following solutions are required:—

Calcium Chloride.—One gramme of pure marble is dissolved in slight excess of dilute hydrochloric acid, the solution neutralised with ammonia, and diluted to 1 litre. This contains the equivalent of 1 milligram of calcium carbonate in 1 Ml.

Soap.—Ten grammes of powdered Castile soap is dissolved in alcohol of about 35 per cent. strength to make 1 litre (methylated spirit can only be employed if free from mineral naphtha). The strength of the solution is then adjusted by means of the calcium chloride solution. To do this, 12 Ml. of the latter is diluted with distilled water to 70 Ml., and put into a stoppered bottle of about 200 Ml. capacity. The soap solution is then run into this in small quantities from a burette, shaking well after each addition, until a lather is formed that persists for five minutes. For this purpose exactly 13 Ml. should be required, and, if necessary, the strength of the soap solution must be adjusted by dilution or the addition of a stronger solution until this is the case.

To determine the *total hardness* of any given water, 70 Ml. of it is to be titrated with the soap solution in the manner described until a lather persisting for five minutes is obtained. From the number of centimetres used 1 Ml. is to be deducted for the soap consumed in producing the lather; the remainder represents the number of "degrees of hardness" of the water, or the number of grains of calcium carbonate per gallon equivalent to the total calcium and magnesium salts present. If the water shows more than 16° of hardness the determination must be repeated, first diluting the water so as to bring it within that limit, and allowing for the dilution in calculating the result. To determine *permanent hardness*, boil a measured quantity of the water briskly in a flask for half an hour, adding distilled water from time to time as required; at the end of that time cool, make up to the original volume with distilled water, and decant or filter out 70 Ml.; titrate this with the soap solution as before. The difference between the total and permanent hardness gives the temporary hardness.

Microscopical Examination of the Deposit.—Useful information may sometimes be obtained by examining with the microscope the deposit which forms on standing. About a pint of water, well shaken up, should be put into a conical glass and left undisturbed for about twelve hours; most of the water is then siphoned off, and small quantities of the deposit transferred to microscope slides by means of a pipette and examined with both low and high powers. Animal and

vegetable organisms are to be noted and identified if possible, and from the kinds of organisms found conclusions may sometimes be reached as to the nature of the contamination which the water has undergone. In many cases a bacteriological examination is necessary, but this lies outside the scope of the present article.

Reporting and Interpretation of Results.—Some diversity exists as to the figures employed in reporting the results of water analysis. Some chemists express all results as grains per gallon, others as parts in 100,000, or, in some cases, parts per million. A committee appointed by the British Association to consider the subject and recommend a uniform system reported in favour of expressing all results as parts per 100,000, and that system is here adopted, except in the case of hardness, for the reason given below.

It is not necessary in every case to perform all the determinations described above. Not infrequently a report is given, with an opinion as to the fitness or otherwise of a water for drinking, from determinations of total solids, chlorine, and free and albuminoid ammonia, together with qualitative tests for nitrite, nitrate, and poisonous metals. The hardness of a water is not usually of importance when the water is only required for drinking; for domestic purposes involving boiling the water, a hard water is evidently undesirable on account of the "fur" that is deposited in the vessels in which it is boiled, especially if most of the hardness is "temporary." For steam boilers, for laundry work, and some other industrial purposes hard water is quite unsuitable. Since the general custom is to speak of the hardness of water in degrees, and any other nomenclature is likely not to be understood by those using water for industrial purposes, the term is here retained. As already explained, each degree of hardness represents the effect of 1 grain of calcium carbonate per gallon, or 1·43 part per 100,000.

It has been stated above, and cannot be too strongly emphasised, that to form a correct opinion as to the suitability of a water for drinking regard must be had to the nature and position of the source. If this is constantly borne in mind the following notes will be of assistance in interpreting the results of analysis. Approval or condemnation must not be based on the result of any one test, but on the combined indications of all the tests employed.

Total Solids.—If not more than 60 parts of total solids per 100,000 are present, no exception need be taken to the water on this account. A high proportion of solids is, of course, undesirable, but not in itself sufficient grounds for con-

demning a water without taking account of the nature of the solids.

Oxygen Absorbed.—Rapid reduction of the permanganate may be due to nitrite, ferrous salt, or other inorganic material, and the difference between the oxygen consumed in fifteen minutes and that consumed in four hours is of more value as an indication of organic impurity. The figures obtained are only comparable with anything like accuracy for waters of the same class. Frankland and Tidy have given the following figures:—For upland surface water, absorption of more than 0·4 part of oxygen per 100,000 indicates an impure water; absorption of from 0·3 to 0·4 part points to doubtful purity. For water other than upland surface, absorption of more than 0·2 part indicates an impure water, from 0·1 to 0·15 part a water of doubtful purity.

Ammonia, "Free" and "Albuminoid."—If less than 0·005 part per 100,000 of albuminoid ammonia is found, the water belongs to the class of very pure water, and the amount of free ammonia is not very important. If the albuminoid is from 0·005 to 0·01, free ammonia above 0·001 must cause the water to be regarded with suspicion. Albuminoid ammonia above 0·01 is a suspicious sign, and if it rises above 0·015 part it is sufficient to condemn a water. Free ammonia above 0·008 is usually a sign of contamination with urine, and in such a case the chlorine will be very high. In all cases the figures for free and albuminoid ammonia must be interpreted in conjunction with the figure for chlorine. High albuminoid ammonia and low chlorine usually indicate organic matter of vegetable origin; if both are high, sewage contamination is the probable cause.

Nitrite and Nitrate.—The presence of nitrite in river or shallow well water is probable indication of recent sewage contamination; in deep well water nitrite may be due to reduction of nitrate by ferrous oxide, etc., and is not of much significance. Nitrate is usually evidence of past organic contamination followed by thorough natural filtration or oxidation, and is not in itself grounds for condemnation, but it should direct attention to the source of contamination, in view of the possibility that in times of flood or other occasional conditions the filtration may become imperfect. In upland surface water the proportion of nitrate and nitrite together averages about 0·01 part per 100,000. In shallow well water they are often from two to five parts, even rising in some cases to as much as twenty-five parts. When this figure is high, suspicion should always be aroused, but the results of the other tests must be fully considered before deciding as to its importance.

Chlorine.—In the absence of any other sufficient cause, a high figure for chlorine usually indicates sewage; if the figure

for albuminoid ammonia is also high, the water may be unhesitatingly condemned. Unpolluted river and spring waters usually contain less than one part of chlorine per 100,000; more than three or four parts must be regarded with suspicion. Average town sewage contains about eleven parts. In the vicinity of the sea or of salt deposits, very high figures for chlorine may be obtained with unpolluted waters, and a sample should not be condemned on this figure alone.

Poisonous Metals.—Good drinking water should be free from lead and copper, or should at worst not contain more than 0·1 per 100,000. Not more than double this quantity of iron should be present.

Temperature of Various Freezing-Mixtures.

(*a*) Materials at 10° C. at commencement :—

Ammonium Nitrate, powdered	1	−16° C.
Water	1	
Sodium Sulphate	3	−19° C.
Nitric Acid	2	
Sodium Sulphate	6	−23° C.
Ammonium Chloride	4	
Potassium Nitrate	2	
Nitric Acid	4	
Sodium Sulphate	6	−26° C.
Ammonium Nitrate	5	
Nitric Acid	4	
Sodium Phosphate	9	−29° C.
Nitric Acid	4	

(*b*) Materials at 0° C. at commencement :—

Snow, or powdered ice	2	−20° C.
Common Salt	1	
Snow, or powdered ice	12	−31° C.
Common Salt	5	
Ammonium Nitrate	5	
Snow, or powdered ice	3	−48° C.
Calcium Chloride, crystalline	4	

Approximate High Temperatures.

Just glowing	525° C.	Orange	1,150° C.
Dark red heat	700°	Commencing white heat	1,300°
Cherry-red heat	850°		
Bright red heat	1,000°	Dazzling white heat	1,500°

MILK ANALYSIS.

AMONG all classes of civilised people, milk is one of the most widely used articles of diet, as well as one of the most valuable and important; it is also one of the most easily and frequently adulterated, either by the addition of water, the removal of part of the cream, or the addition of entirely foreign substances. It may be shown by statistics that adulteration diminishes in proportion as milk is more often submitted to analysis, and offenders exposed or proceeded against; but much more might be done in this way to check adulteration than is at present the case. In order to ascertain the genuineness or otherwise of milk only a few determinations are necessary, requiring care, but presenting no difficulty to a competent worker. It is probable that very many pharmacists might secure a good deal of practice of this kind with satisfactory results both in payment for the work done and in improved professional position. In the present article a careful selection of the processes of milk analysis is given, with sufficiently detailed descriptions to enable any chemist who will devote a little time to obtaining proficiency by practice to successfully carry out the examination of milks that may be submitted to him.

Milk may be obtained from many sources, but unless otherwise specified the term is here intended to refer to cow's milk. It not infrequently happens that samples of various modified milks are submitted for analysis, such as the so-called humanised milks; while medical practitioners sometimes require detailed analysis of human milk. In all such cases, however, the methods of analysis to be followed are the same as for cow's milk, and it will suffice to describe the treatment of the latter.

Constituents of Milk.

The constituents of cow's milk, and the proportions in which they exist in specimens of average composition, are as follows:—

Water	87·6 per cent.
Fat	3·6 per cent.
Milk Sugar	4·8 per cent.
Proteids	3·3 per cent.
Ash	0·7 per cent.

These are average figures, and the proportion of any constituent may vary a little. Certain minimum figures may, however, be taken, representing the composition of genuine milk of very poor quality; then if any sample is found on analysis to contain less of the proper constituents than these minimum proportions, it may be regarded as a mixture of milk and water. It

is not necessary for this purpose to determine all the constituents named above; sugar, proteids, and ash vary but little in their ratio one to another, and they are determined together under the name of "solids not fat." The proportion of fat is determined separately, and from these two determinations it is usually possible to state whether water has been added to the milk or not. Under the Sale of Food and Drugs Acts, the Board of Agriculture was given power to fix limits for the composition of milk and some other articles, and in 1901 the Board issued regulations by which a sample of milk which contains less than 3 per cent. of fat, *or* less than 8·5 per cent. of solids not fat, shall be presumed for the purposes of the Acts, until the contrary is proved, to be not genuine, by reason of the abstraction of milk fat or solids not fat (as the case may be) or the addition of water.

Methods of Analysis.

The usual analysis of milk includes the determination of (1) specific gravity; (2) percentage of total solids; (3) percentage of ash; (4) percentage of fat; (5) presence or absence of preservatives. We proceed to describe the methods used for these determinations, leaving others until later.

It is, of course, essential that each portion of milk used in an analysis should truly represent the bulk from which it is taken; since the cream rises to the surface on standing, milk that has remained undisturbed for any considerable length of time is not homogeneous, and should be well mixed by pouring from one vessel to another and back again several times (shaking is not as good, as more air may be entangled in the milk in this way, and there is risk of churning the cream into butter); for the same reason it is best to commence the analysis as soon as possible after the sample is received, and also in order to prevent the occurrence of curdling or similar changes.

1. Specific Gravity.—This is determined by means of a hydrometer, Westphal balance, or specific gravity bottle, the first being the least accurate; it is usually from 1·029 to 1·034 at 15·5°, at which temperature it should always be determined. Specially graduated hydrometers are sometimes used, and termed lactometers; these are usually graduated to read the "excess gravity" over water taken as 1,000; thus a milk of specific gravity 1·0315 would give a reading of 31·5°. Since the specific gravity of milk is raised by removing part of the cream and lowered by addition of water, it is possible for a much diluted milk to show normal gravity; the gravity determination alone, therefore, is of no value for detecting adulteration. It is of use, however, since it permits of the quantities taken for other determinations being measured instead of weighed; and

any abnormality in the specific gravity is a useful indication of some fault to be looked for further.

2. TOTAL SOLIDS.—Five Gm. of the milk is weighed (or 5 mils measured with an accurate pipette) into a shallow dish, preferably of platinum, which is then heated on a boiling water-bath for about three hours, and then inside a water-oven at 100° for a further two hours. It is then cooled in a desiccator, and weighed with as little exposure as possible, as the residue is somewhat hygroscopic.

3. ASH.—After weighing, the total residue is ignited in the dish over a bunsen flame until a white ash is left; no part of the dish should be heated above very low redness, or some sodium chloride may be lost from the ash. The ash of normal milk consists of chlorides of sodium and potassium, phosphates of potassium, calcium, and magnesium, and traces of sulphates and of iron. The ratio of ash to solids not fat is very constant in genuine milks, being usually 8·3 to 100, and rarely falling outside the limits of 8·0 and 8·6 to 100. In the case of watered milk to which some addition has been made in order to bring the total solids up to the normal amount, the ratio of ash to solids not fat, is very likely to be altered; if this ratio falls outside the limits just named special search should be made for such added substance. If boric acid or borax has been added to the milk the ash is of course raised in quantity, and the addition can be found by qualitative tests; some other preservatives would also be found in the ash, and are mentioned below.

4. FAT.—Several methods are in vogue for this important determination; we describe these in the order of their convenience of application in a laboratory not specially fitted for milk testing.

(*a*) *Werner-Schmidt Method.*—Measure out 10 mils of the milk with a pipette, and add to it about an equal volume of strong hydrochloric acid: boil the mixture for two minutes (not more), then allow to stand for a further three minutes; or immerse the tube in a boiling water-bath for about ten minutes; afterwards cool by immersing in cold water. This heating may be done in a graduated test-tube of the kind made specially for the test, or the mixture may now be transferred to a small cylinder graduated to 50 mils, employing a few drops of water to rinse the tube and draining it well so that none is lost. Now add to the dark liquid about 30 mils of ether, shake well for half a minute, then let stand five minutes to separate. Then take out with a pipette 20 mils of the ethereal solution, evaporate it in a tared dish, dry and weigh the residual fat; the volume of the ethereal solution remaining is read, and a simple calculation then gives the total amount of fat. Sometimes there is a little difficulty in reading exactly the volume of the ethereal layer, owing to the presence of a fluffy stratum of casein at

the junction of the liquids; three-fourths of this stratum may be reckoned to belong to the ethereal liquid. An example will make the method of calculation clear :—10 Ml. of milk of specific gravity, 1·031, treated as above, gave from 20 Ml. of ethereal solution, 0·277 Gm. of fat; there remained in the cylinder 6·5 Ml. of ethereal solution, making a total of 26·5 Ml. The total amount of fat was therefore $0{\cdot}277 \times \frac{26{\cdot}5}{20} = 0{\cdot}367$; the percentage being thus $\frac{3{\cdot}67}{1{\cdot}031} = 3{\cdot}56$.

(*b*) *Adams' Method.*—This is the official method of the Society of Public Analysts. Strips of thick absorbent fat-free paper are required, about 55 × 6 Cm. in dimensions; these can be obtained from apparatus dealers, or good blotting-paper may be dried and thoroughly extracted with ether. One of these strips is rolled up into a loose coil and fastened by a piece of wire; 5 mils or so of the milk is accurately measured or weighed, and slowly poured on to the coil in such a way that it is fairly evenly distributed upon it; the coil is then thoroughly dried by heating for two to three hours in a water oven. It is then placed in a Soxhlet extraction apparatus connected to a flask and a reflux condenser, and thoroughly extracted with dry ether; the ethereal liquid should siphon over at least twelve times, the extraction taking about three hours. The flask is then disconnected and the ether evaporated, and the residue of fat dried in a water-oven for about five hours, or until it loses less than a milligramme in an hour's further heating. It is then weighed and the tare of the flask deducted, giving the weight of the fat, from which the percentage is ascertained by a simple calculation.

(*c*) *Leffmann-Beam Method.*—This can only be carried out where a small centrifugal machine is available; such a machine is very useful in a laboratory where much work of this kind is to be done. With the Leffmann-Beam centrifuge special bottles for milk are supplied, holding about 40 mils, and graduated on the neck. Fifteen mils of milk is placed in the bottle, 3 mils of a mixture of equal parts of fusel oil and hydrochloric acid of specific gravity 1·16 is added, and the liquids mixed by shaking, taking care that none gets into the neck; 9 mils of 95 per cent. sulphuric acid is then added, and the bottle again shaken, then enough of a hot mixture of equal volumes of sulphuric acid and water to bring the liquid nearly up to the zero mark; the bottle is now placed in one of the receptacles of the machine, and filled bottles in the other receptacles in order to balance properly. The handle is then turned, so as to whirl the bottle for one or two minutes at high speed. On now taking the bottle out the fat will be found entirely at the top,

and the percentage is read on the graduations of the neck, which are made to read percentages directly without calculation; in graduating the bottle the specific gravity of the milk is assumed to be normal.

(*d*) Apart from the above methods for direct determination the percentage of fat may be ascertained with substantial accuracy by simple calculation from the total solids and specific gravity, by the following formula:—

$$F = 0{\cdot}859\,T - 0{\cdot}2186\,G,$$

where F is the percentage of fat, T the percentage of total solids, and G the last two units of the specific gravity referred to water as 1,000. Thus if a milk of specific gravity 1·0305 contained 12·5 per cent. of total solids, the percentage of fat would be

$$0{\cdot}859 \times 12{\cdot}5 - 0{\cdot}2186 \times 30{\cdot}5 = 10{\cdot}737 - 6{\cdot}667 = 4{\cdot}07.$$

Obviously also, if the specific gravity and percentage of fat have been determined, the total solids may be found by aid of the same formula.

5. PRESERVATIVES.—The substances most commonly added to milk to preserve it are boric acid and borax, separately or together, and formaldehyde; other preservatives less frequently used are fluorides, hydrogen peroxide, and salicylic acid. Sodium carbonate or bicarbonate is sometimes added to neutralise acidity, and so prevent the curdling of rather stale milk.

Boric acid or *borax* is detected in the ash by the familiar flame test with sulphuric acid and alcohol; to obviate any loss of boron in the incineration it is best to apply the test to the ash of a portion that has been rendered strongly alkaline with soda before evaporation. To determine the amount of boric acid, the ash from 100 mils of milk is dissolved in dilute hydrochloric acid, a little calcium chloride added, and the liquid made faintly alkaline to phenolphthalein by dropping in caustic soda solution; 25 mils of lime water is then added. In this way all phosphate is removed as calcium phosphate. The mixture is then made up to a known volume, an aliquot portion filtered out, and the boric acid determined in the latter by titration with standard acid and alkali, using first methyl orange and then phenolphthalein, glycerin having been added before the last titration, as described in text-books on volumetric analysis and on page 358 of this pocket-book.

Formaldehyde.—One part of formaldehyde in about 50,000 of milk is sufficient to keep it for three days; it is therefore necessary to be able to detect very small quantities. It is also important to test for formaldehyde as soon as the sample of milk is received, as this preservative disappears rather quickly

on keeping. Many tests have been recommended for this purpose, and the following, among others, are satisfactory :—

(*a*) Sulphuric acid test : dilute the milk with an equal volume of water, and carefully run in sulphuric acid of 90 to 94 per cent. strength to which a trace of a ferric salt has been added, so as to form a separate layer; if formaldehyde is present a violet ring is formed at the junction of the liquids, while in its absence only a slight greenish tinge appears. This test will detect 1 in 100,000.

(*b*) Gallic acid test: to 30 mils of the milk add 2 mils of normal sulphuric acid, and distil off 5 mils; to the distillate add 2 to 3 decimils of a saturated solution of gallic acid in pure alcohol, then carefully run in about 4 mils of strong sulphuric acid so as to form a separate layer; in presence of formaldehyde, a green zone appears at the junction of the liquids (preceded by a yellowish colour if much of the aldehyde is present), and gradually changes to a pure blue. This test will detect 1 in 200,000, or even smaller quantities.

Fluorides may be detected in the ash ; as, however, a small quantity of fluoride may be almost completely lost on burning the solids in the ordinary way, it is necessary to have excess of alkali present. Add 1 gramme of dried sodium carbonate to 100 mils of milk, evaporate and ignite the residue in a platinum dish. The ash is then examined by the usual test of heating with sulphuric acid and covering the dish with a piece of glass coated with wax except in certain parts ; etching of the exposed parts shows the presence of fluorides.

Hydrogen Peroxide is detected by adding to 15 mils of the milk 3 drops of a 2 per cent. aqueous solution of paraphenylenediamine hydrochloride and shaking. The appearance of a blue colour at once or after a few minutes indicates the presence of this preservative. As the test depends on the action of an enzyme in the milk the colour is not given if the milk has been boiled ; in this case, however, it is only necessary to add to the milk an equal volume of fresh milk known to be free from hydrogen peroxide, before adding the reagent.

Salicylic Acid is detected as follows:—Acidulate 20 mils of the milk with sulphuric acid and shake well, then add 25 mils of ether, mix, and allow to separate; take 10 mils of the ethereal layer and evaporate to dryness; boil the residue with 20 mils of 40 per cent. alcohol, cool and filter. On adding a little ferric chloride to the filtrate the characteristic violet purple colour is obtained if salicylic acid or salicylate was present in the milk.

Sodium Carbonate or *Bicarbonate* is shown by effervescence of the ash with hydrochloric acid ; for confirmation, 10 mils of

the milk is mixed with an equal volume of alcohol and a few drops of 1 per cent. solution of rosolic acid, when a rose-red colour is obtained. With pure milk the colour is brownish-yellow.

Statement of Results.

In giving a certificate of analysis of milk, it is usually not sufficient to state merely the results obtained, but an opinion must be given, based on those results, as to the genuineness or otherwise of the sample. The presence or absence of added water is to be judged from the amount of solids-not-fat obtained by deducting the percentage of fat found from the percentage of total solids. As already stated, the limit for this figure for genuine milk is taken to be 8·5 per cent.; if less than this is found, a simple calculation shows the percentage of milk of minimum quality that is present, and therefore the percentage of added water. Thus, if a sample of milk gives fat 2·6 per cent., total solids 10·5 per cent., the solids-not-fat is found by difference to be 7·9 per cent.; this corresponds to $\frac{7{\cdot}9}{8{\cdot}5} \times 100 = 92{\cdot}9$ per cent. of milk of minimum quality, and therefore the milk contains 7·1 per cent. of added water. An ingenious perversion of the method of calculating has sometimes been resorted to by the defence, in cases of prosecution for sale of adulterated milk. Taking the above case, for instance, the argument put forward would be that since this milk contains 10·5 per cent. of total solids, the total water in it amounts to 89·5 per cent.; and genuine milk of minimum quality contains 11·25 per cent. of total solids, or 88·75 per cent. of water; therefore the milk in question contains only an excess of 0·75 per cent. of water, and not 7·1 per cent. The fallacy in this argument is too obvious to need pointing out, but, nevertheless, such a defence has sometimes imposed on the Court.

The quality of milk may be lowered, not only by adding water, but also by removing a portion of the cream. If less than 3·0 per cent. of fat is found the difference between this figure and the percentage found gives the deficiency in fat per cent.; since 3·0 per cent. is really a low limit for the fat present, it is probable that the amount of cream actually removed is greater than the amount represented by this difference. Milk containing appreciably less fat than 4·0 per cent., or solids-not-fat than 8·8 per cent., but without falling below the above-named limits, should be described as genuine but of poor quality.

The above tests include all that is necessary in the ordinary commercial analysis of milk; occasionally, however, it is

requisite to determine also the proportions of milk sugar and of proteids; this is done as follows:—

Milk-Sugar (*Lactose*).—Lactose may be estimated either by its reducing action on Pavy's solution, or by its rotation of the plane of polarised light. To prepare Pavy's solution dissolve 20·4 Gm. of sodium potassium tartrate and an equal weight of caustic potash in 200 mils of water, and 4·158 Gm. of pure copper sulphate crystals in another 200 mils of water and pour into the first solution; then add 30 mils of strong ammonia (0·880), and water to 1 litre; or, to 120 mils of Fehling'ssolution add 300 mils of strong ammonia, 100 mils of 10 per cent. caustic soda solution, and water to 1 litre. 100 mils of Pavy's solution exactly oxidises 0·0962 Gm. of lactose; this quantity of the liquid is therefore put into a flask closed by a cork having three holes, through one of which passes the nozzle of the burette, while the other two carry tubes providing entrance and exit for a current of coal gas and the flask is heated to boiling; one volume of milk is diluted to five or ten volumes with about 5 per cent. ammonia, and this diluted milk is run from the burette into the boiling Pavy's solution until the latter is decolorised; the amount of milk used contains 0·0962 Gm. of lactose, and the percentage of the latter is found by a simple calculation.

For the polarimetric determination of the milk sugar it is necessary to first remove the proteids and fat, for which purpose an acid solution of mercuric nitrate is used. Mercury is dissolved in twice its weight of nitric acid of specific gravity 1·42, and to the solution an equal volume of water is then added; 1 mil of this is added to 60 mils of the milk, and water to 100 mils. After well shaking the mixture is filtered, and the rotatory power of the filtrate determined. The filtrate contains the sugar from 60 mils of milk in less than 100 mils, part of the volume of 100 mils being occupied by the proteid and fat; to find the volume of these, multiply the weight of fat by 1·075, and that of the proteids by 0·8. The specific rotatory power of lactose for sodium light is +52·5 at 20° C.; the usual formula $[\alpha]_D = \frac{100a}{lc}$ (where a is the observed angle, l the length of tube, and c the number of grammes of lactose in 100 mils of the liquid) enables the amount of lactose to be found. An example will make these calculations clear; suppose the milk is of specific gravity 1·032, and contains 3·5 per cent. of fat and 4 per cent. of proteids, then—

60 mils of milk weigh 60 × 1·032 = 61·92 Gm.
The fat weighs 61·92 × 0·035 = 2·167 Gm. and measures 2·167 × 1·075 = 2·33 mils.
The proteid weighs 61·92 × 0·4 = 2·477 Gm., and measures 2·477 × 0·8 = 1·98 mils.

The liquid, therefore, measures $100 - (2{\cdot}33 + 1{\cdot}98) = 95\,69$ mils. Suppose the observed angle of rotation, in a 2 dm. tube, is + 2° 47′ (= 2·78°)

$$\text{then } 52{\cdot}5 = \frac{100 \times 2{\cdot}78}{2 \times c} \text{ or } c = \frac{278}{105} = 2{\cdot}6\,5.$$

Since there is 2·65 Gm. of lactose in 100 mils of the liquid, 95·69 mils contains $2\,65 \times 0{\cdot}9569$, and this quantity was contained in 61·92 Gm. of the milk. Therefore the percentage is

$$\frac{100}{61{\cdot}92} \times 2{\cdot}65 \times 0{\cdot}9569 = 4{\cdot}09.$$

In case the percentages of fat and proteid are not known, the true volume of the lactose solution may be found as follows :— Take a second lot of 60 mils of the milk, add 1 Ml. of the mercuric nitrate solution, dilute to 200 mils, filter, and find the rotatory power of the filtrate. If the true volume of the solution first polarised is x, that of the second is $100 + x$; if the angles of rotation are a and a', then—

$$\frac{a}{a'} = \frac{100 + x}{x}$$ from which x is at once found.

Proteids.—The total amount of proteids in milk is found by determining the nitrogen by Kjeldahl's method, and multiplying the figure so obtained by 6·3. Let 5 or 10 mils of milk be put into a Kjeldahl flask with 20 to 25 mils of strong sulphuric acid and a globule of mercury, and the process carried out in the usual way. In the case of milk that has been kept some time, part of the nitrogen will be present as ammonia or amino compounds, but the total nitrogen will still represent the proteids originally present.

Cream and Condensed Milk.

Cream may be diluted with about five times its weight of water, and the mixture then analysed in the same way as milk. Some preservative is usually present in cream; gelatin is also sometimes added to thicken it, and may be detected as follows:—Add just enough acetic acid to the diluted cream to precipitate fat and albuminoids, filter, and to the filtrate add a little solution of tannin; genuine cream gives a slight precipitate, but an abundant precipitate is formed if gelatin is present. Another useful method is to evaporate a portion of the cream to dryness, remove fat as completely as possible with ether, and then take up the residue with a very little boiling water; on cooling the aqueous liquid it will set solid if gelatin was present.

Fifty grammes of condensed milk should be diluted with water to half a litre, and this liquid then analysed in the same way as fresh milk. A very usual ingredient is cane sugar, added

as a preservative; if the sum of the ash, proteid, lactose, and fat is deducted from the total solids, the difference usually represents the cane sugar. The lactose must be determined by Pavy's solution, and not by the polarimeter, on account of the optical activity of cane sugar. Cane sugar may be inverted by boiling the diluted milk with 2 per cent. of citric acid for ten minutes, and the invert sugar determined by titration with Pavy's solution; 100 mils of the latter correspond to 0·0475 Gm. of cane sugar. Lactose is not inverted by the citric acid; it must be determined separately, and allowed for in calculating from the results of the titration after inverting.

Coefficients of Linear Expansion of Some Common Substances, between 0° and 100° C.

Glass	0·0000081	Gold	0·0000151
,, to	0·0000091	Copper	0·0000172
Platinum	0·0000086	Brass	0·0000186
Steel, untempered	0·0000108	Silver	0·0000191
Steel, tempered	0·0000123	Tin	0·0000217
,, ,, to	0·0000138	Lead	0·0000284
Iron	0·0000123		

Board of Trade electrical unit = 1,000 watt-hours.
= 1·34 horse-power-hours.
Velocity of light = 186,000 miles per second.
Velocity of sound in air = 1,120 feet per second.
Velocity of sound in lead = 4,030 feet per second.
Velocity of sound in water = 4,710 feet per second
Velocity of sound in copper = 11,660 feet per second.
Velocity of sound in iron = 16,820 feet per second.

Average Alcoholic Strengths of Some Beverages.

	Per Cent.		Per Cent.
Lager Beer	3 to 4	Port	15 to 25
Ale	4 to 5	Gin	37 to 47
Porter	4 to 5	Whisky	44 to 55
Bottled Beer	7	Rum	44 to 55
Cider	3 to 9	Brandy	44 to 55
Claret	8 to 13	Liqueur, Kümmel	34
Hock	9 to 12	Liqueur, Chartreuse	43
Champagne	8 to 15	Liqueur, Benedictine	25
Sherry	15 to 22		

THE EXAMINATION OF URINE.

THE physical and chemical characters of urine are in very many cases of great importance, and accurate information with regard to them is of high value to the physician in diagnosing disease. The examination of urine is work for which the pharmacist is peculiarly fitted by his training, and most medical practitioners are glad to place it in the hands of those pharmacists who are willing to devote to it the requisite time and care. In the present article information is given with regard to the characters on which information is usually sought, sufficient to enable anyone who is familiar with chemical manipulation to carry out the tests. As a rule, information is only required on some one or more characters, and specific instructions on this point are usually supplied by the physician when sending the urine for examination. In cases where more information is required than is afforded by the tests here detailed reference should be made to works dealing exhaustively with the subject, and the following may be mentioned as among the most suitable:—Allen's 'Chemistry of Urine,' Long's 'Text-book of Urine Analysis,' Halliburton's 'Chemical Physiology and Pathology.'

Preliminary Examination.

The colour, smell, and reaction to litmus paper of all samples should be carefully noted, and the presence or absence of turbidity or a precipitate. The specific gravity is determined in the usual way with a specific gravity bottle or hydrometer. If the latter is used, the special small instrument known as a urinometer is most convenient, as only a small volume of the liquid is necessary for its employment.

ALBUMEN.

Even a trace of albumen in urine is sometimes of considerable pathological significance, and it is, therefore, necessary that all tests for its presence should be applied with the greatest care. For its detection the following tests are selected as the best from the large number that have been put forward, and at least two tests should be applied in each case; there is great divergence of opinion as to their relative delicacy.

N.B.—Whatever test is employed, the urine should in all cases be first tested with litmus paper, and if it is not already acid, *dilute* acetic acid should be added drop by drop until the liquid will *just* redden blue litmus paper; it must then

be filtered, and the tests applied to the perfectly bright filtrate.

Qualitative Tests.

Heat Test.—A few mils of the sample should be boiled in a test-tube for about a minute; albumen, if present, separates as a white precipitate; after a few minutes' standing, this aggregates into flocculi, which *gradually* sink to the bottom. For the detection of very small quantities, the boiled urine is compared with an equal volume that has not been heated.

If the urine has been properly acidified beforehand phosphates will not be precipitated; but to make sure of this any precipitate formed may be tested by adding a few drops more of acetic acid and shaking, when phosphates dissolve but albumen does not.

Nitric Acid Test.—Nitric acid coagulates albumen, forming a ring of white precipitate at the junction of the acid and urine if they are poured into a test-tube without mixing. The most delicate way of applying the test is as follows:—Dissolve 10 parts of magnesium sulphate in 13 of hot water, and filter; to 5 Ml. of this solution add 1 Ml. of nitric acid (sp. gr. 1·42), an dcarefully pour on to the surfact of this in a test-tube a few mils of the urine, taking care that the liquids do not mix. An opalescent zone at the region of contact indicates albumen; traces may not appear until after an interval, up to fifteen minutes.

Copaiba resin is precipitated by nitric acid, but the precipitate, unlike albumen, is soluble in alcohol. Uric acid, acid urates, or urea nitrate, *may* be precipitated, but they are soluble on warming, and their appearance may be prevented by using warm acid in the test. Mucin may cause a cloudiness, but this appears towards the upper part of the liquid, distinct from the albumen ring.

Ferrocyanide Test.—Add excess of acetic acid, and then a solution of potassium ferrocyanide; a white precipitate indicates albumen. In this test also traces may only be shown after a short interval.

Salicyl-sulphonic Acid Test.—A few crystals of this acid, or a small quantity of a 5 per cent. solution in water, added to urine, gives a precipitate or turbidity if albumen is present.

Trichloracetic Acid Test.—A saturated solution of this acid is poured on to the surface of the urine without mixing, when a white cloud appears at the junction of the liquids if albumen is present. Alkaloids also give a white precipitate with this reagent, but in this case the precipitate dissolves on heating or adding excess of the reagent. This is a very

delicate test, and this and the preceding one do not cause precipitation of mucin.

Quantitative Tests.

Picric Acid.—A cold saturated solution of picric acid in water precipitates albumen, and from the volume of the precipitate an approximate idea of the amount of albumen may be obtained. Some other substances, as alkaloids, piperazine, etc., may give precipitates, but these disappear on warming. The test is best applied by means of Esbach's albuminometer, which consists of a cylindrical tube marked with several graduations, as follows:—10 Gm. of picric acid and 20 Gm. of citric acid are dissolved in boiling water, and the solution made up to measure 1 litre when cold. The tube is filled to the mark "U" with the urine, and the reagent then added up to the mark "R."; the tube is inverted several times to mix them, and set aside for twenty-four hours. At the end of this time the volume of precipitate is observed; the tube is so graduated that readings are obtained directly as parts of albumen per thousand. The graduation is empirical, and the results are only comparable if exactly twenty-four hours is allowed for subsidence. Another form of tube is sometimes used which tapers to a blunt point at the bottom, and settling of the precipitate is promoted by whirling in a centrifuge, much less time being then required.

For accurate quantitative determination of the amount of albumen in urine, it must be precipitated by one of the methods described above, collected on a filter, washed, dried, and weighed; or the nitrogen in the precipitate may be determined by Kjeldahl's method, and the amount multiplied by 6·3. In the latter case nitric or picric acid or ferrocyanide must not be used as precipitants, on account of the nitrogen they contain.

SUGAR.

The following tests are suited for the quantitative detection of sugar in urine; if only a qualitative test is required the same tests can, of course, be used, and it is therefore only necessary to describe them once.

The amount of sugar in the urine of diabetic patients may vary greatly; traces are said to be present in normal urine; and generally for pathological purposes less than 0·25 per cent. is of little or no importance. The chemist should be prepared, when necessary, to detect smaller amounts, and to determine quantitatively amounts ranging from 0·25 to 15 per cent. of the urine.

Certain normal constituents of urine simulate the behaviour of sugar in many tests, and great care must be taken

that the presence of sugar is not erroneously reported on account of behaviour really due to these other substances. The chief of them are uric acid, creatinine, and glycuronic acid; in many cases it is advisable to remove them before testing for sugar. In pathological urine glycosuric acid may occur, and this has a strong reducing action on Fehling's solution.

FEHLING'S TEST.—By far the most usual test for sugar in urine is that of Fehling, and for ordinary purposes it is very satisfactory. Fehling's solution must be prepared in two parts, and these two liquids should be kept separately and mixed in exactly equal volumes only a short time before using, as the mixed solution is not stable; where Fehling's solution is mentioned the mixed liquid is intended. They are prepared as follows:—(A) copper sulphate, cryst., pure, 34·64 Gm., water to 500 Ml.; (B) potassium sodium tartrate, 180 Gm., water, 300 Ml.; filter, if necessary, then add 70 Gm. of caustic soda, and make up to 500 Ml.

If the urine to be tested contains albumen, this must be coagulated by heat and removed by filtration; a rough test for sugar should then be made by diluting 2 Ml. of Fehling's solution with 8 Ml. of water and boiling, and adding to the boiling liquid 1 or 2 Ml. of the liquid obtained by diluting the urine with nine times it volume of water. With a little practice the amount of precipitate so obtained will indicate roughly the amount of sugar present, and the urine is then diluted, if necessary, so that the liquid shall contain approximately from 0·25 to 1·0 per cent. of glucose. This diluted urine is then put into the burette for the more accurate determination, which is carried out as follows:—10 Ml. of Fehling's solution and 40 Ml. of water are put into a porcelain basin and heated to boiling; glass vessels should not be used, as the strong hot alkali rapidly attacks the glass and cracking results; the basin should be rather deep, so as to reduce the surface exposed to the air, or a porcelain beaker may be employed. After boiling for about a minute, during which the solution must remain clear and bright, the urine in the burette is run in gradually, keeping the liquid boiling, or boiling up after each addition; the blue colour gradually disappears, and a red precipitate of cuprous oxide forms. When the blue colour is just completely discharged the titration is at an end; this point is observed by stopping the boiling for a few seconds to allow the oxide to settle, inclining the basin and judging the colour of the solution against the white porcelain. A second titration should be made in the same way, but the result of the first allows of nearly the correct amount of urine being run in at once, thus reducing the time and giving greater accuracy. Since 10 Ml. of Fehling's solution is exactly reduced

by 0·05 Gm. of glucose, this amount is contained in the quantity of urine used in the titration, and a simple calculation gives the number of grammes per 100 Ml. ; on multiplying this result by 4·375 the figure obtained represents grains of sugar per fluid ounce.

When the amount of glucose present is but small the error due to the reducing action of uric acid, creatinine, and glycuronic acid is proportionately greater, and it is desirable to remove these substances first ; this may be effectively done by means of mercuric acetate, and the sugar then determined by Pavy's modification of the above test. The procedure is as follows : —

The urine is treated with 5 per cent. of its volume of cold saturated solution of sodium acetate, and 25 per cent. of cold saturated solution of mercuric chloride, and the mixture boiled for a few minutes ; the bulky precipitate is filtered out, and the excess of mercury removed from the filtrate by boiling it with zinc dust for a few minutes and filtering. (The loss of volume at each boiling may, of course, be made up by cooling before filtration, and adding water to bring the volume exactly to what it was before boiling.) This final filtrate is mixed with an equal volume of ammonia, and put into a burette. Pavy's solution is made by mixing Fehling's solution 12 Ml. with ammonia (0·880) 30 Ml., adding 10 Ml. of 10 per cent. solution of caustic soda, and diluting to 100 Ml. ; the oxidising power of this solution is *one-tenth* that of Fehling's, *i.e.*, 100 Ml. reduced represents 0·05 Gm. of glucose. In this case, however, cuprous oxide is not precipitated, but held in solution, and the end-point, shown by the complete disappearance of all colour, is easily seen by viewing the liquid against a white surface. Reduced Pavy's solution is very rapidly re-oxidised on contact with the air ; the titration is therefore conducted in a flask fitted with a three-hole cork ; through one hole passes a tube which is connected to the nozzle of the burette, while the others provide entrance and exit for a current of coal gas ; or the boiling liquid may be covered with a thin layer of paraffin. In any case, but especially if paraffin is used, a few pieces of pumice or pipe-stem will be useful to prevent bumping.

If the substances which might simulate sugar are removed as described the titration it best conducted with Pavy's solution ; but the latter may also be applied in any case whether the urine has been previously treated or not. Another very useful modification of Fehling's test is due to Gerrard, and is carried out as follows : —10 Ml. of Fehling's solution and 40 Ml. of water are heated to boiling, and a 5 per cent. solution of potassium cyanide is then added carefully, finally drop by drop, until the blue colour

is *just* discharged; a further 10 Ml. of Fehling's solution is then added, and the boiling liquid titrated with the urine; the end-point is now again shown by the disappearance of the blue colour. Since no cuprous oxide is precipitated this point is easily observed; only the second quantity of Fehling's solution is reduced by the glucose, and the calculation is made as before. This method has been strongly recommended, and burettes may be obtained for use with it so graduated that the readings are directly in percentages of sugar in the urine instead of in mils.

The following tests for sugar are also useful:—

Picric Acid Test.—A saturated cold solution of picric acid in water is mixed with an equal volume of normal caustic soda solution and boiled; a measured quantity of urine is then added, and the mixed liquid boiled for a minute or so. In the presence of glucose a deep red colour is produced, the depth of colour being proportionate to the amount of glucose present. A fairly accurate estimation may be made by comparing the colour with a standard. Creatinine, which is normally present, produces a similar colour; it must, therefore, be removed by treatment with mercuric acetate, followed by zinc, as described above. A standard coloured solution for comparison is made as follows:—

Liq. Ferri Perchlor. Fort. (s.g. 1·42)	1
Acid. Acetic. Glaciale	4
Liq. Ammon. (s.g. 0·959)	6
Aq. Destil., sufficient to produce	32

The colour of this is the same as that given with the picric acid test, by an undiluted urine containing 1 grain of glucose per fluid ounce. The liquid obtained from the urine in question and sodium picrate is compared with this standard liquid, and one or other diluted until the depth of colour of the two is equal; from the dilution that is necessary the amount of sugar present is found by a simple calculation.

Optical Activity.—Colouring matter and other substances are removed by adding to the urine, at boiling temperature, about 3 per cent. of powdered lead acetate, shaking well, and filtering; or mercuric acetate may be employed, as already described. The colourless filtrate is then examined with the polarimeter, and from the observed rotation the percentage of glucose ($[\alpha]_D = +52{\cdot}7°$) is found by the usual calculation. There is little or no interference by other constituents, hence the results are very fairly accurate.

The two following tests are not capable of being applied quantitatively. They are, nevertheless, sometimes very useful, as they distinguish clearly between sugar and the other reducing substances that may be mistaken for it.

Phenyl-hydrazine Test.—50 Ml. of urine, freed from

albumen, is treated with 2 Gm. of sodium acetate and 1 to 2 Gm. of phenyl-hydrazine hydrochloride, and the liquid heated to 100° C. for half an hour. On cooling, if glucose was present, phenyl-glucosazone separates as a yellow or brick-red precipitate, crystalline or amorphous; if the latter, it must be dissolved in hot alcohol, the solution diluted with water, and boiled to remove alcohol and cooled, when crystals are deposited. Glycuronic acid forms a similar compound, hence the melting point must be determined. The osazone from glycuronic acid melts at 150°, that from glucose at 205°.

INDIGO TEST.—The moderately diluted urine is boiled with a small quantity of orthonitrophenyl-propiolic acid ("nitro-propiol") for five minutes; if glucose is present, a blue colour is produced, due to the formation of indigo blue.

UREA.

The usual method for estimating urea is to decompose it, measure the nitrogen so produced, and calculate from this the amount of urea from which it is derived. Sodium hypobromite is the agent employed for the decomposition, and the solution of this substance is prepared by dissolving 400 Gm. of caustic soda in water and making up to 1 litre; 9 Ml. of this solution is mixed with 1 Ml. of bromine when required, as the mixed liquid does not keep very well. When this solution of sodium hypobromite is added to urine, the urea is decomposed with liberation of the nitrogen; but it is found that the nitrogen produced only corresponds to about 92 per cent. of the amount of urea actually present. If, however, the gas is measured at the usual laboratory temperature of about 18° C. (65·4° F.), its volume is aboot 8 per cent. greater than it would be at the standard temperature of 0° C.; therefore, by omitting to make a correction for temperature and calculating from the volume of gas actually collected, a very nearly correct figure is obtained for the amount of urea. If, however, sugar is present in any considerable quantity, practically the whole of the nitrogen is liberated; with diabetic urine, therefore, if temperature correction is omitted, 8 per cent. should be deducted from the amount of urea found.

The simplest method of making the determination is to employ the ordinary nitrometer, following the same procedure as in determining the strength of spirit of nitrous ether. The nitrometer is first filled with brine to the tap; 5 Ml. of urine is then placed in the cup and carefully introduced, and the cup rinsed with a few drops of water, this being also admitted by the tap. A mixture of 10 Ml. of hypobromite solution and 10 Ml. of water is then introduced in the same way. and nitrogen is at once evolved; when the

reaction has nearly ceased, the flexible tube of the nitrometer is closed with a clip and the liquids mixed well by shaking the tube. When the evolution of gas has ceased and the temperature become constant, the liquid in the two tubes of the nitrometer is brought to the same level and the volume of gas read off. Each mil of nitrogen represents 2·7 milligrammes of urea. If a nitrometer is not available, the hypobromite solution may be put into a flask and the urine measured into a small test tube, which is also placed in the flask; the latter is then closed with a cork through which passes a glass tube, communicating by means of india-rubber tubing with another glass tube passing through a cork in the top of an ordinary burette without tap, or with the tap open; a long piece of india-rubber tubing connects the nozzle of the burette to a funnel, which is held by a clamp at a convenient height. The cork at the top of the burette is removed and water poured in through the funnel until it reaches the zero mark; the cork is then replaced tightly. The flask containing the hypobromite and urine is now inclined, so that the latter runs out of the tube and the two liquids mix; when most of the nitrogen has been evolved the flask is well shaken; after reaction is complete, the position of the funnel is adjusted so that the water stands at the same height in the burette and the funnel, and the volume of gas is then read off.

If, instead of urea, the total nitrogen of all the constituents of the urine is required, a determination must be made by Kjeldahl's method in the usual manner.

URIC ACID.

To determine uric acid, powdered ammonium chloride is added in small quantities to 100 Ml. of the urine until no more is dissolved, about 30 Gm. being necessary. After standing for two hours, with occasional stirring, the precipitate, consisting of acid ammonium urate, is collected on a filter and washed twice with saturated solution of ammonium chloride. It is then washed off the filter with about 100 Ml. of water, 20 Ml. of strong sulphuric acid added, and the liquid titrated while still hot (about 60° C. is best) with N/10 permanganate; the end point is reached when the pink colour, after shaking, remains for about two or three seconds. Each mil of N/10 permanganate used up represents 3·75 milligrammes of uric acid.

If preferred, the acid ammonium urate may be heated to boiling with excess of dilute hydrochloric acid, the liquid cooled and left standing for two hours, the uric acid collected on a filter, washed with a little cold water and then with

alcohol, dried and weighed. To the weight found 1 milligramme is added for every 15 Ml. of mother liquor (not washings).

BILE PIGMENTS.

The presence of bile in urine is shown by the characteristic colours produced when the bile pigments are acted on by nitric acid. A little of the urine is gently poured on to the surface of some *fuming* nitric acid in a test-tube. If bile pigments are present a green ring appears at the zone of contact, and below this appear, in order, violet, red, and yellow zones. The latter without the green zone do not indicate bile.

Traces only of bile pigments are sometimes important, and for their detection the urine should be treated with moderate excess of lime water, and carbon dioxide then passed until the excess of lime is thrown down. The precipitate is collected and treated with fuming nitric acid, when the same characteristic colours as above will be observed if bile is present.

MICROSCOPICAL EXAMINATION.

A portion of the urine (about 100 Ml. or more) is set aside in a conical glass vessel for twenty-four hours, in order that the sediment may collect in a small volume at the bottom. In hot weather, about one-fourth of its volume of saturated chloroform water may be added to prevent decomposition. If, however, a centrifuge is available, the deposit may be caused to collect at the bottom by whirling for a few minutes.

A drop of the liquid from the bottom of the settling vessel is taken out with a pipette, placed on a glass slide, and covered with a thin cover-slip for examination with the microscope. The principal objects to be looked for are those mentioned below; it is not possible, however, to give such verbal descriptions as will enable most of them to be identified with certainty; the requisite knowledge of each can only be obtained by practice.

Blood Corpuscles.—These are biconcave, and of an average diameter of 0·0077 Mm.; they retain their shape fairly well in acid urine, but soon become more or less eroded if the urine is alkaline. They will not be found in rouleaux.

Confirmation of the presence of blood may be obtained by evaporating a little of the deposit to dryness with a fragment of sodium chloride at a gentle heat. The residue is treated with a few drops of glacial acetic acid and heated on a slide. When cool, reddish-brown rhomboidal plates of

hæmin may be found with the microscope if blood was present.

Pus Corpuscles.—These vary in size, but are usually rather larger than blood corpuscles, and spherical, not biconcave. If much pus is present the lower portion of the urine that has been standing will be converted to a thick viscid mass on mixing with an equal volume of strong potash solution; this glairy substance may be formed spontaneously in alkaline urine.

Epithelium Cells.—These are much larger than corpuscles; they may be of almost any shape, have ordinarily a well-marked nucleus, and are often united in groups of three or four together.

Casts.—These are casts of portions of the uriniferous tubules of the kidney, and usually much longer than broad; several different kinds occur, and experience alone will enable them to be satisfactorily identified.

Crystals.—These may consist of uric acid, or of many other substances; most of them may be recognised, with practice, by their shape and behaviour to reagents.

PRACTICAL METHODS OF BACTERIOLOGICAL INVESTIGATION.

IN the preparation of this monograph it has been found necessary to quote from current English and Continental text-books, and advantage has also been taken of the current literature dealing with bacteriological investigation to include recent views and methods of procedure.

The following sources may be mentioned in particular, as the references indicated in the text refer to these works, viz. :—Hewlett's 'Manual of Bacteriology,' Frankland's 'Micro-organisms in Water,' Crookshank's 'Bacteriology and Infective Diseases,' Swithinbank's 'Bacteriology of Milk,' Klobstock's 'Manual of Clinical Chemistry, Microscopy, and Bacteriology,' Curtis' 'Essentials of Bacteriology,' Cornil's 'Les Bacteries,' and Zapffe's 'Bacteriology.'

Formulæ for the ordinary laboratory media and stains will be found in Section IX. of the 'Pharmaceutical Journal Formulary.'

The preparation of media and cultivation methods are dealt with at considerable length in *The Pharmaceutical Journal*, viz. :—For August 26 and October 14, 1905; and March 31, 1906.

1. BACTERIOLOGICAL EXAMINATION OF MILK.

Milk is a perfect nidus for micro-organisms, and possesses normally a very luxuriant flora. The bacterial content of dairy milk is a very indefinite quantity, varying from a few thousands to several millions per mil. The bacteria present in greatest numbers are those producing lactic and butyric fermentations—*e.g.*, *B. acidi lactici*, *Clostridium Butyricum*, etc. The lactic ferments are largely non-sporing, the butyric ones chiefly sporing species. The spores of the latter are able to withstand boiling for a few minutes, and consequently may be found in "sterilised" milk. Organisms also occur having more or less specific effects, and give rise to blue milk (*B. cyanogenes*), red milk (*B. lactis erythrogenes*), yellow milk (*B. synxanthus*), bitter milk (maple leaf organism), soapy milk (*B. lactis saponacei*), etc. In addition to the organisms named, pathogenic species may be also met with—viz., the tubercle, diphtheria, typhoid, and comma bacilli, and the *S. pyogenes aureus*, *S. scarlatinæ*, and *Streptococcus pyogenes*.

B. enteritidis sporogenes, the cause of epidemic diarrhœa, is also occasionally found. In searching for special pathogenic organisms, information bearing on the source of pollution will be helpful—*e.g.*, the presence of udder disease in the cow.

prevailing conditions of contamination or infection at time of milking, and exposure (to dust and flies) during transit to consumer. Physical examination may be made if necessary. Cholera organisms have been found in boiled milk. The microscopical examination of the milk before and after centrifugalisation or sedimentation will likewise often yield good results.

1. Examination of Cover-glass Preparations.

(*a*) Simple Staining.—The presence of casein and fat in the milk is troublesome, and apt to confuse the issue. The following method, however, gives good results: Place a few loopfuls of milk on a grease-free slide, and allow to dry at room temperature. Fix with one or two drops of alcohol-ether (*part. æq.*), and add before drying an equal number of loopfuls of a sodium carbonate or sodium hydrate solution (5·50 per cent. dilut.). Clear the film by washing alternately with 5 per cent. solution of CH_3COOH and distilled water. Dry between layers of fine filter paper. Stain with any of the aniline dyes (carbol-fuchsin, methylene blue, gentian violet), wash in water and examine.

(*b*) Compound or Differential Staining.—Remove the fat by centrifugalisation and prepare a film from the particulate matter. If no centrifuge is available, add 20 per cent. of Acid. Carbol. Liq., B.P., and shake well. Set aside (in tall conical glass) in an ice chest for twenty-four hours, and remove a little of the sediment by means of a sterile pipette. Fix in both cases by alcohol-ether. Stain by any of the following methods:—

(1) According to Gram (Nicholle's modification, cf. p. 302, "Schenk"), *B. typhosus*, *B. diphtheriæ*, *B. streptococcus* will be decolorised. (2) According to Ziehl-Nielsen (cf. p. 74, "Schenk"), the tubercle bacilli, or other acid-fast organisms are stained red, and the milk or casein cells will be blue. (3) According to Neisser (cf. p. 88, "Zapffe") the polar granules of *B. diphtheriæ* are deeply stained.

2. Cultural Examination.

(*a*) Plate Cultivation.—Make blank dilutions with sterile water to ascertain contamination. Prepare a suitable dilution (usually 1 in 500, if fresh) and inoculate tubes of liquid gelatin, agar, etc., for aërobic and anaërobic cultivation with fractional quantities, *e.g.*, 0·05 Ml., 0·1 Ml., 0·2 Ml., 0·5 Ml. Pour into Petri or flat-bottomed dishes and incubate at the room temperature (gelatin), or at 37° C. (agar). Count the number of colonies on the second, third, and fourth days, and make the necessary number of sub-cultures.

(*b*) Primary Tube Cultivation.—Take ten tubes of 10 Ml. of the milk, and incubate three of them at room tem-

perature, and three of them at 37° C. Place four in water-bath at 80° C. for fifteen minutes, and then enclose each in a Buchner's or vacuum desiccator.

Test the primary culture in forty-eight hours for *B. coli*, the presence of indol, and *B. enteritidis sporogenes*.

Methods of Examination for Special Micro-Organisms in Milk.

Bacillus Diphtheriæ.—Inoculate six tubes or plates of Löffler's medium with the particulate matter from sedimentation or centrifugalisation. Growth occurs in twelve to twenty hours. The colonies are scattered, nucleated, round, white, finally becoming yellow.

Methods of Staining.—Neisser's and Löffler's methods are the best for differential purposes.

Bacillus Streptococcus.—Add a loopful of the particulate matter (cf. *B. diphtheriæ*) to 1 or 2 Ml. of sterile salt solution. Inoculate agar plates with a loopful of this dilution, and incubate at 37° C. When the colonies appear, subculture those resembling streptococcus colonies in bouillon, and on blood serum. Subculture from the bouillon in milk, gelatin and agar, carefully noting the characters of the growth, etc.

Method of Staining.—Gram's method is the most satisfactory. Next to Gram's method, the most useful is Löffler's blue.

Bacillus Coli Communis.—(*a*) Inoculate six agar plates with a 1 in 500 or 1 in 1,000 dilution by brushing over the surface of each consecutively without recharging the brush. Incubate at 42° C., and subculture the coliform colonies (bouillon, milk, litmus milk, gelatin "shake," cultures, etc.).

(*b*) Inoculate six tubes of phenol bouillon (0·05 per cent. of C_6H_5OH) with crude or diluted milk. Those which show abundant turbidity after twenty-four to forty-eight hours at 37° C. may be placed upon phenol-gelatin.

The following are the main bio-chemical features of the *B. coli* group :—(1) They are non-sporing and non-liquefying; (2) they rarely stain by Gram's method; (3) They are motile; (4) they produce acid and gas in glucose and lactose media; (5) they produce acid in milk, and usually coagulate it; (6) they grow well at a temperature of 42° C.

Bacillus Enteritidis Sporogenes of Klein.—Inoculate six tubes of freshly sterilised milk with 1 Ml. of a 1 in 500 dilution of the milk to be examined, or, if preferred, 0·1 Ml. of the crude milk. Heat at 80° C. for fifteen minutes. Remove, cool, and place in Buchner's tubes or cylinder containing freshly prepared alkaline pyrogallol solution. Seal the tubes or cylinder with great care, making it absolute. Incubate at 37° C. After forty-eight hours take out the

tubes and examine them for *B. enteritidis sporogenes.* The "enteritidis change" is characterised by copious gas formation, clear or slightly turbid whey in the middle of the tube, with faintly pinkish flocculi of casein floating on top, and casein mucus at sides and bottom of tube.

Pus Cells.—Prepare a cover-slip preparation from a little of the centrifugalised deposit in the following way :—Spread evenly over the surface and fix by drying over the Bunsen. Wash fixed film with ether, or alternately with alcohol and ether, until all the superfluous fat is removed. Stain by (*a*) one of the ordinary solutions—*e.g.*, Löffler's blue—or (*b*) Gram's method.

2. BACTERIOLOGICAL EXAMINATION OF BUTTER.

Place 120 Gm. of butter in a sterilised flask, add 150 Ml. of sterile salt solution, and heat in a water-bath at about 35° C., shaking gently until the latter has melted—*i.e.*, until a milk-like emulsion is formed. Inoculate tubes of gelatin and agar for plate cultivation. Place the remainder in a sedimentation flask in the refrigerator for twenty-four hours. Then remove the superficial solidified fat by means of a sterile spatula and decant the turbid liquid. Examine sediment for organisms.

3. BACTERIOLOGICAL EXAMINATION OF CHEESE.

Remove a thin slice of the cheese under examination by cutting with a sterile knife parallel to the surface. Discard this, and with a sterile knife cut perpendicularly downward from the bared surface. Introduce into the prepared surface a coarse, sterile platinum needle, slightly roughened with a file near the distal end. Inoculate with this needle a sufficient number of tubes of bouillon for ultimately making aerobic and anaerobic plate cultivations.

4. BACTERIOLOGICAL EXAMINATION OF MOULDS.

With the exception of the ringworms and allied fungi, the hyphomycetes are not of very great pathological importance. Mucors and aspergilli may be met with in the ear and nose, and, less frequently, *Aspergillus fumigatus* in the lung tissue (pneumo-mycosis).

The examination of hyphomycetes may be advantageously carried out for differential purposes in the Petri dish itself. Drop carefully on the centre of the mould colony, by means of a pipette, a droplet of eosin (1 per cent. aq. sol.). Place a thin cover-glass upon the centre of the drop, and press together to get close contact. Remove the dish to the microscope stage and examine margin of growth with a $\frac{1}{6}$-in. objec-

tive. If this process is impracticable, remove a portion of the growth, tease up gently with needles in a little ammoniated alcohol, absorb surplus fluid with blotting-paper, and mount in Farrant's solution (p. 621, "Crookshank") or in glycerin jelly. If desired they may be stained by irrigation method with fuchsin, or by covering with aniline-gentian-violet and heating gently.

Ringworm.

Two affections are distinguishable by reason of a difference in the size of the spores of the fungi. The first is due to *Microsporon Andonini* (round or ovoid spores, 3 to 4μ in diameter) occurring in early childhood, forming 80-90 per cent. of the ringworm met with in London; the second variety, *Tricophyton Megasporon* (chains of mycelial spores; endospores, 4 to 12μ in diam.), is divided into three groups according to the habitat—viz., the (*a*) *endothrix* form (interior of the hair), (*b*) *ectothrix* (outside of the hair), and (*c*) *endo-ectothrix* (partly inside and outside of the hair).

The ectothrix form is responsible for all the tinia sycosis and ringworm of the nails, and half the cases of tinia circinata.

Cultural Examination.—The ringworm fungi form white fluffy growths (for appearance *vide* pp. 85-93, "Curtis") after seven days on beer-wort agar and gelatin (liquefaction). For cultivation: Remove the diseased hairs or stumps (by traction in the axis of its growth, so as to obtain the soft bulb intact if possible) with forceps to a sterile glass slide. Cut away aerial portions with a sterile scalpel, divide diseased parts into fragments, and well wash with sterile water to remove bacteria, yeasts, sarcinæ, etc. Transfer the fragments with a platinum needle to beer-wort agar and incubate at 30° C.

Pure cultures may be made on French proof agar (cf. p. 74, "Curtis") by tapping a tube containing a culture possessing aerial hyphæ over the surface of the medium; spores are ejected, and growth ensues. It may be mentioned here that all true ringworm fungi have their aerial fructifications developed on the same plan—viz., a central rod bearing terminally and laterally small spores attached by a small pedicle. Klatsch (impression) preparata may be made from cultures to demonstrate aerial hyphæ.

Microscopic Examination.—Clear the hair by maceration with Liq. Potassæ, B.P., *q.s.*, for twenty minutes, wash in 75 per cent. alcohol, dry and stain by Gram-Weigert's method (modified)—*e.g.*, (1) Stain in aniline-gentian-violet for thirty minutes. (2) Treat with Gram's iodine solution,

three minutes. (3) Decolorise in aniline oil, thirty minutes. (4) Counter-stain in eosin, one minute.

Favus.

The specific organism (*Achorion Schœnleinii*) occurs on the hairy parts of the body in the form of compact, sulphur-yellow, cup-shaped bodies, which are usually pierced by a hair, and imbedded in the skin. These crusts, or scutula, are isolated by piercing the horny layer and prising them out of the skin. The specimens are examined unstained.

The scutulum is seen to be composed of epidermis, radiate mycelial threads, and spores. The mycelial threads are of varying width, with many septa, often bifurcating, and having bulbous ends.

In favus of the scalp, the mycelium is composed of chains of jointed rods (resembling meta-tarsal bones) and spherical cells. Examine hair, scales, and nail secretions by means of stained specimens (cf. ringworm).

Cultural Examination.—Cultivate at 35° C. in glycerin-agar. The grey colonies are circular or oval in shape, snowy-white in tint, finely powdered over the raised surface in young cultures, slightly wrinkled in older ones. From the margin, fine branches pass out in a radiating direction. In very old cultures, a brownish, or *café au lait*, tint is seen, and the surface becomes very rugged or honey-combed.

5. BACTERIOLOGICAL EXAMINATION OF YEASTS.

Yeasts were formerly relegated to a subordinate position among the achlorophyllous thallophytes, being viewed as pure saprophytes—*i.e.*, incapable of invading living tissues, whether animal or vegetable, and therefore possessing little pathological significance when compared with the hyphomycetes and bacteria. This view has been discarded since the organism of "Thrush," *S. albicans*, was classed as a yeast, and the saccharomycetes are now important bacteriologically apart from their value in brewing.

Morphologically, they consist of round or oval cells, arranged singly or in chains. The single cells are, generally speaking, much larger than bacteria. Their diameter may be as much as 8 or 9μ. The thin cell-wall encloses a granular protoplasm, containing one or more vacuoles, and in old cultures a nucleus. Multiplication occurs by a system of budding or gemmation, the buds or daughter-cells remaining attached for a considerable time to the mother-cell. This is well seen under the microscope if the yeast has been grown in a saccharine fluid.

Thrush or Soor Fungus.

The yeast *Saccharomyces albicans* is the cause of Thrush in infants; it is usually located in circular milk-white patches on the tongue and mucous membrane of the mouth, occasionally along the pharynx to the œsophagus. It has also been found in diphtheritic membrane and on furred tongues. It also occurs in adults recovering from phthisis and cancer.

The fungus may be cultivated (usually not necessary) on the ordinary laboratory media. In gelatin and agar streaks, the growth is snow white, and at first dry; subsequently it becomes moist and wrinkled. No liquefaction of the gelatin occurs.

Cover-glass preparations may be stained according to Gram or Kuhne-Weigert cf. p. 274 "Klopstock"). Films prepared from an oro-pharyngeal patch show under the microscope double contoured hyaline mycelia, having transverse septa and indentations, and often having lateral branches which interlace with each other. Films from cultures, on the other hand, show cells having the characteristics of the typical yeast cells already described, the mycelial filaments only occurring in older cultures, especially when deprived of sugar.

6. BACTERIOLOGICAL EXAMINATION OF WATER.

Owing to the rapidity with which bacteria multiply, it is obviously necessary to examine immediately on receipt or collection. Samples may be collected in sterilised Erlenmeyer flasks, sterilised stoppered Winchester-quart bottles, or in Sternberg's bulbs. If the city water supply is to be examined, the sample may be taken from a faucet after the water has been running for about half-an-hour. In sampling water from a river, reservoir, etc., the container should be immersed about a foot below the surface. The bottle is opened and closed under the water, and hermetically sealed before it is transported. Should a sample be desired not from the surface but from a given depth below the surface, the apparatus devised by Miguel may be employed (*vide* Frankland's 'Micro-organisms in Water').

A bacteriological investigation carried out in conformity with the procedures recommended by the Committee of the Royal Institute of Public Health should include :—(*a*) Enumeration of the bacteria present on a medium incubated at room temperature (18°-20° C.). (*b*) Search for *B. coli* and identification and enumeration of the organism if present. (*c*) Enumeration of the bacteria present on a medium incubated at blood heat (36°-38° C.). (*d*) Search and enumera-

tion of streptococci. May also be advisable to search for *B. enteritidis sporogenes.*

It will be observed that the R.I.P.H. recommend incubation at high and low temperatures in order to arrive at a more exact conclusion as to the number of bacteria present. As the purity of a water depends on the pathogenicity or otherwise of the germs present, it is possible to discriminate in this way between the non-pathogenic and pathogenic forms. Certain types of the thallophyta other than the schizomycetes frequently appear on the laboratory media, especially glucose-containing media, and are easily distinguishable microscopically, more so on prolonged incubation.

PHYSICAL EXAMINATION.—The temperature and reaction should be first tested, and an examination made of any deposit or suspended matter. Bubbles of gas, if present, should be noted. Data as to source, etc., should be recorded, as in general analytical practice.

QUANTITATIVE EXAMINATION.—The sample should be gently mixed and plate cultivations made. To five tubes of 10-15 Ml. of liquefied gelatin, add the following quantities of the water under examination: 0·5 Ml., 0·2 Ml., 0·2 Ml., 0·1 Ml., 0·1 Ml. Mix well, and pour into the corresponding number of sterilised Petri dishes. Allow the gelatin to set, and incubate at 22° C. for as long as possible before complete liquefaction takes place. Count the colonies which appear after forty-eight hours' incubation, take the average at the period of maximum growth, multiply up according to the fraction which has been used, and return as so many organisms per mil. The colonies are counted by means of Wolffhügel's apparatus or Pake's disc (cf. "Zapffe," pp. 135-6).

Pure water, according to Miguel's standard, may contain from 100 to 1,000 organisms per mil, very impure water being defined to contain 100,000, and upwards per mil.

QUALITATIVE EXAMINATION.—(*a*) The ratio of organisms liquefying gelatin. This is ascertained from the gelatin plates employed for enumeration.

The ratio of liquefying to non-liquefying organisms should not exceed one to ten, as above this points to sewage contamination (*b*) The number of organisms which multiply at blood-heat. At the time of making the gelatin plates for quantitative examination, several agar plates may be made for quantitative purposes, and incubated at blood-heat. On the second or third day colonies will have appeared, and these should be studied and sub-cultured in suitable media.

DETECTION OF SPECIAL ORGANISMS.—Take a sterilised Berkefeld filter and pump or aspirate through it a litre of the

water under examination, and with a sterilised brush (rubber tooth-brush) transfer the collected particulate matter to 5 or 10 Ml. of sterile water. This concentration of the organismal content of the litre of water is used as follows :—

(1) Place 0·5 or 1 Ml. in each of three sterilised tubes of 10-15 Ml. of fresh sterilised milk. Incubate anaerobically and examine for *B. enteritidis sporogenes*, as described under milk (q.v.).

(2) Add from 0·1 to 0·5 Ml. to three tubes of phenolated gelatin, and plate. Colonies developing should be examined for *B. coli communis*, or inoculate three tubes of Parietti's broth (cf. p. 5, "Curtis"), and incubate at 42° C. Those tubes which show growth in one to three days should be examined for *B. coli*.

Tubes of glucose-formate-bouillon may be also inoculated with 0·1 to 0·5 Ml., and incubated in a Buchner's tube at 42° C., and all the tubes which show turbidity in twenty-four hours may be plated out in gelatin or alkaline glucose litmus agar, and the *B. coli*, if present, thus isolated. Sub-cultures should be made in gelatin or glucose gelatin (for gas production), milk (for acidity and coagulation), and peptone water (for indol). MacConkey recommends a bile-salt-broth (sodium taurocholate, 0·5 Gm.; glucose, 0·5 Gm.; peptone, 2 Gm.; water, 100 Ml.) for detecting gas and indol formation; the medium is used with Durham's tube.

(3) *B. typhosus* may be examined for by adopting exactly the same methods as for *B. coli*.

(4) Sewage organisms and the organisms indicative of surface pollution should also be examined for.

If the organisms *B. coli*, *B. enteritidis sporogenes*, and *streptococci* are present in the water, it may be taken as proved that such water has been recently polluted, and should be condemned. Crude sewage generally contains in 1 Ml. (*a*) one to ten million bacteria; (*b*) 100,000 *B. coli* (or closely allied forms); (*c*) 100 spores of *B. enteritidis sporogenes;* and (*d*) 1,000 *streptococci* (Houston).

7. BACTERIOLOGICAL EXAMINATION OF THE SECRETIONS AND DEPOSITS IN THE MOUTH AND PHARYNX.

In the examination of oro-pharyngeal pathological products, the place of first importance belongs to the diphtheria bacilli. Of secondary importance only are the staphylo-strepto-, pneumo-cocci, influenza bacilli, and the diplobacillus of Friedländer, which occur in angina and in mixed diphtheritic infections. Finally, the "soor fungus," *Oidium albicans* (see above) should be mentioned.

Routine procedure for the detection of the diphtheria bacillus. (1) Direct identification. A cover-slip preparation is made directly from the swabbing or membrane according to the method of Neisser. If present, the Klebs-Löffler bacillus appears as a slender, longish rod, stained brown, and generally containing granules of a deep blue or inky tint.

This reaction is not always infallible, and the result should always be confirmed by serum culture control before giving a report.

(2) CULTURAL EXAMINATION.—A piece of membrane or a throat swabbing is rubbed over the surface of several tubes of Löffler's blood-serum, care being taken not to break up the medium. The tubes are then incubated for six hours at 37° C. It is rarely possible to find any visible growth in so short a time, and a scraping is therefore taken from the whole surface of the medium, and a cover-glass preparation made and stained with Löffler's blue.

Diphtheria bacilli, if present, will show the following features, viz.: (1) slender rods having the same diameter, (2) involution forms, (3) parallel grouping, and (4) the characteristic polar staining. If no bacilli can be detected the tubes must be incubated again, and examined at the end of twelve or twenty-four hours.

After twenty-four hours' growth, the diphtheria bacilli will have developed colonies about the size of a pin's head, round, prominent, and yellowish-white. If the colonies lying close together coalesce, a yellowish-white coating is formed which still presents a distinctly granular appearance.

If after twelve to twenty-four hours cocci alone have grown, it is very improbable that the case is one of diphtheria. However, the plate must be examined again on the following day, as in rare cases diphtheria bacilli develop late—namely, when gargles, etc., have been used shortly before obtaining the material for examination.

Pseudo-organisms may be differentiated by foregoing biological and morphological characters, but in case of doubt it is advisable to cultivate on neutral litmus agar (K.L.B. = alkalinity). and alkaline nutrient broth (K.L.B. = more acidity). Also *vide* Curtis's 'Essentials,' pp. 164 *et seq.*

8. BACTERIOLOGICAL EXAMINATION OF SPUTUM.

Pour the sputum into a sterile Petri dish placed over a dark background, and remove one or more of the thick yellowish masses to the cover of the dish. Spread this material out by means of two platinum wires and isolate a distinctly purulent fleck (the nucleus).

The fleck, having in this way been freed from the adherent mucus and bacteria which it has collected in its passage through the upper respiratory tract, may now be used for planting cultures or the preparation of smears.

Examination of Stained Films.—Smear a little of the prepared sputum over a cover-glass held in cornet forceps (adding a little sterile water, if necessary), so as to form a thin film. Dry and fix in the usual way. Stain as follows:—(1) According to the method of Ziehl-Nielson (cf. "Hewlett," p. 207). The tubercle bacilli will appear as delicate red rods, often beaded or segmented on a blue background of cells, mucus, and putrefactive or other bacilli. (2) With carbol-fuchsin. Dilute carbol-fuchsin is dropped on the smear, heated to the steaming point over a small flame (support on asbestos board), and at once washed off, as the details are hard to recognise in too deeply stained specimens. All bacteria other than tubercle bacilli will be stained blue. (3) According to Gram (cf. "Hewlett," p. 78). The tubercle bacilli, pneumococci, streptococci, staphylococci, and the *Micrococcus tetragenus* are stained, while *Micrococcus catarrhalis*, influenza bacilli, Friedländer's diplobacilli, *B. pyocyaneus*, *B. pestis*, are decolorised. The former, or Gram-positive bacteria, owing to their dark stain, are prominent against the brown background of decolorised cellular elements.

Cultural Examination.—Wash the prepared sputum in physiological salt solution. Inoculate tubes of agar, glycerin-agar, blood-agar, blood-serum, and bouillon with the washed fleck. Incubate at 37° C. When the presence of many germs capable of development is suspected, the same fleck is smeared on a number of cultures to obtain isolated colonies.

Tubercle Bacilli.—Material for smears should always be taken from a number of suspected places in the sputum, the so-called nuclei being specially sought after. In specimens stained as described the tubercle bacilli appear as slim rods of varying length, often slightly curved. They lie in groups, singly or in pairs, which may be parallel or at right angles to one another. They are often of uneven thickness or irregularly granular. Colourless spots are seen between the stained granules, so that the bacilli resemble a string of pearls. The number of bacilli are best counted by the method of Czaplewski—viz., the number of bacilli in a given field is made the numerator of a fraction; the number of fields counted, the denominator. If in one or more entire smears only a few bacilli are counted, then the denominator is written as a Roman numeral, *e.g.*: $\frac{6}{I}$ = 6 bacilli in a field; $\frac{\infty}{I}$ = innumerable bacilli in a field; $\frac{1}{5}$ = 1 bacillus in five fields; $\frac{2}{I}$ = 2

bacilli in an entire smear; $\frac{1}{vi}$ = 1 bacillus in six entire smears, and so forth. It is perhaps well to express the minimum and maximum number observed (for example $\frac{0-6}{1}$ etc.), and also the average number found in a number of fields (for example, $\frac{0-6}{1} = \frac{3}{1}$).

Pneumococci.—Cover-glass specimens prepared from the rusty sputum are best stained by the Gram-eosin method (cf. "Hewlett," p. 76). The diplococci appear in the stained preparation to lie in small oval clear spaces outlined by the counter-stain. Frequently they occur in chains. The pneumococci may be distinguished from Friedländer's bacillus by staining with Gram, and also by producing no growth on gelatin below 24° C.

Streptococci.—Isolate by inoculating blood-serum or Löffler's blood-serum, and incubating at 37° C. for six to seven hours, and then examining. Streptococci, if present in the sputum, will be found forming beautiful chains. This is the most satisfactory way of eliminating contaminating organisms.

Staphylococci.—*S. aureus* or *albus* is usually present in the sputum, more rarely the *S. citreus*. Staphylococci are best grown on agar for differential purposes. They appear under the microscope as round cocci usually arranged like a bunch of grapes, and stain according to Gram.

Micrococcus Tetragenus.—This organism occurs in the sputum only as a producer of mixed infection in tuberculosis. The cells occur singly (diameter 1μ); in pairs, or in fours, and enclosed within a capsule. It stains with the ordinary aniline dyes and by Gram's method. Develops slowly on gelatin (without liquefaction) and agar, forming a thick, white, shining growth.

Micrococcus Catarrhalis.—This organism occurs in the sputum in bronchitis and broncho-pneumonia generally associated with streptococci and the influenza bacilli. It appears as a diplococcus or tetracoccus, but never forms chains. It is much larger than the gonococcus, which it resembles in appearance, as well as by decolorising with Gram.

Influenza Bacilli.—Inoculate tubes of blood-agar and glycerin-agar with a prepared fleck, well wash with physiological salt solution, and incubate at 37° C. After twenty-four hours, take out of incubator, and prepare Klatsch preparations from a small, transparent, drop-like colony. Stain with carbol-methylene blue (Kühne, cf. "Hewlett," p. 75) and examine. It appears as a very fine short (0·5μ) rod with rounded ends. It is decolorised by Gram.

Diplobacillus of Friedländer.—The pneumo-bacilli are plump rods with rounded ends, varying in size and form, often resembling cocci. They lie in pairs, and possess, like the true pneumococci, a capsule, which is conspicuous in sputum films in contrast to those made from cultures. They are decolorised by Gram. A stab-inoculation in gelatin resembles a "nail" in appearance, occasionally accompanied by gas bubbles.

Bacillus Pyocyaneus.—This organism is the source of the colour of blue or bluish-green sputum. In cover-glass preparations the bacilli appear as small, slim rods with rounded extremities. They are decolorised by Gram. The organism differs from the influenza bacillus in that it is easily cultivated on the usual culture media, produces pigment, and is motile (a single flagellum).

9. BACTERIOLOGICAL EXAMINATION OF FÆCES.

In making a bacteriological examination of the intestinal evacuations, the general characteristics should be observed, as in certain infections abnormal features are always present. Thus, bloody mucus stools occur in dysentery, flecks of mucus and pus in the evacuations in intestinal tuberculosis, stools of a characteristic rice-water appearance in Asiatic cholera, and occasionally evacuations are met with of a green colour due to *B. pyocyaneus.*

Preparation for Examination.—Fluid and thin-pasty stools are poured into a shallow dish, stirred to a uniform consistency, and traces are then removed for planting cultures or microscopic examination. Very thin evacuations are allowed to settle, or at once centrifuged, and the sediment examined. Formed stools are rubbed in a mortar with water or physiological salt solution. Macroscopical constituents, such as mucus and other intestinal wall products, are best isolated by spreading the fæces on a very fine sieve (200 mesh), and washing freely with water, stirring meanwhile; the fæcal sieve suggested by Boas is most useful for this purpose.

Cultural Examination.—(1) Inoculate tubes of bouillon and cultivate at 37° C. Examine for turbidity. (2) Inoculate tubes of gelatin, (*a*) stab, (*b*) streak, (*c*) shake. Examine daily for gas formation. (3) Recent milk tubes are inoculated, heated to 80° C. for ten to fifteen minutes, and then incubated anaerobically at 37° C. (cf. "Milk") by means of alkaline pyrogallol. Coagulation in forty-eight hours indicates *B. coli* and *B. enteritidis sporogenes.* In the latter case the milk undergoes the "enteritidis" change. (4) Inoculate tubes of litmus-whey and incubate at 37° C. Typhoid bacilli, dysentery bacilli, and type A of the para-typhoid bacilli, produce, after

twenty-four hours, a small amount of acid (typhoid under 3 per cent. N/10 acid), and the tubes show a slight reddish tinge, while coli bacteria produce more than 7 per cent. of N/10 acid, and the tubes are coloured bright red. Para-typhoid bacillus B produces at first a small amount of acid, but after a few days' growth turns the medium blue. (5) Prepare: stab, and "shake" (*schüttel*) cultures in 2 per cent. glucose-agar and neutral-red agar. Incubate at 37° C. Most varieties of coli and both types of para-typhoid bacilli cause fermentation with the formation of gas (CO_2), also reduction in the neutral-red agar, with the production of a greenish fluorescence. (6) Inoculate six tubes of Barsiekow's culture medium (cf. p. 284, "Klopstock"), containing 1 per cent. of glucose. Incubate at 37° C. for twenty-four hours. Dysentery tubes show acid formation, but no coagulation. Typhoid tubes show acid formation and cloudiness, due to slight coagulation. Coli tubes show acid formation and complete coagulation. (7) Cultivate in peptone water and test for indol—(*a*) with nitrite, (*b*) without nitrite. *B. coli* gives a positive reaction in (*a*), and the bacillus of Asiatic cholera in (*b*).

Microscopical Examination.—(1) Prepare hanging-drops from sub-cultures on bouillon, and examine for motility. Typhoid bacilli, alkaligenes, the two types of para-typhoid bacilli, and the cholera bacilli are motile. *B. coli* is non-motile, or slightly motile, while dysentery bacilli possess no motility. (2) Prepare "Klatch" preparata from the gelatin plates when the colonies are twenty-four hours old, and stain with carbol-fuchsin. (3) Prepare cover-slip preparations from material (*e.g.*, mucus fleck) and pure culture, and stain with—(*a*) Carbol-fuchsin. In pure culture cholera bacilli show semi-lunar or S-shaped figures. Preparations from the rice-like flakes in cholera show curved rods or commata lying parallel to each other. (*b*) Gram's method.—*B. coli*, *B. typhosus*, and dysentery bacilli are decolorised.

Typhoid Bacilli.—For isolation and differential purposes plant traces of the material to be examined on agar, Conradi-Drigalski's litmus agar, and Piorkowski urine gelatin (cf. "Klopstock," pp. 283-4). (1) Incubate the agar and litmus agar plates at 37° C. After fourteen to twenty-four hours look for small, transparent, bluish iridescent colonies on the agar plates, and small, blue, sharply outlined colonies, resembling dewdrops, on the Conradi-Drigalski plates. Prepare hanging-drops from these and examine carefully. If motile rods, having the appearance of typhoid bacilli (cf. pp. 177-8, "Curtis"), are seen, make sub-cultures on agar (slanting). Make a "preliminary agglutination test" in the following way:—Place a trace of the colony on a cover-glass in a drop of diluted (1 in 1,000) high-potency serum (from an animal

immunised with T.B.). Use as a control a hanging-drop made from normal serum (× 10 the concentration of the immune) of the same kind of animal. Place the cover-glasses upon concave slides, and examine with a low power. If clumping occurs in the hanging-drop from the specific serum, either at once or after a few minutes, while the control remains homogeneous, the reaction is positive, and the bacteria are in all probability typhoid bacilli. On the following day the media described in the routine examination are inoculated with a pure culture for biological observation, and a quantitative microscopic test is carried out with the bacteria (*vide* below). (2) Incubate the urine-gelatin plates at 21·5° to 22° C., and examine with a low power. Typhoid colonies show a small, usually oblong, clear nucleus, which, depending upon the character of the flagella, has at each end four to six branches about four to six times the length of the nucleus, and frequently spirally arranged. Other typhoid colonies possess no nucleus at all, or are rounded and finally granular.

Transplant any colonies possessing the foregoing characteristic appearance upon agar tubes. Test the pure culture on the following day, as described above.

The Macroscopical Quantitative Agglutination Test is carried out in the following way:—Add one loopful (about 2 milligrams) of a twenty-four hours' agar culture to each of a series of tubes containing 1 Ml. of immune serum, diluted in different proportions, *e.g.*, 1 : 100, 1 : 200, 1 : 500, 1 : 1,000, etc. First smear the culture on the side of the tube just above the fluid, and rub with a drop of it until all visible lumps have disappeared, then gradually mix with the rest until homogeneous.

If agglutination does not occur at once incubate tubes at 37° C. Test the tubes by holding them horizontally above the head and look upward through the thin layer of diluted serum. If agglutination has taken place the clear liquid is seen to be filled with granules. Controls should be made from authentic typhoid cultures with the immune serum, with normal serum, and with the salt solution used as diluent.

Para-Typhoid Bacilli.—The two types A. and B. are detected, and isolated from the dejecta by similar methods to those employed for typhoid bacilli (q.v.). Urine-gelatin is, however, not used for their detection, as para-typhoid bacilli produce no fibril forms when grown on it. They are identified by their biological characteristics and by the agglutination test.

Dysentery Bacilli.—In addition to the biological and bio-chemical characters already described, the dysentery

bacilli are positively identified by agglutination with a high potency serum. As, however, the dysentery bacilli agglutinate more slowly than the typhoid bacilli, the inoculated tubes are first incubated at 37° C., and then placed for twelve hours in an ice-chest. The detection of dysentery bacilli in the fæces is, as a rule, easy so long as the evacuations are of a typical mucous character.

Cholera Vibriones.—Smears are made when possible from one of the whitish, slimy, rice-like flakes, and stained with dilute carbol-fuchsin (1 : 9). Frequently, typical cholera bacilli are present in these smears in great numbers, lying in groups parallel to each other. In addition, hanging drops are made from a rice-like flake with peptone water, and examined fresh and stained, at once, and after half-an-hour, in an incubator at 37° C.

Occasionally the vibriones are seen to collect at the margin of the drop. Cultivations are made in gelatin, agar, and peptone water, as described. Finally, serum tests are carried out with the pure culture (quantitative microscopical agglutination test and Pfeiffer's reaction, cf. "Hewlett," pp 252-3).

Tubercle Bacilli.—Stained cover-slip preparations are made from the flecks of mucus and pus present in the diarrhœal evacuations from intestinal tuberculosis. If the fæces are formed they are (according to Strasburger) mixed with water and centrifuged. The cloudy liquid above the sediment is decanted, and diluted with 96 per cent. alcohol (2 parts of fluid to be examined, 1 part alcohol). It is then centrifuged again, and smears made from sediment. Care should be exercised in forming an opinion from the cover-slip preparations, as other acid-fast bacilli are occasionally present.

Staphylococci and Streptococci.—In acute intestinal catarrh, the pyogenic bacteria are seen in the evacuations in such large numbers, that the micro-organisms usually present are completely overshadowed by them. They are detected by cover-slip preparations, stained with dilute carbol-fuchsin, and according to Gram (cf. "Sputum").

10. BACTERIOLOGICAL EXAMINATION OF URINE.

Ascertain, approximately, the number of micro-organisms present by preparing a hanging-drop. If many (*e.g.*, the so-called bacteriuria), cover-slip preparations may be made directly. It most cases, however, it is advisable to centrifugalise the urine in sterile tubes, and use the sediment so obtained for examination.

Sedimentation is difficult to get in some cases, *e.g.*, bacteriuria and ammoniacal urine. In the former case, add, before centrifugalising, absolute alcohol (to lower the density), and in the latter, add dilute KOH, and heat on water-bath. In both instances, the precipitate is rendered unfit for cultural use.

Urine, turbid from precipitated urates, must be cleared by incubating for a few minutes at 37° C.

Cover-slip Examination.—Smears are prepared in the usual way. Modifications in technique are, however, necessary in certain cases, *e.g.*, in the presence of a large amount of crystalline salts, fix in alcohol-ether. Stain with dilute borax-methylene-blue (1 : 9), two minutes, without heating, according to Gram, and according to one of the methods for detecting tubercle bacilli (q.v.).

Cultural Examination.—Agar is the most suitable for isolating the bacteria which appear in the urine. Special culture media are, however, necessary for the detection of tubercle bacilli and gonococci.

Bacterium Coli.—This is present in the urine from cases of cystitis and pyelitis. The urine is usually acid in reaction. *B. coli* appears in stained smears made from urinary sediment as a plump, straight rod with rounded ends, and of varying length. The bacteria lie singly, in pairs, or in groups, and frequently form chains; more rarely they lie within the cells (epithelial).

They are decolourised in specimens stained according to Gram. For methods of identification, cf. the examination of milk for special organisms, also the examination of the fæces.

Staphylococci and Streptococci.—Both varieties of cocci stain, according to Gram, and are therefore conspicuous in cover-slips so stained. Staphylococci frequently lie within the cells. Staphylococci and streptococci are distinguished from gonococci by their form, staining characteristics, and the ease with which they can be cultivated in the ordinary laboratory media. For cultural characteristics cf. examination of sputum.

Tubercle Bacilli.—Prepare cover-slip preparations and stain as directed for tubercle bacilli in the examination of sputum (q.v.). The bacilli will present similar features.

In tubercular cystitis the bacilli are often present in the urine in great numbers, lying either singly or in groups, and frequently in characteristically plaited or S-shaped arrangement. In tuberculosis of the kidney their detection is extremely difficult, and a great number of specimens must be examined before the first bacillus is found.

When unsuccessful in detecting the tubercle bacilli in the sediment obtained by centrifugalisation in the ordinary way, the following method may be tried:—Pour as large a quantity of the urine as possible into a conical sedimentation-glass (containing a crystal of thymol), and stand for twelve hours. Withdraw the lowest portion and centrifugalise. For further particulars of identification, and differentiation from other acid-fast bacilli cf. "Sputum," also, Curtis's 'Essentials,' pp. 143-145.

Typhoid Bacilli.—The bacilli are found in the urine in typhoidal cystitis. The urine is acid in reaction, and contains usually enormous quantities of typhoid bacilli. These are, as a rule, the only bacteria present. On examining the sediment in hanging-drop, numerous highly motile bacilli are seen. In stained cover-slip preparations they appear as small rods, which are decolorised by Gram. They are cultivated, and identified according to the method described under examination of the fæces.

Gonococci.—The gonococci are present in the urine in gonorrhœal cystitis and (indirectly) in gonorrhœa. Urine from chronic gonorrhœa contains numerous filaments or "fish-hooks." These are most numerous in the first morning urine. The filaments are removed with a pipette and carefully spread upon a cover-glass or slide. For identification, *vide* "Examination of the Urethral Secretion."

Proteus Vulgaris.—The bacilli occur in urine (ammoniacal) either alone or associated with other micro-organisms, especially *B. coli*. Microscopical examination shows rods of varying size, which frequently form long spiral threads, and for the most part are decolorised by Gram. In hanging-drop they appear highly motile. The colonies in gelatin plates are characterised by the variable outline, and ramifying branches known as "swarmers" or "swarming islets" (cf. p. 65, "Curtis").

Proteus Vulgaris ferments grape and cane-sugar, but not milk-sugar, and forms a large amount of indol. It decomposes albuminoid substances, with the formation of foul-smelling products.

11. BACTERIOLOGICAL EXAMINATION OF THE URETHRAL AND PROSTATIC SECRETIONS.

The gonococcus of Neisser, or *Micrococcus gonorrhœæ*, is the principal organism to be searched for in the urethral secretion, as it is, in the majority of cases, the exciting cause of urethritis and vulvitis. It is generally, even at an early stage, associated with other organisms, of which Foulerton (pp. 40-81, 'Trans. Instit. Prevent. Med.,' First Series,

1897) gives a list of no less than eighteen species belonging to the coccus group alone. These include several diplococci, which have to be distinguished from the gonococcus—*e.g.*, the *Diplococcus intra-cellularis meningitidis* of "*Weichselbaum.*"

MICROSCOPICAL EXAMINATION.—Cover-glass preparations of the pus or discharge are best prepared in the following way:—(1) Smear thin films on cover-glasses and allow to dry in the air. (2) Fix with alcohol-ether for fifteen minutes. After fixing, stain two of the preparations with Löffler's blue (3—5 m.), wash in water, dry, and mount. Examine with a 1/12 in. oil-immersion lens. Ovoid cocci in pairs, and occasionally in tetrads, occurring within the pus cells in groups of not less than four pairs, are practically characteristic. Next, stain by Gram's method. After washing with alcohol, counterstain with Bismarck brown. On drying and examining as before, gonococci, if present, will be seen to be stained brown, while streptococci or staphylococci appear violet (having taken up the para-rosaniline in Gram's process).

CULTURAL EXAMINATION.—Gonococci cannot be grown on ordinary laboratory media. Foulerton recommends cultivation of the pus on 1½ in. agar plates, streaked with fresh human blood. Blood, obtained by aseptically pricking the finger, is taken up in a sterile capillary tube, and deposited in the centre of each plate. A trace of gonorrhœal pus is taken up on a small sterile camel's hair brush, rubbed up with a drop of the blood, and smeared over the surface of the agar. Inoculate a set of plain agar plates with the pus in the same way. Incubate both sets at 37° C. In forty-eight hours colonies of the gonococcus should be recognisable on the blood agar, but not on the plain agar. After twenty-four hours' growth at 37° C. the colonies of the gonococci appear as transparent, greyish specks, which increase in size up to the end of three days. At this stage the colony measures 1 to 2 Mm. in diameter, is raised, brownish, and finely granular in appearance, and irregularly rounded with a crinkled margin.

An organism suspected to be *Micrococcus gonorrhœæ* should comply with the following postulates:—It should (*a*) occur in all colony in pus, (*b*) decolorise when treated by Gram's method, (*c*) not grow on agar at either 20° or 36° C. Prostatic secretion is examined in the same way as the urethral secretion.

2. BACTERIOLOGICAL EXAMINATION OF BLOOD.

The bacteriological examination of blood is not confined solely to the detection of specific micro-organisms such as Obermeyer's spirilla and typhoid bacilli, but is also directed

to the detection of certain small parasitic protozoa known as hæmatozoa, and trypanosomes.

The malarial parasite is a type of the former, and *Trypanosoma gambiense* (sleeping sickness) an example of the latter. Blood is obtained for examination from the lobe of the ear or the finger tip, under aseptic conditions.

The drops of blood are drawn up into a capillary pipette (*vide* "Hewlett," fig. 6, p. 39), and sealed up. In the absence of capillary tubes the blood may be spotted on a cover-glass or glass slide, and allowed to dry, or on a piece of blotting-paper. In these cases, a droplet of water must be added, and a solution made for cultural, and hanging-drop examination.

Cover-slip Preparation.—Touch the blood with the middle of one of the narrower ground edges of a microscopic slide, and draw this rapidly across a clean cover-slip free from grease, supported by another slide. An evenly distributed film will be obtained. Allow the smears to dry in the air, and fix in the usual way. Other methods, such as Hyam's and Manson's (cf., "Curtis," p. 240) may also be employed. Specimens may be also fixed by (*a*) immersion in one of the following—absolute alcohol, alcohol and ether (*p. æq.*), and formalin, or (*b*) with heat. In the latter case the method of Kowarsky is followed—the cover-glasses are placed with the film side up upon a hollow copper cylinder (fig. 12, p. 62, "Klopstock"), which is provided with a depression for the reception of a crystal of urea. The bottom of the cylinder is carefully heated with a Bunsen or alcohol lamp, and when the crystal melts (132° to 135° C.), fixation is complete. This takes two to three minutes.

Malaria.—The protozoan parasite of malaria may be met with in the blood in four distinct types, viz.: (1) Spherical bodies; (2) flagellated bodies; (3) crescentic bodies; and (4) segmented or rosette bodies. For their description, *vide* Hewlett's 'Manual of Bacteriology,' pp. 237-9.

Stain with a 1 per cent. aqueous solution of eosin for five minutes, wash thoroughly, and immerse in saturated aqueous methylene blue for two to three minutes. Wash well, dry, and mount. The plasmodia in the red corpuscles (stained pink) are stained blue, and are distinguished from the nuclei by their shape, and by the presence of pigment. Other stains may be used for demonstrating the parasite—viz., Jenner's combined eosin-methylene blue, Erlich-Biondi solution, and Erlich's hæmatoxylin (for details see p. 241 "Curtis"). Flagellate bodies are best demonstrated by Manson's method. This consists in removing the hæmoglobin from a specially prepared film (for details see *Brit. Med. Journ.*,

1896, 2, p. 122, or "Curtis," p. 242) with 15 per cent. acetic acid, washing in water, and staining with 20 per cent. carbol-fuchsin for six to eight hours. Negative results in the examination for the malarial parasite must be accepted with caution, unless repeated.

Trypanosoma.—Several trypanosomes have been found in tsetse fly and other entomophilous diseases by different investigators; one, *T. Lewesi*, found in rats is stated to be non-pathogenic; *T. hominis* is the only one found in man. The organism consists of a long-shaped protozoon containing a large nucleus centrally, and a vacuole or contractile space at the other end. It has only one flagellum, which originates from a small mass of chromatin at the anterior end. The flagellum which forms the edge of undulating membrane traversing the entire length of the organism is further extended as a free tail for some distance. It measures 18·26μ. by 2 to 2·5μ. The trypanosoma differs from analogous flagellates in moving backwards by means of this membrane. It is further characterised by possessing behind the vacuole some patches of pigment: the so-called eye spots or micronucleus. The protozoon reproduces itself by (1) longitudinal division or fission, (2) transverse division, and (3) formation of rosettes by multiple division. The fission is preceded by a division of the micronucleus or centrosome, followed by a division of the flagellum nucleus and the protoplasm. Blood should be centrifugalised previous to examination, as the trypanosomes accumulate in the leucocyte layer above the red corpuscles. Specimens are fixed as already described, and stained with Leishman's stain, thionin blue, and Borrel's blue (methylene blue and silver oxide, *ad sat.*). The latter stain is used in conjunction with eosin and tannin in Laveran's method of staining. Briefly, this consists of treating the prepared film for five to twenty minutes with a freshly made mixture of the following:—Borrel's stain, Ml., eosin sol., 1 in 1,000, 4 Ml.; water, 6 Ml.; next washing in water and then treating with a 5 per cent. solution of tannin for a few minutes. Wash in water, and also in distilled water. Finally, if precipitate be found on preparation, clear in clove oil and brush off with xylol.

Spirilla of Relapsing Fever.—Obermeyer's spirillum occurs as a long, slender, spiral filament, not unlike the spirillum rubrum, 20 to 30μ. in length, and actively motile. They usually lie singly or a few side by side, and rarely form marls. Smears are prepared in the same way as for the detection of the malarial protozoa. The spirilla are best stained, according to Günther, in the following way: Smears are thoroughly dried by placing in the incubator at 37° C., removing and immersing in 5 per cent. CH_3COOH to extract

the hæmoglobin. After ten seconds the acetic acid is blown off, and the air-dried cover-slip preparation held for several seconds, film down, over the mouth of a bottle of liq. ammon. ; it is then stained for a few seconds with Erlich's aniline-water gentian-violet. The spirilla are detected with difficulty in unstained specimens ; in swishing about they displace the blood corpuscles.

Spirochæta Pallida.—This organism is considered the specific cause of syphilis. Preparations are made from the serum, fixed by one of the methods already described, and stained by Giemsa's method (a modification of Romanowski's method). For this the following solutions are required :— (1) 1 per cent. aqueous solution of eosin ; (2) 0·08 per cent. aqueous solution of azur (Höchst). A mixture is prepared for the actual staining by adding 1 Ml. of No. 2 to 9 Ml. of a 1-200 (aq.) dilution of No. 1. The film is floated on this mixture in a watch-glass. The degree of staining is controlled by microscopic examination, using the dry system, and on the appearance of a precipitate the smear is washed with 35 per cent. alcohol, dried and mounted. The *Spirochæta pallida* shows spirally twisted threads which bend at a right angle at several points. The organism may be cultivated on the ordinary laboratory media. On gelatin, growth occurs at room temperature, and at the end of twenty-four hours a very fine, greyish-white, thready mass like cloudy streaks, and having a peculiar reflecting surface, can be seen. Liquefaction occurs after some time.

Typhoid Bacilli.—Blood obtained by venepuncture may be cultivated right away on bouillon or liquefied agar at 37° C. Schottmüller recommends 2 to 3 Ml. of the blood to be added to tubes containing 6 Ml. of the agar, cooled to 45° C. After mixing, the cultures are poured into Petri dishes or Erlenmeyer flasks and incubated at 37° C. Examine daily. The typical colonies appear as deep, greenish-black points within the culture media, and gradually grow to the size of a pea.

The surface colonies, which are dark grey in colour, grow even larger. The cultures are identified as previously described.

Agglutination Reaction.—(*a*) Macroscopic examination. This is best carried out according to Ficker. About 2 C.c. of the blood obtained by venepuncture, cupping, or from the finger-tip is collected in a small centrifuge tube. When coagulated, the clot is loosened with a sterile platinum needle, and the tube set aside on ice for some hours.

The serum is removed with a pipette, and a dilution of 1 in 10 prepared with sterile 0·85 per cent. NaCl solution, and centrifugalised till clear. 0·2 and 0·1 Ml. of this dilution are

placed in conical test tubes. To tube one, 0·85 Ml. of the "diagnosticum" (a mixture of dead typhoid bacilli) is added; to tube two, 0·9 Ml. A third receives 1 Ml. of the "diagnosticum" without the addition of serum (control). The tubes are corked, and set aside in the dark at room temperature. Positive agglutination may be seen after ten, twelve, to fourteen hours, and is observed as described under typhoid in the examination of the fæces. Apparatus (agglutometer) for carrying this operation out is obtainable from Parke, Davis, and Co.

(*b*) *Microscopic Examination.*—The ends of the sealed pipette or capillary tube are broken off, and a drop of the serum or blood is blown out on to a clean cover-glass or slide. A small loopful of this is placed in the depression of a hollow slide, and with same loop four loopfuls of sterile broth, salt solution, or water, added, and the whole mixed up. A loopful of this solution is then mixed with an equal loopful of filtered typhoid culture on a clean cover-glass, and a hanging drop prepared (= 1 in 10 dilution). A simpler way is to mix one loopful of the serum or blood with nine loopfuls of the filtered typhoid culture, and make a hanging drop of the mixture. Many prefer a dilution of 1 in 30 or more (cf. "Curtis," p. 189). The hanging-drops are examined under the microscope, a 1/6th in. objective being sufficient for the purpose, and observed for half an hour. The hanging-drop should show the following phenomena:—

The motility of the bacilli is instantaneously or quickly arrested, and in a few minutes they begin to aggregate together into clumps, and by the end of half an hour only a few individuals show a slight Brownian movement.

A control should be made, if possible, with healthy blood.

13. BACTERIOLOGICAL DETERMINATION OF THE OPSONIC INDEX.

Since Metschnikoff formulated his theory of phagocytosis considerable light has been thrown on the activity with which the white corpuscles show to living bacteria. Wright has shown that the leucocyte loses its power of absorbing and destroying bacteria when it is separated from the blood serum, and also that certain treatment of the serum destroys or modifies this power. From this he assumes that there exists in the blood some constituent which stimulates the leucocyte's relish for destroying micro-organisms. This constituent has been designated "opsonin," which means "provider of appetite." Further, it has been demonstrated that separate opsonins are required for different diseases—*e.g.*, a member of a tuberculous family may inherit a blood whose leucocytes have a poor appetite for tubercle bacilli owing to

a deficiency in opsonin. It is obvious from the latter instance that something must be done for the patient in order to ward off an attack, and this is accomplished in modern treatment of such diseases by raising the opsonic power by suitable means of treatment. The progress of the treatment is arrived at by a determination of the opsonic power, and from this is deduced the opsonic index. The opsonic index for a given organism—*e.g.*, *B. tuberculosis*—is the ratio of the opsonic power of the serum of a patient as compared with that of a normal being. The following is an outline of the bacteriological technique :—(1) The leucocytes of a normal person are separated as much as possible from the other corpuscles and the serum; the resulting fluid is termed the "leucocytic mud." (2) A pure culture of the disease germ (T.B. in this case) is required. (3) Some fresh blood serum, separated from the corpuscles, is obtained from the patient. (4) Some fresh blood from a normal being is procured.

Preparations (1), (2), and (3) are mixed together in equal proportions and incubated at 37° C. for fifteen minutes; (1), (2), and (4) are treated similarly and used as a control. Film preparations are made and stained as described under "Bacteriological Examination of Blood," and the average number of bacteria ingested in both cases determined—*e.g.*, the control film shows an average of twenty bacteria per leucocyte, and the patient's film an average of only ten, then the opsonic index is expressed, taking the control as unity, as a decimal : 5/10 = 0·5. The normal tuberculo-opsonic index has been found to average 0·95. An index below 0·8 or above 1·2 is suggestive of tuberculosis.

14. BACTERIOLOGICAL EXAMINATION OF SKIN.

Material for examination is obtained from purulent affections of the skin by puncture with a sterile needle or by incision.

In dermatomycosis epidermal scales are obtained by scraping with a dull, slightly moistened scalpel, or, according to Unna, by means of adhesive plaster, the scales being removed from the plaster by treatment with benzene, and freed with HCl-alcohol from the zinc oxide. The material is examined microscopically, and by means of cultures. Among the bacteria to be met with are *Staphylococcus aureus* or *albus* (furunculous processes), pyogenic cocci and typhoid bacilli (acute abscesses), tetanus bacilli (wounds), *Bacterium coli*, and *B. Lactis Aerogenes* (gas phlegmona). Hyphomycetes and yeasts also occur, *e.g.*, ringworm, favus, etc.

Bacillus Mallei.—In suspected cases cultures are planted (from the pus or discharge) upon glycerin-agar and potato.

After two days the potato will show a honey-yellow or amber coating, which, after a week, assumes a brownish-red tint. Cover-slip preparations are prepared from the material in the usual way, and are stained with Löffler's alkaline methylene blue. The bacilli are small, slim, slightly curved, non-motile rods, about the size of tubercle bacilli.

In the tissues they are difficult to demonstrate. Abbott ('Princip. of Bact.,' third edit.) recommends the following method:—Rinse the sections in distilled water, stain on the slide with dilute carbol-fuchsin (1 in 10 aq.) for half an hour. Wash for ten seconds three times with 0·3 per cent. CH_3COOH. Wash, dry, clear in xylol, and mount.

Anthrax Bacilli.—Smears are obtained with dilute methylene blue, according to Gram, and by one of the methods for demonstrating spores. The bacilli may be cultivated on agar and gelatin. After twenty-four hours' growth characteristic colonies are seen (cf. p. 133, *et seq.*, "Curtis").

"Klatsch" preparata, examined with a low power, show spiral branches radiating from a centre composed of a non-transparent whorl of threads, presenting the appearance of a tangle of hair. Stab cultures in gelatin show a characteristic appearance compared to an inverted fir or "Norfolk pine" tree.

In stained smears the bacilli usually have a slight bulbous enlargement at their ends, and at the same time a slight concavity, so that when two bacilli be end to end a small hole is found between the points of contact (bamboo-form). In the Gram specimens they are often unevenly stained, and appear granular. For further particulars cf. p. 191, "Crookshank," and p. 151, "Hewlett."

Tetanus Bacilli.—Cover-glass preparations are prepared from the pus or discharge, and stained by Gram's method. If "drum-sticks" or spore-bearing rods are seen in the microscopic examination, the bacilli may be isolated by cultivation according to Kitasato. The material is planted upon agar, and incubated for two days at 37° C.

The mixed culture is heated in a water-bath at 80° C. for about one hour to destroy the less resistant contaminating bacilli. From this anaerobic cultures are made in the usual way (cf. p. 222, "Curtis"). After a few days' growth on gelatin small colonies with radiating branches have developed.

Gelatin is liquefied. The bacilli develop much more rapidly on agar. When examined with a low power, the delicate colonies appear as a maze of fine threads.

Bacillus of Soft Chancre (*Ulcus Molle*).—Smears from the secretion of fresh ulcers are stained with Löffler's methylene blue. Ducrey's bacilli appear as short bacilli, having

rounded ends, frequently showing polar staining, and lie in groups, pairs, or singly, both within and without the cells. They are decolorised by Gram. Celloidin sections may be stained according to Krefting—viz. :—(1) Stain on the slide with Unna's methylene blue (cf. p. 164, "Schenk"), two to five minutes. (2) Dry with filter paper. (3) Aniline-xylol, two to three hours. (4) Xylol, Canada balsam. Sections from the periphery of excised soft chancre show the bacilli lying frequently in parallel chains in the lymphatic spaces of the tissue.

Cultivate upon blood-agar (2 parts liquefied agar, cooled to 40° to 50° C., and 1 part rabbit blood) at 37° C. After forty-eight hours, dark-grey colonies the size of a pin's head develop.

15. BACTERIOLOGICAL STANDARDISATION OF DISINFECTANTS.

Until the Rideal-Walker method of standardising disinfectants was formulated, there was no generally recognised standard for the determination of the germicidal power.

The methods of Koch and Sternberg left too much room for modification in the way of procedure, with consequent discrepancies in results.

In order to eliminate these differences, due to varying chemical and physical conditions, it is necessary to observe the following factors in selecting any particular process :— Time, age of culture, constitution of medium and its reaction, variations in vital resistance of species of microbe worked with, proportion of culture to disinfectant, temperature of medication, and temperature of incubation.

The method now followed consists in comparing the disinfectant action of a preparation with carbolic acid as a standard. The comparative lethal action is designated in terms of "the carbolic acid co-efficient." This figure is obtained thus :—The particular strength of the disinfectant which will kill in a given time is divided by the strength of carbolic acid which, under the same conditions, will kill the same microbe in the same time. Thus, if a 1 in 80 solution of disinfectant x will destroy the typhoid bacillus in five minutes, and the strength of carbolic acid which will act similarly is 1 in 100, the carbolic acid co-efficient of x is $\frac{80}{100} = 0{\cdot}8$: if a solution of disinfectant y, of strength 1 in 150, is similarly equal to carbolic acid 1 in 100, the carbolic co-efficient would be $\frac{150}{100} = 1{\cdot}5$.

The *modus operandi* is as follows :—A special test-tube rack is made use of. It consists of a lower tier with five holes for five test-tubes, and an upper tier with two rows (one behind the other) of fifteen holes each, and divided by

spacing into three groups of ten. Into the bottom row test-tubes, 5 Ml. each of various strengths of the disinfectant and of carbolic acid for comparison, are placed, and into each are dropped at intervals of half a minute five drops of (1) a broth culture of the organism chosen, *e.g.*, the typhoid bacillus, *Bacterium coli*, or *Micrococcus pyogenes aureus*, or (2) an emulsion of the organism, as in the case of *B. pestis* (from a forty-eight hours' old agar culture, made with sterile H_2O).

Sub-cultures are then made, in the first example: on bouillon; in the second, on gelatin or agar—at intervals of exactly half a minute. (The tubes are placed in upper tiers of rack previous to inoculation.) In this way a sub-culture is made from each tube after intervals of exactly two and a-half, five, seven and a-half, ten, and fifteen minutes.

The inoculated tubes are then incubated (gelatin at 21° C., bouillon and agar at 37° C.); if no growth occurs it is assumed that the organism has been killed, the reverse if growth occurs. The following data (obtained by Dr. Klein) are given as illustrative of the foregoing brief *résumé*:—

BACTERIOLOGICAL TEST.

B. Pestis, forty-eight hours' agar culture at 37° C.
Room temperature, 15° to 18° C.

Sample.	Dilution.	Cultures Exposed. Minutes. 5	10	15	Subculture. Period of Incubation.	Temperature.	Remarks.
Formalin, 40 p.c.	1·100	+	+	+	7 days	37° C.	Copious Growth.
,,	1·50	+	+	+	7 days	37° C.	
,,	1·30	+	+	+	7 days	37° C.	Slight Reduction in 15 min.
Pure Phenol....	1·80	+	−	−	7 days	37° C.	Reduction in 5 minutes.

+ = Growth; − = No growth.

THE ANALYSIS OF METALLIC SALTS.

NOTES ON THE GROUPS.

THE analysis of a mixture of substances can only be satisfactorily performed after the student has become thoroughly acquainted with the reactions of the individual substances. For this purpose many excellent books are available, in particular, Newth's 'Manual of Chemical Analysis' and F. M. Perkin's 'Qualitative Chemical Analysis' are recommended; the most exhaustive and thorough is probably Fresenius's 'Qualitative Chemical Analysis,' which, however, is rather antiquated in its terminology. The usual scheme of analysis for the detection of the ordinary metals should be used intelligently, and the principles and reactions underlying each process mastered if success is to be assured. In what follows directions are given for the analysis of inorganic salts, and, if followed intelligently, the methods set forth will suffice for even a complex mixture of salts. The reactions involved in the ordinary analytical processes are explained and equations given. The general scheme to be followed is then given in a condensed tabular form for convenient reference.

PRELIMINARY TESTS.

If the substance to be examined is a solid, it must be brought into solution in order to submit it to the systematic tests for metals. Much useful information, however, may first be gained by applying a few preliminary tests to the dry substance. If it is already in solution, the reaction of the liquid to litmus paper is ascertained and a small portion evaporated to dryness for preliminary tests. The obvious characters of the substance may suggest the use of certain tests and render others superfluous. Preliminary tests should generally include the following:—

(1) Heat a little in a dry test tube.

If it melts, a large number of salts are at once shown to be absent; the presence of salts of the alkalies or alkaline earth metals is highly probable.

Water may be given off from hydroxides or from hydrated crystalline salts. The drops that collect in the cool part of the tube should be tested with litmus paper.

Charring indicates organic matter, which may be in combination, as a salt of an organic acid, or may be an admixture of some other substance such as sugar.

If gas is evolved it should be identified by simple tests. It may include (*a*) oxygen, re-igniting a glowing splint of wood; from chlorate, etc., nitrate or peroxide. (*b*) Nitrous oxide, be-

ANALYSIS OF METALLIC SALTS IN SOLUTION.

(1) Add dilute HCl, heat and cool again; filter.

Precipitate. Wash with cold water; boil with water and filter, washing with boiling water.

Residue. Wash on the filter with NH_4HO.

Residue. Black indicates Hg (ous)

Filtrate. Acidify with HNO_3; ppt. indicates Ag.

Filtrate. Add K_2CrO_4. Yellow ppt. indicates Pb.

(2) Filtrate. Boil, and pass H_2S through the hot liquid; filter.

Precipitate. Warm with yellow $(NH_4)_2S$; filter.

Residue. Wash, then boil in dilute HNO_3; filter:

Residue. Black indicates Hg (ic).

Filtrate. Add dilute H_2SO_4, concentrate till H_2SO_4 fumes are evolved, dilute and filter.

Ppt. White indicates Pb.

Filtrate. Add NH_4HO; filter.

Ppt. White indicates Bi.

Filtrate. (Blue if Cu is present.) Add excess of KCN, pass H_2S; filter.

Ppt. Yellow indicates Cd.

Filtrate. Boil with dil. H_2SO_4, add K_4FeC_6. Red ppt. indicates Cu.

(3) Filtrate. Acidify with dilute HCl, collect and wash ppt., and boil it with strong HCl; filter.

Residue. Yellow indicates As.

Filtrate. Add Pt foil and Zn.

Black stain on Pt indicates Sb.

Deposit: Boil with strong HCl, filter if necessary; to filtrate, add HgCl. Grey ppt. indicates Sn.

(3a) Filtrate. Evaporate to dryness, ignite residue, dissolve in dilute HCl, add a little HNO_3, and boil. Add NH_4Cl and NH_4HO, boil, filter.

Precipitate. If original solution contains phosphate follow the special method described in notes; if phosphate is absent fuse precipitate with Na_2CO_3 and KNO_3 (or $KClO_4$), boil with water and filter; or boil ppt. with water and Na_2O_2 and filter.

Residue. Brown indicates Fe.

Filtrate. (Yellow if Cr is present.) Warm with NH_4Cl, filter.

Ppt. White indicates Al.

Filtrate. Add $HC_2H_3O_2$ and $Pb(C_2H_3O_2)_2$.

Ppt. yellow indicates Cr.

(3b) Filtrate. Add $(NH_4)_2S$, or pass H_2S; filter.

Precipitate. Treat with cold dilute HCl; filter.

Residue. Dissolve in HCl and $KClO_3$, evap. to dryness; dissolve in H_2O, add KCN in excess, then NaOH and bromine water; boil; filter.

Ppt. Black indicates Ni.

Filtrate. Evaporate and test on borax bead. Blue indicates Co.

Filtrate. Add NaOH, boil, filter.

Ppt. Brown indicates Mn.

Filtrate. Pass H_2S.

Ppt. White indicates Zn.

(4) Filtrate. Add $(NH_4)_2CO_3$, warm; filter.

Precipitate. Dissolve in dilute $HC_2H_3O_2$, add K_2CrO_4, filter.

Ppt. Yellow indicates Ba.

Filtrate. Divide into two portions.

1. Add $CaSO_4$.

Ppt. White indicates Sr.

2. If Sr is absent add $(NH_4)_2C_2O_4$.

Ppt. White indicates Ca. If Sr is present boil with $(NH_4)_2S_2O_3$, filter; to filtrate add $(NH_4)_2C_2O_4$. White ppt. indicates Ca.

(5) Filtrate. Divide into two portions.

Add Na_2HPO_4.

Ppt. White indicates Mg.

Evap. to dryness and expel NH_4 salts by heat; divide into two portions.

Dissolve in little H_2O, add HCl and $PtCl_4$.

Ppt. Yellow indicates K.

Apply flame-test for Na and Li.

having like oxygen but less powerfully; from ammonium nitrate. (*c*) Nitrogen peroxide, recognised by colour and smell; from nitrate. (*d*) Carbon dioxide, giving precipitate in lime water; from bicarbonates or many carbonates. (*e*) Sulphur dioxide, having characteristic smell; from some sulphites, sulphates, and other sulphur compounds. (*f*) Halogens, identified by colour and smell; from haloid salts, together with oxidising and acid substances. (*g*) Ammonia, showing ammonium compounds. (*h*) Sulphuretted hydrogen, from some sulphides and other sulphur compounds. (*i*) Phosphoretted hydrogen, from hypophosphites.

If the substance is volatilised as white fumes, the presence of an ammonium salt is probable.

If no change occurs, a large number of substances are excluded.

(2) Heat another small portion on charcoal in the blow-pipe flame. Alkali salts may melt and run into the charcoal. Chlorate or nitrate causes the charcoal to burn vividly. Many oxides form a white infusible residue. Zinc oxide is yellow while hot, white on cooling; several metals yield residues of characteristic colour.

(3) Mix a little with potassium cyanide and sodium carbonate and heat on charcoal in the reducing blow-pipe flame. Copper (scales) and silver (beads) are reduced to metal without forming an incrustation. Antimony, bismuth, tin, and lead form incrustations as well as metallic beads; the beads may be identified by their physical properties.

(4) If a coloured residue was obtained in (2) make a borax bead, add a little of the substance, and again heat in the oxidising flames. Cobalt gives a blue bead, nickel a red-brown, manganese a violet or lilac, chromium a green, copper green while hot, bluish when cold.

(5) Apply flame test. The following colours are characteristic:—Yellow, sodium; violet, potassium; crimson, lithium or strontium; orange-red, calcium; yellowish-green, barium; green, copper or boric acid; blue, lead, arsenic, bismuth, or copper as chloride.

(6) To a small quantity add dilute sulphuric acid, cold, then heat. Characteristic gases are evolved by carbonate, sulphite, sulphide, cyanide, and nitrite.

(7) To a small quantity add strong sulphuric acid, cold, then heat. Chloride, fluoride, cyanide, and nitrate evolve the respective acids. Bromide gives bromine and iodide gives iodine; formate yields carbon monoxide, oxalate yields carbon monoxide and carbon dioxide. Tartrate chars easily, citrate more slowly, reducing the acid with evolution of sulphur dioxide.

PREPARATION OF THE SOLUTION.

Having gained as much information as possible by these preliminary tests, the substance is next treated with water, first cold, then hot. If it does not dissolve, a little hydrochloric acid is added and the mixture boiled. If an insoluble portion still remains, the liquid is poured or filtered off, and the residue boiled with strong hydrochloric acid. If this fails to dissolve it, aqua regia must be tried. The solution obtained by one of these methods is subjected to the systematic examination for bases as described. Any substance which cannot be dissolved by aqua regia is dried and mixed with about twice its own weight each of dry potassium and sodium carbonates and half as much potassium nitrate, and fused in a crucible till effervescence ceases. On boiling the fused mass in water and filtering, the acids originally present will be found as alkali salts in the filtrate. The insoluble portion will contain carbonates of the metals of the original substance, and is to be dissolved in hydrochloric acid.

EXAMINATION FOR METALS.

In the systematic examination of the prepared solution for metals the following group reagents are employed:—

(1) Hydrochloric acid,
(2) Hydrogen sulphide,
(3a) Ammonium hydroxide,
(3b) Ammonium sulphide,
(4) Ammonium carbonate.

Many other schemes have been proposed and can be actually employed, the use of H_2S being in some dispensed with. The above group reagents are, however, those in general use. Note that ammonium salts are employed because of the ease with which the added reagent may eventually be removed by ignition.

If a precipitate be obtained in applying the group tests to a solution, after filtering it out and before passing on to test for the new group, a portion of the filtrate should always be tested with a little more of the group-reagent that caused the precipitate, to ensure that sufficient has been used to remove the whole of the substances precipitated by it.

FIRST GROUP.

Dilute hydrochloric acid is added to the prepared solution, after which the liquid is heated, cooled, and filtered. On the addition of HCl, AgCl and HgCl are precipitated, being insoluble in weak acid. Some $PbCl_2$, unless the amount of lead salt present be very small, will also be precipitated with AgCl and HgCl, since $PbCl_2$ is only slightly soluble in cold water. The chlorides of the remaining metals (*e.g.*, $SbCl_3$,) are soluble in water or weak acid, and therefore

remain in the filtrate. SbOCl and BiOCl may be precipitated here. The liquid is therefore heated, adding a little more HCl, if necessary, when these oxychlorides redissolve. Cool again before filtering. It is advisable to use *dilute* HCl, for three reasons—

(*a*) Strong acid precipitates various salts if the solutions be fairly strong.

(*b*) AgCl and HgCl are to some extent soluble in strong HCl ; traces might therefore be overlooked.

(*c*) The presence of too much HCl prevents the precipitation of small quantities of some of the metals of the next group.

Silver and mercurous salts are precipitated by H_2S, but their previous separation as AgCl and HgCl simplifies the analysis of the next group. Moreover, H_2S precipitates from mercurous solutions, not the mercurous sulphide (Hg_2S), but a mixture of Hg and HgS. When the portion of the H_2S precipitate insoluble in $(NH_4)_2S$ (*vide* second group) is boiled with HNO_3, the HgS remains insoluble, but any metallic mercury would dissolve and complicate the analysis of the nitric acid solution.

Separation of the Chlorides.

Separation of the three chlorides is effected by (i.) boiling with a considerable quantity of water, which dissolves the $PbCl_2$; (ii.) the insoluble residue of AgCl and HgCl is treated with ammonia, which dissolves (*a*) AgCl, forming a soluble metallo-amine $AgCl(NH_3)_2$, AgCl from which is reprecipitated on adding HNO_3 to the filtrate, and (*b*) converts the HgCl into a black insoluble metallo-amine,

$$2HgCl+2NH_3=NH_2Hg_2Cl+NH_4Cl.$$

It is advisable to treat the AgCl and HgCl with ammonia *on the filter*. so as to remove the soluble silver compound from the insoluble black mercurous amine, which is rather unstable, and yields some metallic mercury by decomposition. If only a small quantity of silver, relative to the amount of mercury, be present, and the mixed chlorides be digested with ammonia in a test tube, this metallic mercury will decompose the silver chloride,

$$AgCl+Hg=HgCl+Ag,$$

and consequently the silver, instead of being found in the ammoniacal filtrate, will be left on the filter (with the mercury compound) as metallic silver.

SECOND GROUP.

Separation of the next group by H_2S requires very careful manipulation to ensure success. The original solution may have been alkaline, neutral or acid ; the filtrate after addition of HCl and separation of AgCl, HgCl, and $PbCl_2$ (partially) will of course be acid. H_2S will therefore only pre-

cipitate those metals whose sulphides are insoluble in weak acids, viz., Hg, Pb, Cu, Cd, Bi, As, Sb, and Sn. The separation of these sulphides by H_2S should be carefully and thoroughly performed, since failure to effect this causes the unseparated portion to appear in the filtrate after treatment with H_2S, and confuses the analysis of the remaining groups. Its proper performance requires time and discretion, and the beginner often finds it tedious. Attention to the following hints will secure satisfactory results. Remember that the sulphides in question are soluble in *strong* HCl; if the solution contains much acid, separation will be slow, and perhaps incomplete. Pass a fairly rapid stream of H_2S into the liquid until it smells strongly of the gas; warm the solution gently and again pass the gas, afterwards raising it to boiling and passing H_2S into it again. Now set it aside for several minutes and filter a little of the supernatant fluid; dilute this with an equal bulk of water, heat it to boiling, saturate with H_2S, and set it aside for five minutes. If no precipitate forms the operation may be regarded as completed, but if any precipitate appears it should be returned to the bulk, the whole diluted with an equal bulk of water and the treatment with H_2S repeated at boiling temperature until a small portion of filtrate gives no further precipitate. Complete precipitation often seems tedious, but it should on no account be scamped. The following points should be remembered:—Lead and mercury give a coloured precipitate when H_2S is first passed into their solutions, double salts (*e.g.*, $HgCl_2HgS$, and $PbCl_2PbS$) being formed, which are completely converted into black sulphides by continued action of the gas. Arsenic, if present as arsenate, is only precipitated as sulphide when the arsenate has been reduced by the H_2S to the arseni*ous* state, and this reaction requires a boiling temperature for its completion. If the solution contained ferric salts, chromic, or nitric acid, these will be reduced by sulphuretted hydrogen, giving a precipitate of sulphur which is easily distinguished from the yellow CdS, and As_2S_3 by its paler colour and density. Ferric salts are reduced to ferrous—

$$2FeCl_3 + H_2S = 2FeCl_2 + 2HCl + S.$$

Chromic acid is reduced to chromium chloride:—

$$2H_2CrO_4 + 3H_2S + 6HCl = Cr_2Cl_6 + 3S + 8H_2O$$

Nitric acid is reduced to nitric oxide:—

$$2HNO_3 + 3H_2S = 2NO + 3S + 4H_2O.$$

Treatment of the Precipitated Sulphides.

The sulphides precipitated from weakly acid hot solutions and allowed to stand filter much more easily than when precipitated from cold neutral solutions without subsequent digestion. Precipitated sulphides exhibit to a marked degree the property of becoming "colloidal," and consequently pass-

ing through the filter paper when all adhering saline matter has been washed away. If H_2S water or very dilute acetic acid be used for washing the precipitate, this tendency is checked. The washed precipitate is now digested with ammonium sulphide, which effects a separation into two portions:—

(A) insoluble in $(NH_4)_2S$—(Hg, Pb, Bi, Cd, Cu),
(B) soluble in $(NH_4)_2S$—(As, Sb, Sn).

The mixture should not be boiled lest some of the sulphides of As, Sb, and Sn are re-precipitated. After digestion for a few minutes, the insoluble portion, if any remains, is separated by filtration and the treatment repeated.

(A) This portion is washed until free from $(NH_4)_2S$, again sub-divided by boiling with dilute nitric acid in which HgS is insoluble, while the sulphides of lead, copper, bismuth, and cadmium dissolve, forming nitrates. If Hg be present, a black residue of HgS will be left. This is filtered out, dissolved in a small quantity of aqua regia, and this solution (which will contain $HgCl_2$) subjected to confirmatory reactions for mercury. This confirmation is necessary for the following reason. When the sulphides insoluble in ammonium sulphide are treated with HNO_3 to form nitrates, H_2S is produced, *e.g.*:—

$$PbS+2HNO_3 = Pb(NO_3)_2+H_2S.$$

The H_2S reacts with the excess of nitric acid to form free sulphur:—

$$3H_2S+2HNO_3 = 3S+2NO+4H_2O,$$

and this sulphur sometimes encloses a portion of the sulphides other than mercury sulphide, and protects them from the action of the nitric acid. A black residue insoluble in HNO, may, therefore, be obtained in the absence of mercury, and should always be further tested.

Treatment of the Nitric Acid Solution.

The nitric acid solution containing $Pb(NO_3)_2$, $Bi(NO_3)_3$, $Cu(NO_3)_2$, and $Cd(NO_3)_2$ may be treated in two ways:—

(*a*) Evaporate to a low bulk, add sufficient dilute sulphuric acid to displace the whole of the nitric acid, and convert the nitrates into sulphates. Continue the evaporation until white sulphuric acid fumes begin to be evolved. This shows that all nitric acid is dissipated, for if this be not accomplished some lead nitrate will remain in solution and interfere with the subsequent detection of cadmium. The sulphates with the excess of sulphuric acid are now allowed to cool, and on the addition of water the sulphates of bismuth, copper, and cadmium, being soluble, may be filtered off from the white insoluble $PbSO_4$. To the solution excess of ammonia is added. Bismuth hydroxide is precipitated, but the copper and

cadmium hydroxides redissolve to form soluble compounds with the ammonia. The bismuth hydroxide is filtered off, washed, and dissolved in the least possible quantity of warm dilute HCl by pouring the latter over the filter and returning the filtrate until all the precipitate has dissolved. The solution contains $BiCl_3$, and on pouring this into a comparatively large volume of water a white cloudy precipitate of oxychloride, BiOCl, is produced. The less acid used for dissolving the hydroxide the more delicate does this reaction become.

The filtrate from the $Bi(OH)_3$ will be blue if copper be present. To this a solution of potassium cyanide is added in excess. This precipitates $CdCy_2$, which combines with excess of KCy to form the soluble double cyanide, K_2CdCy_4-$(2KCy{\cdot}CdCy_2)$. The action of KCy on cupr*ic* solutions is in the main the same, but differs in this. Cupric cyanide is unstable and decomposes into cupr*ous* cyanide and cyanogen,

$$CuSO_4 + 2KCy = CuCy_2 + K_2SO_4$$
$$CuCy_2 = CuCy + CN.$$

The cuprous cyanide dissolves in excess of KCy to form a double cuprous potassium cyanide, which probably has the formula $K_3CuCy_4(CuCy,3KCy)$. This double cyanide is colourless, hence addition of KCy solution decolorises the previously blue copper solution. To separate Cd and Cu use is made of the fact that H_2S decomposes the cadmium potassium cyanide producing a yellow precipitate of CdS, while the cuprous potassium cyanide is unaffected. After separation of cadmium sulphide by H_2S, and removing excess of the latter, the presence of copper in the filtrate may be confirmed by boiling it with dilute sulphuric acid, which expels hydrocyanic acid and forms cupric sulphate (and free copper, since cuprous sulphate immediately decomposes into cupric sulphate and metallic copper),

$$2CuCy + H_2SO_4 = Cu_2SO_4 + 2HCy$$

Cupr*ous* cyanide. Cupr*ous* sulphate.

$$Cu_2SO_4 = CuSO_4 + Cu,$$

and the original blue colour of the solution reappears. To this the usual confirmatory reactions for copper may be applied.

(*b*) An alternative method for the treatment of the solution of copper, cadmium, lead and bismuth nitrates is to precipitate lead and bismuth together as hydroxides with ammonia. The mixed hydroxides are dissolved by nitric acid to form nitrates, in which solution bismuth is detected by the formation of oxynitrate and lead as sulphate.

Sulphides Soluble in $(NH_4)_2S$.

(B) The filtrate obtained after treatment of the whole H_2S precipitate with ammonium sulphide solution may contain

arsenic, antimony, and tin. As_2S_3, Sb_2S_3 (with some Sb_2S_5, if antimonic compounds were present in the original solution), SnS from stannous and SnS_2 from stannic compounds are precipitated by H_2S. The treatment with ammonium sulphide results in the formation of soluble ammonium thio-compounds of As, Sb, and Sn, the lower sulphides As_2S_3, Sb_2S_3, and SnS first taking up sulphur (from the polysulphide present in the ammonium sulphide solution) to form As_2S_5, Sb_2S_5, and SnS_2. These sulphides unite with ammonium sulphide to form various compounds, of which the following may be taken as typical:—

$$Sb_2S_5 + 3(NH_4)_2S = 2(NH_4)_3SbS_4,$$

Ammonium thio-antimonate.

$$SnS_2 + (NH_4)_2S = (NH_4)_2SnS_3,$$

Ammonium thio-stannate.

The filtrate is now warmed with *weak* hydrochloric acid (if strong acid be used, some antimony sulphide may be dissolved). This re-precipitates the sulphides, which are to be filtered off and washed free from soluble ammonium compounds. The re-precipitation of these sulphides is due to the instability of the free acids (formed by addition of HCl), corresponding to the ammonium thio-compounds just mentioned.

$$\text{(i.)}\ (NH_4)_2SnS_3 + 2HCl = H_2SnS_3 + 2NH_4Cl.$$
$$\text{(ii.)}\ H_2SnS_3 = H_2S + SnS_2.$$

Compare this with the action of an acid on a carbonate, *e.g.*—

$$\text{(i.)}\ CaCO_3 + 2HCl = H_2CO_3 + CaCl_2.$$
$$\text{(ii.)}\ H_2CO_3 = H_2O + CO_2.$$

In the latter case we have unstable carbonic acid liberated, which decomposes into anhydride (CO_2) and water. In the former an unstable thio-acid is liberated, which decomposes into thio-anhydride (SnS_2) and H_2S, the sulphur analogue of water. These reactions show the strong analogy of sulphur to oxygen. The precipitate will contain the higher sulphides As_2S_5, SnS_2, and Sb_2S_5, the last decomposing to some extent into sulphur and the lower sulphide; some sulphur will also be present from the decomposition of polysulphide by the HCl. Separation may be effected (i.) by boiling with strong hydrochloric acid, which dissolves tin and antimony sulphides, forming chlorides and leaving yellow arsenic sulphide insoluble, or (ii.) by warming with solution of ammonium carbonate which has just the reverse effect, sulphides of tin and antimony being insoluble in this reagent (some SnS_2 will dissolve if the mixture be boiled), while As_2S_5 dissolves, forming a mixed compound, intermediate between an arsenate and thio-arsenate, carbonic acid being evolved.

In case (i.) confirmatory tests for arsenic are applied to the insoluble portion, while the HCl solution is well diluted and

poured into a dish containing a piece of platinum foil and a fragment of zinc. The zinc-platinum couple reduces the antimony and tin to the metallic state, the former being mostly deposited on the platinum as a black film while the tin appears as a flocculent precipitate. After fifteen minutes the platinum is removed and confirmatory tests for antimony applied to the black coating. Any zinc remaining is carefully removed or dissolved by the addition of a little more *dilute* HCl and the fluid carefully decanted from the flocculent deposit. The latter is carefully drained and boiled with a *small quantity* of strong HCl, which dissolves the tin, forming stannous chloride. Any black insoluble residue should be examined for antimony. The hydrochloric solution is now freely diluted in a white porcelain basin, and H_2S passed into it—brown stannous sulphide, SnS, is precipitated, very small quantities being detected by contrast with the white porcelain, or any of the reduction reactions for $SnCl_2$, *e.g.*, heating with $HgCl_2$ may be employed instead of H_2S. Remember that both tin and its sulphide are insoluble in *weak*, but soluble in strong HCl.

If ammonium carbonate be used for the separation of As from Sb and Sn, the insoluble portion is well washed, dissolved in strong HCl, and the diluted solution treated with zinc and platinum, as described above.

Tests for Phosphates, Oxalates, etc.

The filtrate and washings from the group precipitate produced by H_2S are usually rather voluminous. They should be united and concentrated by careful evaporation to a small volume. The solution will contain now only the salts of those metals whose sulphides are soluble in dilute acids or water. Before proceeding further it is necessary to test for the presence of organic matter, oxalates and phosphates, the reason being that citrates, tartrates, and some other organic substances prevent, more or less completely, the precipitation of iron, aluminium, and chromium by ammonia; and phosphates or oxalates, which are only kept in solution by the presence of acid, will be precipitated on the addition of ammonia, and will complicate and render difficult the identification of the normal constituents of this precipitate. Organic matter and oxalates should have been detected in the preliminary tests. If present, they may be destroyed by evaporating the solution to dryness and incinerating the residue, and then dissolving the ash with the aid of acid, filtering from any silica that may remain, and proceeding to apply the systematic tests to the solution. Phosphate is to be tested for by adding a little of the solution to a solution of ammonium molybdate with excess of nitric acid and heating gently. A yellow precipitate indicates phosphate; in this case a special method must be adopted, as will be explained.

In the absence of phosphates, and organic matter, if present, having been removed by burning, nitric acid is added, and the mixture boiled to convert ferrous iron to the ferric condition. If iron be absent, the nitric acid treatment may be omitted. This may easily be determined by testing a drop of the concentrated fluid on a white plate with ferricyanide of potassium. If iron be present it is necessary to convert it into ferric salt, because ferrous iron is incompletely precipitated by ammonia. In order to avoid using an unnecessarily large quantity of nitric acid, and so overloading the solution with reagents, it is advisable to add a few drops at a time, boiling and testing the solution after each addition until no more ferr*ous* iron can be detected by the formation of a blue colour when a drop of the solution is mixed on a white plate with a drop of weak *freshly* made solution of potassium ferricyanide. Old solutions of this salt give a blue colour with both ferrous and ferric salts.

THIRD GROUP—DIVISION A.

To the liquid resulting from the treatment just described, add NH_4Cl and NH_4HO, boil, and filter. The ammonia precipitates iron, aluminium, and chromium as hydroxides insoluble in excess. Although nickel, cobalt, manganese, and zinc form hydroxides insoluble in water, they are not precipitated here, owing to their solubility in excess of ammonia. Magnesium is also *partly* precipitated as magnesium hydroxide by ammonia when the latter is added to a neutral solution of magnesium salt.

$$MgCl_2 + 2NH_4OH = Mg(OH)_2 + 2NH_4Cl.$$

This precipitation only occurs to the extent of half the magnesium present, because the ammonium salt formed, as shown in the above equation, unites with the other half to form a double magnesium-ammonium salt, which is not precipitated by ammonia. The following equation, therefore, more nearly represents the action of ammonia on a *neutral* solution of magnesium salt:—

$$2MgCl_2 + 2NH_4OH = MgCl_2{\cdot}2NH_4Cl + Mg(OH).$$

If, however, ammonia be added to an acid solution of a magnesium salt, the ammonium salt first formed by the neutralization of the acid prevents the precipitation of the magnesium by the further addition of ammonia, if sufficient acid be present. This is usually the case with the filtrate from the H_2S precipitate, but in order to make certain that the precipitation of magnesium hydroxide shall not occur, some solution of ammonium chloride should be added before the ammonia. On the addition of ammonia under the conditions described, the hydroxides of iron (ferric), aluminium, and

chromium are precipitated. The mixture is boiled, since the latter two are incompletely precipitated in the cold and in presence of excess of ammonia.

Separation of the Metals of Group 3a.

The precipitate is collected, washed, and dried. The hydroxides lose water and are converted into oxides, Fe_2O_3, Al_2O_3, Cr_2O_3. The dried oxides are fused with sodium carbonate and potassium nitrate (or chlorate). The iron oxide is unaffected by this treatment, and remains as an insoluble reddish-brown powder. The aluminium oxide combines with the alkali to form a soluble sodium or potassium aluminate—

$$Al_2O_3 + K_2CO_3 = 2KAlO_2 + CO_2.$$

The chromic oxide also unites with the alkali in presence of oxidising agents, like KNO_3 or $KClO_3$, to form yellow potassium chromate, K_2CrO_4.

(i.) $Cr_2O_3 + 3O = 2CrO_3.$
(ii.) $CrO_3 + K_2CO_3 = K_2CrO_4 + CO_2.$

The fused mass is, therefore, boiled with water, any ferric oxide filtered out, and the filtrate divided into two parts. One part is examined for aluminium by adding an excess of ammonium chloride. This decomposes the potassium aluminate—the reaction being hastened by warming—and a precipitate of hydrated aluminium oxide, $Al_2O_3 2H_2O$ or $Al_2O(OH)_4$, is produced. This hydrated oxide is rather denser than the gelatinous normal aluminium hydroxide, $Al_2(OH)_6$, precipitated by addition of ammonia to solutions of ordinary aluminium salts.

$$2KAlO_2 + 2NH_4Cl = Al_2O_3 + 2KCl + 2NH_3 + H_2O$$

A relatively large amount of ammonium chloride is required for this reaction, because a considerable quantity of potassium carbonate has been used in the formation of the aluminate by fusion, and the excess of K_2CO_3 uses up ammonium chloride—

$$K_2CO_3 + 2NH_4Cl = 2KCl + (NH_4)_2CO_3.$$

Instead of adding ammonium chloride, one can add hydrochloric acid until a distinctly acid reaction is obtained after warming. This decomposes the aluminate, forming aluminium and potassium chlorides—

$$2KAlO_2 + 8HCl = Al_2Cl_6 + 2KCl + 4H_2O$$

By now adding ammonia a gelatinous precipitate of aluminium hydroxide is obtained—

$$Al_2Cl_6 + 6NH_4OH = Al_2(OH)_6 + 6NH_4Cl$$

The portion of the fluid reserved for the detection of chromium will be yellow from the presence of potassium chromate

if this element be present. Confirmation of this is obtained by adding acetic acid to a faint acid reaction to convert the excess of alkali carbonate to acetate, and then solution of lead acetate: a yellow precipitate of lead chromate will be obtained—

$$K_2CrO_4 + Pb(C_2H_3O_2)_2 = PbCrO_4 + 2KC_2H_3O_2.$$

It is necessary to convert the carbonate of potassium into acetate before adding the lead solution, otherwise a white precipitate of lead carbonate will be obtained. If manganese be present in the original solution the fused mass obtained by heating the group precipitate with alkali carbonate and nitrate will be green from the formation of potassium manganate. For although the manganous hydroxide precipitated by ammonia is soluble in excess of this reagent, particularly in presence of ammonium salts, during the heating and filtration (after addition of ammonia) to separate the hydroxides of iron, aluminium, and chromium, some of the manganous salt becomes oxidised to mangano-manganic oxide, Mn_2O_3, which, being insoluble in ammonia, is precipitated along with the iron, aluminium, and chromium. When this precipitate is dried and fused with alkali carbonate and nitrate, the manganese oxide (compare Cr_2O_3) is oxidised and combines with some of the alkali, forming green potassium manganate, K_2MnO_4, which dissolves in water and interferes with the reactions for the detection of aluminium and chromium. If a green solution is obtained here, the alkaline solution before acidifying is heated and treated drop by drop with alcohol until the green colour is just removed. The manganate is reduced by the alcohol, aldehyde being formed, and the manganese is re-precipitated as Mn_2O_3.

$$2K_2MnO_4 + 3C_2H_6O =$$
$$4KOH + Mn_2O_3 + 3C_2H_4O + H_2O.$$

The brown precipitate of Mn_2O_3 should be filtered out and the filtrate tested as described for aluminium and chromium. Instead of fusing the hydroxides of Al, Cr, and Fe with alkali and an oxidiser, they may be boiled with sodium peroxide. The separation of the three follows the same lines as when fusion is employed.

Special Method—Phosphate Present.

If the molybdate test, applied before separating the third group, showed any phosphate to be present, the procedure must be as follows:—Ammonium chloride and ammonia are added, and any precipitate is collected and washed, the filtrate being set aside to test for Group 3b. The ammonia precipitate is dissolved in a little warm dilute HCl, and the solution nearly neutralised with Na_2CO_3. A mixture of

sodium acetate and acetic acid is then added, and the solution boiled and filtered.

The precipitate may contain phosphates of Al, Cr, and Fe, since these are insoluble in hot dilute acetic acid. Phosphates of the other metals of this group and of Group 3b are not now precipitated, being soluble in dilute acetic acid. The precipitate is boiled with water and a little sodium peroxide, Na_2O_2. Chromium is thus oxidised to chromate, colouring the solution yellow; after filtering this may be confirmed by adding acetic acid and lead acetate. Iron remains undissolved, and is confirmed by dissolving in HCl and adding K_4FeCy_6. Aluminium will exist as sodium aluminate in the filtrate from the iron and be precipitated by adding NH_4Cl.

Having thus removed the Fe, Al, and Cr, the filtrate from the sodium acetate treatment must be tested to see if it still contains phosphate. To a small quantity of it $FeCl_3$ is added drop by drop. If no precipitate is produced, but the liquid becomes brownish, no phosphate remains. To the remainder of the liquid NH_4Cl and NH_4HO are added. If the amount of phosphate originally present was not sufficient to combine with the whole of these metals, the remainder is now precipitated, and from this point the analysis is continued exactly as if phosphate had not been present.

If, on the other hand, the addition of $FeCl_3$ to a small quantity of the filtrate produces a whitish precipitate, this shows that phosphate is still contained in the liquid. The whole of it is now treated with $FeCl_3$, adding the latter until a brown colour begins to be formed. On now boiling and filtering the whole of the phosphate will be left on the filter as ferric phosphate, together with a small quantity of ferric oxyacetate from the excess of iron used. The precipitate is thrown away, and the filtrate is now treated with ammonium sulphide. From this point the analysis proceeds as if phosphate had not been present.

THIRD GROUP.—DIVISION B.

To the alkaline filtrate from the Group 3a precipitate, ammonium sulphide is added. This precipitates nickel, cobalt, manganese, and zinc as sulphides, these being insoluble in water or alkali. If we suppose these four metals to be present as chlorides, and let M stand for Ni, Co, Mn, or Zn, the following equation represents the reaction:—

$$MCl_2 + (NH_4)_2S = MS + 2NH_4Cl.$$

They were not precipitated by sulphuretted hydrogen, because this reagent was applied in presence of free hydrochloric acid. Addition of great excess of ammonium sulphide should be avoided, because nickel sulphide dissolves to some extent under these conditions. When this occurs the filtrate is brownish-black. If a brown filtrate is obtained it must be boiled to remov the excess of ammonium sulphide

when the black nickel sulphide is usually deposited. If, after boiling, the filtrate is not colourless, add hydrochloric acid until a faint acid reaction is obtained, and boil again. This should effect the entire removal of nickel.

Separation of the Metals of Group 3b.

The separation of these four sulphides may be effected in several different ways. The simplest method is perhaps to treat them with *cold dilute* hydrochloric acid, which dissolves MnS and ZnS, forming the corresponding chlorides, $MnCl_2$ and $ZnCl_2$. Shake the mixture for some time—*without warming*—and then filter—the filtrate contains the manganese and zinc chlorides, while the black sulphides of nickel and cobalt remain on the filter. Note that NiS and CoS are not precipitated by sulphuretted hydrogen from solutions of nickel and cobalt salts in presence of free hydrochloric acid; when precipitated from alkaline solutions, however, they do not redissolve in *cold dilute* HCl, but if the acid be strong, or *hot* dilute acid be employed, they do dissolve. The filtrate containing the manganese and zinc is now well boiled to remove every trace of sulphuretted hydrogen formed by the solution of the sulphides:—

$$MnS + 2HCl = MnCl_2 + H_2S.$$
$$ZnS + 2HCl = ZnCl_2 + H_2S.$$

The fluid thus freed from H_2S is now *cooled*, and then caustic potash in excess is added. The zinc hydroxide first produced dissolves in the excess of KOH, forming a soluble zincate of potassium:—

$$\text{(i.)}\ ZnCl_2 + 2KOH = Zn(OH)_2 + 2KCl.$$
$$\text{(ii.)}\ Zn(OH)_2 + 2KOH = K_2ZnO_2 + 2H_2O,$$
$$(ZnO,H_2O)\quad (K_2O,H_2O)\quad (K_2O,ZnO).$$

As zinc carbonate would not re-dissolve, it is important that the KOH used should be free from carbonate. The manganous hydroxide is precipitated, being insoluble in the excess of potassium hydroxide, but quickly absorbing oxygen becomes converted chiefly into brown mangano-manganic oxide, Mn_2O_3. This precipitate must be filtered off and tested by confirmatory reactions for manganese, *e.g.*, fusion on platinum with potassium carbonate and nitrate to form green potassium manganate. Ammonium sulphide is added to the alkaline filtrate containing the zinc. This precipitates zinc sulphide, since ZnS is insoluble in alkali. Zinc and manganese may also be separated by taking advantage of the solubility of MnS and insolubility of ZnS in acetic acid. This may be utilised in two ways:—Either the precipitated sulphides are treated with acetic acid, or H_2S is passed through the solution containing the two metals in presence of free acetic acid (not hydrochloric acid, which prevents the precipitation of both MnS and ZnS).

The portion not dissolved by cold dilute HCl may contain NiS and CoS. This is dissolved in hot strong HCl, with the addition of a fragment of $KClO_3$, and the solution evaporated to dryness, leaving the metals as chlorides. This residue is now tested with the borax bead. If indications of nickel only are obtained it is only necessary to apply confirmatory tests to the residue, as cobalt must be absent; if, on the other hand, a blue bead is obtained, cobalt is present, and nickel must also be looked for, as the colour it gives to the bead is quite masked by the stronger cobalt colour. In this case the residue is dissolved in water, and solution of potassium cyanide added until the precipitate at first formed redissolves. Then add sodium hydroxide in excess, and bromine water or sodium hypochlorite, and boil. Nickel is precipitated as black hydroxide $Ni(OH)_3$, while cobalt remains in solution.

Potassium cyanide at first forms nickel cyanide and cobalt cyanide, which dissolve in more of the reagents forming double cyanides $NiCy_2$, 2KCy, and $CoCy_2$, 4KCy (or K_4CoCy_6, potassium cobaltocyanide, like ferrocyanide, K_4FeCy_6). On boiling these double salts with alkali and an oxidising agent, the nickel salt is decomposed, and the black hydroxide $Ni(OH)_3$ (also regarded as hydrated sesquioxide, $Ni_2O_3 \cdot 3H_2O$) is thrown down; the cobalt compound also undergoes oxidation, but the cobalt remains in solution as potassium cobalticyanide, K_3CoCy_6.

$$NiCy_2, 2KCy + 3NaOH + Br = 2KCy + Ni(OH)_3 + 2NaCy + NaBr.$$

$$K_4CoCy_6 + Br = K_3CoCy_6 + KBr.$$

FOURTH GROUP.

The filtrate from Group 3b is concentrated and the fourth group (barium, strontium, and calcium) precipitated as carbonates by addition of ammonium carbonate. Magnesium carbonate, although insoluble in water, is not precipitated here on account of the formation of soluble double magnesium-ammonium compounds, as already mentioned. The exact separation of the fourth group requires care for its successful performance, for the following reason:—when ammonium carbonate is added, the following reaction takes place, M standing for any one of the three metals Ba, Ca, or Sr—

$$MCl_2 + (NH_4)_2CO_3 = MCO_3 + 2NH_4Cl.$$

If the mixture be boiled the reaction is partly reversed, particularly in presence of large excess of ammonium salts, and this latter condition always occurs at this stage of analysis, because of the previous use of ammonium salts for the separation of the preceding groups. This reversed reaction is exhibited, for example, by calcium carbonate—

$$CaCO_3 + 2NH_4Cl = CaCl_2 + (NH_4)_2CO_3.$$

The liquid after addition of ammonium carbonate should be, therefore, only slightly warmed to promote the aggregation

of the precipitated carbonates into a sandy crystalline condition, so as to render their separation and washing easy, but *not boiled*. If the mixture be boiled, a portion of the precipitated carbonates undergoes the reverse reaction already mentioned. The barium, strontium, or calcium chloride so formed, being soluble, will go into the filtrate and will form a precipitate and be mistaken for magnesium when sodium phosphate is added for the detection of that metal.

Separation of the Metals of Group IV.

The carbonates of barium, strontium, and calcium are now dissolved in acetic acid, acetates of the metals being formed and carbon dioxide evolved.

$$MCO_3 + 2HC_2H_3O_2 = M(C_2H_3O_2)_2 + H_2O + CO_2.$$

Barium is separated as chromate by addition of (neutral) potassium chromate—

$$Ba(C_2H_3O_2)_2 + K_2CrO_4 = BaCrO_4 + 2KC_2H_3O_2,$$

barium chromate being insoluble in water or acetic acid. Strontium chromate is only slightly soluble in water, but more easily in presence of the excess of acetic acid used in dissolving the carbonates, while calcium chromate is easily soluble in water only. Strontium and calcium will, therefore, be found in the filtrate from the yellow barium chromate. The exact separation of these two metals is rather tedious, but a simple method sufficient for most purposes is as follows. To a *small portion* of the filtrate some saturated solution of calcium sulphate is added, and the mixture set aside for some time. If strontium be present a precipitate of $SrSO_4$ will be obtained, since it is much less soluble (1 in 77,000) than $CaSO_4$ (1 in about 400).

$$Sr(C_2H_3O_2)_2 + CaSO_4 = SrSO_4 + Ca(C_2H_3O_2)_2.$$

In this case the reserved portion of the filtrate is treated with dilute sulphuric acid and set aside to allow the complete deposition of the strontium sulphate.

$$Sr(C_2H_3O_2)_2 + H_2SO_4 = SrSO_4 + 2HC_2H_3O_2.$$

This precipitate will include some calcium sulphate if the quantity of calcium salt present amounts to enough to reach the limit of solubility of the calcium sulphate.

$$Ca(C_2H_3O_2)_2 + H_2SO_4 = CaSO_4 + 2HC_2H_3O_2.$$

In any case, however, *all* the calcium sulphate does not come down on account of its slight solubility in water, and, if it is present at all, sufficient will always be found in the filtrate from the strontium precipitate to yield a precipitate of calcium oxalate on the addition of ammonium oxalate and ammonia, since calcium oxalate is practically quite insoluble in water, ammonia, or acetic acid.

$$CaSO + (NH_4)_2C_2O_4 = CaC_2O_4 + (NH_4)_2SO_4.$$

FIFTH GROUP.

The filtrate from the fourth group contains now only salts of magnesium, potassium, sodium, and ammonium. (Since the group precipitants added in the course of analysis have been ammonium compounds, the presence of ammonia must be determined by examination of the original substance.) This filtrate is divided into two portions, one larger than the other. To the smaller portion sodium phosphate is added. If magnesium be present a *crystalline* precipitate of ammonio-magnesium phosphate is obtained.

$$MgCl_2 + Na_2HPO_4 + NH_4OH = MgNH_4PO_4 + 2NaCl + H_2O.$$

Since this compound is much less soluble in water containing free ammonia, some solution of ammonia is added. The precipitate appears in dilute solutions only on standing, and any small precipitate obtained, not distinctly crystalline, should be viewed with suspicion, since it may be due to traces of calcium, etc., not completely precipitated in the previous group. The larger portion of the filtrate from the fourth group is evaporated to dryness and ignited to remove the ammonium salts, since these form also an insoluble double chloride with platinum perchloride. The ignited residue, therefore, may contain magnesium (whose presence is determined by examination of the other portion), potassium and sodium and lithium. Part of it is dissolved in the least possible quantity of water, the solution placed in a watch-glass, acidulated with hydrochloric acid, and platinum perchloride added; a yellow precipitate of double chloride of platinum and potassium, $K_2PtCl_4 = 2KCl \cdot PtCl_4$, is obtained if potassium be present. The presence of sodium or lithium is shown by applying the flame-test to the residue from ignition. If neither magnesium, potassium, nor sodium be present, the filtrate from the fifth group will contain nothing but the excess of ammonium salts used as group reagents; when evaporated and ignited it therefore leaves no residue.

The accompanying tabular arrangement recapitulates the systematic tests necessary for separation of the metals from one another; in some cases a method mentioned in the table is an alternative to the one given in these notes.

It must be noted that while the tests given suffice for *separation*, confirmatory tests of the identity of each metal separated must always be applied.

EXAMINATION FOR ACIDS.

When the metal or metals in the substance under examination have been found, careful consideration of the solubility of the substance in water and in acids will usually give information as to what acids can and cannot be present. If the preliminary tests have been carefully carried out, also, most

of the common acids will have disclosed their presence. The tests which are specially serviceable for this purpose are the heating alone, and with dilute and strong sulphuric acid.

It is often advantageous to remove heavy metals before testing for acids. This is done by boiling the salt with slight excess of Na_2CO_3, filtering, neutralising the filtrate with HNO_3, and employing this for the tests. But it is not necessary to do this in all cases, and when the metals have been found it will usually be possible to decide whether anything is to be gained by their removal.

The reagents which are of greatest service in identifying acid radicals are barium chloride and silver nitrate. According to their behaviour with these substances, the ordinary acids may be divided into five groups (the reagents to be added to *neutral* solutions).

A. Barium chloride gives no precipitate.

(1) Silver nitrate gives a precipitate insoluble in nitric acid and coloured as follows: —

Chloride, white.
Bromide, yellowish white.
Iodide, light yellow.
Cyanide, white.
Ferrocyanide, white.
Ferricyanide, orange yellow.
Hypochlorite, white.
Thiocyanate, white.

(2) Silver nitrate gives a precipitate, soluble in nitric acid, and coloured as follows: —

Nitrite, white.
Hypophosphite, white becoming brown, then black, on warming.
Sulphite, white.
Sulphide, black.

B. Barium chloride gives a white precipitate, soluble in nitric acid. Silver nitrate gives a precipitate, soluble in nitric acid, and coloured as follows: —

Phosphate, yellow.
Arsenate, chocolate.
Pyrophosphate, white.
Arsenite, yellow.
Metaphosphate, white.
Chromate, red.
Phosphite, white, becoming black on heating.
Silicate, orange.
Iodate (soluble with difficulty in HNO_3).
Thiosulphate, brown.
Borate, white.
Carbonate, white.

C. Barium chloride gives a white precipitate, insoluble in nitric acid. Silver nitrate gives no precipitate.

Sulphate.
Fluoride.

D. Neither barium chloride nor silver nitrate gives a precipitate.

Nitrate, chlorate, perchlorate, permanganate, formate, acetate.

The acids of the last group must, of course, be tested for individually. Appropriate confirmatory tests should also be employed to identify completely the acids comprised in all the above groups. For details of these individual tests reference should be made to one of the text-books recommended.

INTERNATIONAL ATOMIC WEIGHTS (1907), WITH NAMES AND SYMBOLS OF THE ELEMENTS.

H = 1·008; O = 16·00.

Aluminium ..	Al	27·1	Neodymium ..	Nd	143·6
Antimony	Sb	120·2	Neon	Ne	20
Argon	A	39·9	Nickel	Ni	58·7
Arsenic	As	75·0	Nitrogen	N	14·01
Barium	Ba	137·4	Osmium	Os	191
Bismuth	Bi	208·0	Oxygen	O	16·00
Boron	B	11·0	Palladium	Pd	106·5
Bromine	Br	79·96	Phosphorus ..	P	31·0
Cadmium	Cd	112·4	Platinum	Pt	194·8
Cæsium	Cs	132·9	Potassium	K	39·15
Calcium	Ca	40·1	Praseodymium	Pr	140·5
Carbon	C	12·00	Radium	Rd	225
Cerium	Ce	140·25	Rhodium	Rh	103·0
Chlorine	Cl	35·45	Rubidium	Rb	85·5
Chromium	Cr	52·1	Ruthenium ..	Ru	101·7
Cobalt	Co	59·0	Samarium	Sa	150·3
Columbium ..	Cb	94	Scandium	Sc	44·1
Copper	Cu	63·6	Selenium	Se	79·2
Erbium	Er	166	Silicon	Si	28·4
Europium	Eu	152	Silver	Ag	107·93
Fluorine	F	19·0	Sodium	Na	23·05
Gadolinium ..	Gd	156	Strontium	Sr	87·6
Gallium	Ga	70	Sulphur	S	32·06
Germanium ..	Ge	72·5	Tantalum	Ta	181
Glucinum	Gl	9·1	Tellurium	Te	127·6
Gold	Au	197·2	Terbium	Tb	159·2
Helium	He	4·0	Thallium	Tl	204·1
Hydrogen	H	1·008	Thorium	Th	232·5
Indium	In	115	Thulium	Tm	171
Iodine	I	126·97	Tin	Sn	119·0
Iridium	Ir	193·0	Titanium	Ti	48·1
Iron	Fe	55·9	Tungsten	W	184
Krypton	Kr	81·8	Uranium	U	238·5
Lanthanum ..	La	138·9	Vanadium	V	51·2
Lead	Pb	206·9	Xenon	Xe	128
Lithium	Li	7·03	Ytterbium	Yb	173·0
Magnesium ..	Mg	24·36	Yttrium	Yt	89·0
Manganese	Mn	55·0	Zinc	Zn	65·4
Mercury	Hg	200·0	Zirconium	Zr	90·6
Molybdenum ..	Mo	96·0			

VOLUMETRIC ANALYSIS.

Note.

Throughout this article the atomic weights employed are those adopted by the International Committee (1907), according to which oxygen = 16, and hydrogen = 1·008; these are now in general use by chemists. They differ somewhat from those given in the British Pharmacopœia, in which hydrogen = 1.

Introductory.

Among all the various methods of examining chemical substances that are used in medicine for the purpose of ascertaining whether they are of the proper strength and degree of purity, none is of more importance than the general method known as volumetric analysis. Harmful impurities may, of course, be looked for by applying the special tests for each in turn; but if all such have been proved absent, it by no means follows that the substance under examination is fit for use. Perfectly harmless impurities, such as water, may be present in sufficient quantity to very materially reduce the strength, and therefore the value, of the chemical in question. An illustration of this is afforded by sodium bromide; this salt may be obtained, by slight variation in the conditions of manufacture, as the anhydrous substance NaBr, and also as the hydrated salt $NaBr,2H_2O$. The latter contains only 74·1 per cent. of real sodium bromide; but if supplied for medicinal use and submitted to only qualitative tests for impurities, it would pass all the requirements in this respect of the Pharmacopœia; while, if dispensed in medicine, the patient would receive only three-quarters of the intended dose. It is necessary, therefore, to supplement qualitative tests for impurities by a quantitative test to show exactly what percentage of the true substance is present; and for this reason the Pharmacopœia characters and tests for the various definite chemical substances that are official include in nearly all cases qualitative and quantitative tests.

Quantitative tests may be applied by two general methods, known as gravimetric and volumetric; in the former, or measurement by weighing, a known quantity of the material under examination is treated in such a way that the whole of the ingredient which it is desired to measure is converted into some substance which, from its insolubility or some other property, can be easily collected and freed from impurity; this newly formed substance is then weighed, and from its weight the weight of the substance from which it is

formed is found by a simple calculation. In the instance already referred to—viz., sodium bromide—if a weighed quantity of the salt is dissolved in water and solution of silver nitrate and a little nitric acid are added, all the bromide present is converted to silver bromide, which is insoluble; this precipitate is then collected, washed to free it from the substances remaining in solution, dried and weighed. The molecular weight of silver bromide is 187·89, and one molecule is formed from one molecule of sodium bromide, of molecular weight 103·01; therefore the weight of silver bromide obtained, multiplied by the fraction $\frac{10301}{18789}$, gives the exact weight of real sodium bromide present in the weight of the salt taken for the test. But one molecule of sodium bromide, in forming one molecule of silver bromide, must react with one molecule of silver nitrate, of which the molecular weight is 169·94; therefore it is clear that if we knew, not the weight of silver bromide formed, but the weight of silver nitrate used up in forming it, we could equally well calculate the weight of the sodium bromide. And if the silver nitrate is added in the form of a solution of which we know the strength, and added in such a way that only just enough is used to react with the sodium bromide, and the quantity added can be accurately measured, we then have all the data necessary for finding how much silver nitrate has been used up, and how much real sodium bromide was present. The method here outlined is the volumetric method, or method of measurement by volume.

The exact measurement of the solution used is obtained by adding it from a burette, a graduated tube with a tap at the lower end. The strength of the solution used is fixed by dissolving an accurately weighed quantity and making up the solution to an accurately measured volume; the only other matter to provide for is some indication of the exact point at which just enough and not too much of the silver solution has been added. The method of doing this will be explained later; enough has been said to show that volumetric methods are usually much simpler and much more expeditious than gravimetric methods; the official tests can only be carried out when some familiarity with volumetric analysis has been attained; and the matter certainly does not lose in interest for students from the fact that this section of work is specifically mentioned in the Minor syllabus. It is not proposed here to attempt a complete or exhaustive treatise on the subject, for which a text book should be studied, but to give such directions and explanations as will enable apprentices and other students with limited opportunities to understand and "perform those volumetric determinations which are described in the British Pharmacopœia."

Apparatus and Chemicals.

It will not be necessary to provide much apparatus; a burette with glass tap, holding 50 mils (C.c.) and graduated in tenths of a mil, and a burette stand, are of course required and two or three stoppered flasks holding an exact volume when filled to the mark on the neck, for which convenient sizes will be 500, 250, and 100 Ml. In addition, a 500 Ml. graduated stoppered cylinder is a convenience, and one or two small flasks or beakers and porcelain dishes will be wanted to contain the reacting solutions in any determination that is made. In addition to the ordinary chemicals that are at hand in every pharmacy, small quantities of methyl orange and phenol-phthalein should be obtained; an eighth of an ounce of each will last a long time.

Normal and Decinormal Solutions.

The principle on which volumetric analysis depends has already been given in general terms, and may now be discussed rather more fully. The substance to be analysed is acted on by some reagent with which it will combine or otherwise react, this reagent being added from the burette in the form of a solution of known strength; by reading the height of liquid in the burette before and after reaction, the volume that has been used is ascertained. The solution is usually so prepared that 1 litre (1,000 Ml.) contains one equivalent in grammes of the active substance. The "equivalent" of an element, it will be remembered, is that number of parts by weight of the element which will combine with, or replace in a compound, one part by weight of hydrogen; and, similarly, the "equivalent" of a compound is that number of parts by weight which contain an "equivalent" of the element which will take the chief part in the reaction that is to be made use of. An example will make this more clear; the equivalent of sodium (in this case identical with the atomic weight) is 23·05; and since "parts by weight" are to be grammes, a solution for volumetric work, in which sodium is to be the active element, must contain 23·05 grammes of that element in every 1,000 Ml. The molecular formulæ of compounds are convenient for showing what weights are equivalents; thus, sodium hydroxide, NaOH, has the molecular weight 23·05 + 16 + 1·008 = 40·06. Anhydrous sodium carbonate, Na_2CO_3, has the molecular weight 46·1 + 12 + 48 = 106·1. Sodium bicarbonate, $NaHCO_3$, has the molecular weight 23·05 + 1·008 + 12 + 48 = 84 = 84·06. The first and last of these compounds each contain one atom of sodium in the molecule, while the second contains two; the equivalents are, therefore,

sodium hydroxide 40·06, sodium carbonate $\frac{106·1}{2} = 53·05$ sodium bicarbonate 84·06. Solutions containing these amounts respectively in one litre are known as *normal* solutions; solutions of one-tenth of this strength are very frequently used, and are called *decinormal;* and weaker solutions are sometimes used for certain purposes.

The Process of Titration.

If any one of these solutions is added to some sulphuric acid until the whole of it is neutralised, the following equations—

$$H_2SO_4 + 2NaOH = Na_2SO_4 + 2H_2O$$
$$H_2SO_4 + Na_2CO_3 = Na_2SO_4 + H_2O + CO_2$$
$$H_2SO_4 + 2NaHCO_3 = Na_2SO_4 + 2H_2O + 2CO_2$$

show that 98·08 grammes

$$(H_2SO_4 = 2·016 + 32·06 + 64 = 98·08)$$

of the acid will require just 2 litres of the alkaline solution to neutralise it, or 49·04 grammes (the "equivalent" of sulphuric acid), will require 1 litre; in other words, 1 mil of a normal alkaline solution will neutralise 0·04904 gramme of sulphuric acid. If then, we have an unknown amount of sulphuric acid which we wish to determine, it will be sufficient to run into the vessel containing it enough of a normal alkaline solution—*e.g.*, NaOH—to just neutralise it. The point of neutrality is shown by adding to the liquid a few drops of aqueous solution of methyl orange; this substance makes a red solution if free acid is present, and a yellow solution if free alkali is present; while in a perfectly neutral solution its colour is orange, and easily distinguished from the red or yellow. Having exactly neutralised the acid, we find by reading the burette how much normal soda solution has been used; since every 1 Ml. is equivalent to 0·04904 gramme of sulphuric acid, the number of Ml. used, multiplied by 0·04904, gives the weight in grammes of the true acid in the quantity taken for determination.

The process of adding a liquid from a burette until the desired end-point is reached is termed *titration;* the titration just described is quite typical of most, and, if carefully considered, will suffice to make the general principles and procedure clear.

Preparation of Solutions.

Before going into the details of the various cases in which volumetric analysis is applied, it is necessary to describe more fully the preparation of the solutions to be employed. In the case which was taken as an illustration, where silver nitrate solution of known strength is made use of, the latter

is prepared by the simple process of dissolving an accurately weighed amount of the pure salt in water and making up the solution to a known measure. The crystalline silver nitrate of the Pharmacopœia, as usually supplied, is a pure salt, except for the presence of traces of moisture; good white crystals should be chosen, roughly powdered in a mortar, and dried for about fifteen minutes in a water oven or for a few hours in a desiccator; the salt will then be ready for use. If there is any doubt at all about its purity it should be dissolved in a small quantity of hot water to which a few drops of nitric acid have been added, and the liquid set aside for crystals to form. If necessary, these can be further recrystallised in the same way.

One molecular weight of silver nitrate, $AgNO_3$, contains one equivalent (in this case identical with the atomic weight) of silver; since the molecular weight of silver nitrate is 169·94 (= 107·93 + 14·01 + 48), this number of grammes dissolved and made up to 1 litre would make a normal solution. It is, however, more convenient in this case to use a decinormal solution. To prepare the latter, 16·994 Gm. of pure silver nitrate is dissolved in water, and the solution diluted until it measures just 1 litre. (The student may probably prefer to make a smaller quantity. To make 500, 250, or 100 Ml. respectively, it is, of course, only necessary to take one-half, one-quarter, or one-tenth of the above weight.)

Another solution which is very useful, and which may be prepared in a similar manner, is that of sodium carbonate; but in this case it will be necessary to prepare the salt specially for the purpose, and this is done as follows:— About one or two ounces of sodium bicarbonate, B.P., is shaken up well with two or three ounces of distilled water and transferred to a filter-paper; when all the liquid has passed through, the salt on the paper is washed two or three times, using about an ounce of distilled water each time. By this treatment the impurities, which are more soluble than the bicarbonate itself, are removed; the washed salt is then taken from the filter, dried by gentle heating, and then further heated in a porcelain or platinum dish over a Bunsen or spirit lamp flame, so that the bottom of the dish is just red-hot. After heating in this way, stirring every three or four minutes, for about twenty minutes, all the bicarbonate is decomposed and pure anhydrous sodium carbonate remains. We have already seen that a normal solution of the latter salt must contain 53·05 Gm. in 1 litre; this quantity is, therefore, carefully weighed out and dissolved in water, and the solution diluted to just 1 litre.

In many cases it is not possible to weigh out exactly the

quantity of a substance necessary to make a normal solution, owing to the presence in the substance of some small but unknown proportion of water or some other impurity, and the procedure must then be somewhat different. Sulphuric acid, for example, contains usually about 2 or 3 per cent. of water and traces of other impurities. The equations and figures given in our previous chapter show that 49·04 Gm. of the pure acid must be contained in 1 litre of normal solution; we therefore take a rather larger quantity—say, 52 Gm.—and dilute to 1 litre (since the specific gravity is 1·84, $\frac{52}{1{\cdot}84} = 2{\cdot}82$ Ml. may be measured to avoid weighing). This will produce a solution a little stronger than normal, and the exact strength of this solution is found by carefully measuring out 20 Ml. of it (or some other convenient quantity) into a flask or beaker, adding a little methyl orange solution, and then running into this from the burette the previously prepared normal sodium carbonate solution until the red colour of the liquid is just changed to orange (being careful to stop before a full yellow colour is produced). Suppose 20·5 Ml. are required: then, since 20 Ml. of the acid solution are equivalent to 20·5 Ml. of normal, a simple calculation shows that $\frac{20 \times 1000}{20{\cdot}5}$ = 975·6 Ml. are equivalent to 1 litre of normal. The burette is now filled with distilled water; 24·4 Ml. (1,000 – 975·6 = 24·4) of this are run into the 1-litre flask, and enough of the acid added to make up just 1 litre. After well shaking, this solution will now be normal sulphuric acid. A beginner should make at least two titrations of the original acid solution with the normal sodium carbonate, and if the results of the two do not quite agree the mean of the results should be taken. After dilution of the acid to normal strength a further titration of the solution so produced, with the sodium carbonate, will furnish a useful check.

The method that has just been described is of general application; that is to say, in all cases where it is not practicable to weigh out the correct quantity of a substance to make a normal solution, a rather larger quantity is taken, and the solution prepared with this is titrated against a normal solution, and its strength then adjusted in accordance with the result so found. If the requisite normal solution is not at hand, a small quantity of a pure solid substance may be weighed out and used for the titration. Thus in the above instance, if no normal sodium carbonate solution is available, a few grammes of pure anhydrous sodium carbonate may be prepared in the way described above. After cooling a little, the salt is transferred to a weighing bottle,

and when completely cold, the bottle and its contents are weighed; a small quantity is then taken out and dissolved in water, and the exact amount so taken is found by again weighing the bottle, with its remaining contents. The weighed-out quantity is dissolved in water, a little methyl orange added (now making a *yellow*-coloured solution), and the sulphuric acid solution of unknown strength is then added from the burette until the colour changes to orange, and the volume of the acid solution so used is found by reading the burette. Since 53·05 Gm. of sodium carbonate makes 1 litre of normal solution, 0·05305 of this salt represents 1 mil, and the number of mils of normal solution equivalent to the amount of salt actually taken can be found by a simple calculation. A comparison of this number with the number of mils of the acid solution that were used shows the strength of the latter.

It will now be evident that when a normal solution of either acid or alkali has been prepared, it is a simple matter to obtain a normal solution of any other acid or alkali. Thus normal solution of caustic soda, caustic potash, hydrochloric acid, oxalic acid, etc., can be obtained by taking rather more than one equivalent in grammes of one of these substances, dissolving and making up to a litre, and then determining the exact strength of the solution by titrating with normal sodium carbonate or normal sulphuric acid, as the case may be, and from the result of the titration adjusting the strength of the solution by the addition of water until it also is normal. It must be noted that since oxalic acid is dibasic,

$$2NaOH + H_2C_2O_4,2H_2O = Na_2C_2O_4 + 3H_2O,$$

its equivalent is half its molecular weight.

Oxidising Solutions.

An important class of volumetric solutions consists of those whose action is one of oxidation. These are, of course, used for determining the amount of an oxidisable substance in a given quantity of some material. For instance, the saccharated carbonate of iron of the B.P. is a mixture of ferrous carbonate, ferric hydroxide and sugar, and it is required to contain not less than one-third of its weight of the first of these. Ferric hydroxide is not capable of further oxidation, and the conditions of a titration can be made such that sugar shall not be oxidised. If, then, a known weight of the saccharated carbonate is titrated with an oxidising agent, only the ferrous salt will be acted on, and the amount of the oxidising agent used will show how much ferrous salt was present. The oxidising agents commonly used are potassium bichromate and potassium permanganate. When potassium bichromate, $K_2Cr_2O_7$, acts on an oxidisable material in an

acid solution, each molecule of the salt yields three atoms of oxygen, in accordance with the equation,

$$K_2Cr_2O_7 + 4H_2SO_4 = K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3O.$$

But since one atom of oxygen combines with, or is equivalent to, two atoms of hydrogen, the equivalent of oxygen is only half the atomic weight, and one molecule of potassium bichromate yields six equivalents of oxygen. From this it follows that to make a normal solution of potassium bichromate we should need to take one-sixth part of a molecular weight in grammes to make each litre of the solution. A more convenient strength, however, for this solution is decinormal. We take, therefore, one-sixtieth part of a molecular weight in grammes;

$$K_2Cr_2O_7 = 78{\cdot}3 + 104{\cdot}2 + 112 = 294{\cdot}5 \text{ and}$$

$$\frac{294{\cdot}5}{60} = 4{\cdot}9083;$$

4·9083 Gm. of the bichromate, then, dissolved in water, and the solution made up to 1 litre, will produce the decinormal solution we require. "Pure" potassium bichromate, as supplied by chemists, is usually pure enough to be used for this purpose. It may be dried for a short time before weighing out, as described above for silver nitrate; and, if necessary, it can be recrystallised by dissolving in a little hot water and setting the solution aside to cool.

When potassium permanganate acts on an oxidisable material in acid solution, every two molecules of the salt yield five atoms, and therefore ten equivalents, of oxygen, in accordance with the following equation:—

$$2KMnO_4 + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 3H_2O + 5O.$$

A decinormal solution must therefore contain in each litre one one-hundredth part of twice the molecular weight—*i.e.*, one-fiftieth of the molecular weight—in grammes. $KMnO_4$ = 39·15 + 55·0 + 64 = 158·15; therefore 3·1630 Gm. will be required. But the crystals of this salt are usually rather under 100 per cent. strength, and it will therefore be necessary to take rather more than this weight to make a litre of solution, and having made it, to determine its strength by operating on a substance of known purity. Ferrous ammonium sulphate, $FeSO_4(NH_4)_2SO_4,6H_2O$, is easily obtained in quite pure crystals, and it may be kept in a stoppered bottle for a long time without undergoing any oxidation; it is therefore well suited for determining the strength of the permanganate solution. When this salt is oxidised in presence of acid, the iron is changed from the ferrous to the ferric state in accordance with the following equation:—

$$2[FeSO_4(NH_4)_2SO_46H_2O] + O + H_2SO_4 = Fe_2(SO_4)_3 + 2(NH_4)_2SO_4 + 7H_2O.$$

That is, two molecules of the salt require one atom of oxygen, or one molecule requires one equivalent. Since 1 litre of any decinormal oxidising solution yields one-tenth of one equivalent of oxygen in grammes, one-tenth of a molecular weight in grammes of this iron salt will just consume a litre of such a solution.

$$FeSO_4(NH_4)_2SO_4 \cdot 6H_2O = 55{\cdot}90 + 32{\cdot}06 + 64{\cdot}00 + (2 \times 18{\cdot}04) + 32{\cdot}06 + 64{\cdot}00 + (6 \times 18\,016) = 392{\cdot}20.$$

Therefore 39·220 Gm. would require 1 litre of decinormal permanganate, or 0·03922 Gm. represents 1 Ml. About 0·5 Gm. is therefore weighed out accurately, dissolved in water strongly acidified with sulphuric acid, and titrated with the permanganate solution of which we want to know the exact strength. It is, of course, essential that the iron salt shall not be liable to oxidation during the process by anything other than the permanganate; but ordinary water contains air dissolved in it, and the oxygen of this would combine with some of the iron salt; the water to be used must therefore be well boiled before use, in order to get rid of the dissolved air. This precaution is obviously not only necessary in this case, but whenever an oxidisable substance is to be titrated with permanganate or bichromate. A convenient plan is to boil a fairly large volume of water in a flask or beaker for about twenty minutes, then put on the surface of the water a thin layer of heavy paraffin oil (Paraffinum Liquidum, B.P.) and stop the heating. When the water is cold, portions may be removed as required by means of a pipette, the layer of oil protecting what is left from contact with the air. Some of this boiled water, then, is added to some sulphuric acid, the weighed quantity of iron salt dissolved in it, and the permanganate solution then gradually run in from a burette. As fast as the iron is oxidised, the colour of the permanganate disappears, the potassium and manganese sulphates that are formed from it being both colourless salts. As soon as all the ferrous iron is converted to the ferric state, a further drop of permanganate colours the liquid pink; the first appearance of a pink colour that does not disappear on shaking the flask is therefore an indication that the oxidation is complete. Since 0·03922 Gm. of iron salt represents 1 Ml. of decinormal solution, we can find at once what number of mils of the latter would have been decolorised by the amount of salt taken; and comparison of this number with the number actually employed enables us to calculate the amount of our permanganate solution that must be diluted to 1 litre in order that decinormal solution may result.

In the case of many oxidisable substances it is found more advantageous to employ as oxidiser a substance which does not itself yield oxygen, but by means of which oxidisation can

be brought about indirectly. Iodine is very useful for this purpose; in presence of a body having a strong affinity for oxygen, iodine and water form hydriodic acid and oxygen in accordance with the equation:—

$$I_2 + H_2O = 2HI + O.$$

Since two atoms of iodine liberate one of oxygen, one atomic weight of iodine liberates one equivalent of oxygen. A decinormal solution of iodine must therefore contain in 1 litre one-tenth of an atomic weight of iodine in grammes—that is, 12·697 Gm. If perfectly pure iodine is available, the solution may be prepared by accurately weighing out this quantity, dissolving it in about 250 Ml. of water by the aid of about 18 Gm. of pure potassium iodide, and diluting the solution to exactly 1 litre. As ordinarily occurring, however, iodine is liable to contain small quantities of chlorine and bromine; these may be removed by mixing it with about one-fourth of its weight of potassium iodide, and subliming by a gentle heat from a small wide beaker into another one inverted over it, the edges of the two being made to fit closely together by rubbing each separately on a flat stone with a little very fine emery powder and water, to produce a flat ground edge. The resublimed iodine so obtained is pure except for a trace of moisture, and this may be removed by keeping it for some hours in a desiccator over sulphuric acid.

It may be more convenient, however to use iodine without previous purification, taking slightly more than the weight given above and ascertaining the exact strength of the solution by titrating a pure substance with it. Arsenious anhydride (Acidum Arseniosum, B.P.) is easily obtained of 100 per cent. strength; this is oxidised by iodine solution in accordance with the equation:—

$$As_4O_6 + 4I_2 + 4H_2O = 2As_2O_5 + 8HI.$$

Thus, one-eighth of the molecule represented by As_4O_6 requires one equivalent of oxygen, or of iodine; $As_4O_6 = 300{\cdot}00 + 96{\cdot}00 = 396{\cdot}00$; therefore 4·950 Gm. represents 1 litre of decinormal solution, or 0·00495 represents 1 Ml. About 0·08 Gm. of the substance is therefore weighed out accurately, dissolved in warm water to which about 0·5 Gm. of sodium bicarbonate has been added, and the liquid titrated with the iodine solution. The bicarbonate is required to neutralise the hydriodic acid formed in the titration, and which, if left free, would prevent the reaction becoming complete; the liquid must not be heated much above 60° C. in dissolving the arsenious anhydride, or some of the bicarbonate would be converted to carbonate, which itself combines with iodine, and would therefore cause an error. The titration is complete

as soon as the liquid becomes of a slight yellowish colour, showing that the iodine has ceased to combine, owing to the arsenic being all oxidised. From the result of the titration, the strength of the iodine solution is adjusted as in the former instances.

De-oxidising Solutions.

The strength of many oxidising substances can be determined by allowing them to act on potassium iodide in solution, when iodine is liberated in accordance with the equation:—

$$2KI + H_2O + O = 2KOH + I_2.$$

The amount of iodine can be determined by titration with decinormal solution of any substance—*e.g.*, arsenious anhydride, which is readily oxidised by it. Decinormal arsenious solution may, of course, be prepared by dissolving 4·950 Gm. of pure arsenious oxide and about 30 Gm. of sodium bicarbonate in water, and making the solution up to 1 litre. It is more usual, however, to employ for the purpose a solution of sodium thiosulphate. This salt (commonly known also as hyposulphite of soda, and usually termed "hypo" by photographers, who use it largely) reacts with iodine in accordance with the equation:—

$$2Na_2S_2O_3{\cdot}5H_2O + I_2 = Na_2S_4O_6 + 2NaI + 5H_2O,$$

which shows that one molecule of the salt requires one atom, or equivalent, of iodine. One-tenth of a molecular weight in grammes will therefore make 1 litre of decinormal solution. $Na_2S_2O_3,5H_2O = 46{\cdot}10 + 64{\cdot}12 + 48{\cdot}00 + (5\times18{\cdot}016) = 248{\cdot}3$; therefore 24·83 Gm. of the pure crystalline salt must be taken to make 1 litre. The salt is easily obtained of almost perfect purity; or less pure material may be employed and the strength of the solution determined by titration with the decinormal iodine solution. The products of the reaction, as shown in the equation, are sodium iodide and sodium tetrathionate, $Na_2S_4O_6$.

Indicators.

We have now dealt with the preparation of the chief of the solutions required for the ordinary processes of volumetric analysis. Before proceeding to the application of the method in individual cases, it is necessary to describe briefly the means employed for accurately observing the completion of a reaction.

Reference has already been made to the use of methyl orange to indicate the point of neutrality when an acid is titrated with an alkali, or *vice versâ*. The solution is best prepared by dissolving 0·1 Gm. in 100 Ml. of distilled water; one or two drops of this solution added to the liquid

to be titrated will be sufficient to give it a well-marked colour, and, if normal solutions are being used, the change from acid or alkaline to neutral will be readily observed. If weaker solutions, as decinormal, for example, are being used, the effect of one drop more or less from the burette is, of course, proportionately smaller, and since ordinary distilled water is often appreciably alkaline from traces of ammonia in it, the following will be found a good method of procedure. Two similar flasks of equal size are taken, and the liquid to be titrated is put into one of them, while the other is filled to a corresponding height with distilled water; equal small quantities of methyl orange solution are next added to the two, when the distilled water will usually be found to give a decided yellow colour. If this is the case, decinormal acid is added drop by drop until the neutral tint (orange) is obtained, and the amount of acid so used is noted. The titration is then proceeded with, using the neutralised distilled water as a standard for colour, and continuing the additions from the burette to the other flask until the tint is exactly matched when viewed against white paper. If the titration is of an alkali with acid, from the burette reading is to be deducted the amount of acid used to neutralise the distilled water, this representing alkalinity not due to the substance undergoing analysis, but to the water in which it is dissolved. Conversely, if the titration is of an acid with an alkali, the amount of acid required by the distilled water is added to the burette reading.

If the distilled water was neutral to begin with, there is, of course, no correction to be applied to the burette reading; in either case, the end-point of the titration is not judged by mentally comparing the colour of the solution with a remembered neutral tint, but by actually comparing it with the neutral colour in the flask of distilled water; and any error that may have occurred in judging the neutrality of the latter is eliminated by making the correction described above.

Methyl orange is unaffected by carbonic acid; consequently in alkali carbonates or bicarbonates the alkali may be determined by titration with an acid, using this indicator, just as if it were free alkali. On the other hand, organic acids do not give a good reaction with methyl orange, and it is therefore not suitable to employ in determining any organic acid by titration with alkali.

For the last-named purpose, phenol-phthalein is by far the best indicator to employ. The most suitable solution of this substance is made by dissolving 1·0 Gm. in 100 Ml. of 50 per cent. alcohol. On adding one or two drops of this solution to an alkaline liquid, a pink or red colour is produced; on neutralising with acid, even a weak organic acid,

the colour disappears, leaving a colourless solution ; hence such an acid can be titrated by adding phenol-phthalein to its solution and running in standard alkali from a burette until a faint pink colour just remains in the solution after shaking. When this indicator is employed, carbonate must not be present either in the liquid to be titrated or the solution in the burette; the colour produced by alkali is discharged by carbon dioxide, and since this gas, if liberated, will partly escape and partly remain dissolved in the liquid, the point at which the colour disappears is not the end-point of the reaction. In certain cases, however, phenol-phthalein may be employed with advantage in presence of carbonate ; this will be referred to subsequently.

One or other of the indicators we have just discussed is suitable in almost every case when an alkali is to be titrated with an acid, or *vice versâ*. Several other indicators are, however, in common use for this purpose, and may be mentioned. Litmus solution shows a blue colour with alkali and a red with acid, and gives a fairly well-distinguished intermediate tint in neutral solutions ; it is sometimes more useful in the form of litmus paper when the solution is coloured by some other substance ; the effect of small drops of the liquid on this paper may be tried at intervals as the reaction proceeds. Lacmoid closely resembles litmus in behaviour ; rosolic acid gives a violet-red with alkali and a yellow with acid ; cochineal gives a bluish-purple with alkali and a pale red with acid ; it is very useful in titrating alkaloids.

When the reaction is not one between acid and alkali, some other means than the above must be employed to indicate its completion. In the case of titrating a haloid salt (chloride, bromide, or iodide) with silver nitrate, potassium chromate is the substance used. Two or three drops of a cold saturated solution of the neutral yellow chromate are added to the solution, and the silver solution then run in gradually from a burette. As long as any unaltered haloid salt remains in solution any silver chromate that may be formed is at once decomposed, the silver combining with the halogen. As soon, therefore, as the haloid salt has all been decomposed by the silver nitrate, one drop more of the solution of the latter forms silver chromate which now remains. As this salt has a strong red colour, its first appearance is very noticeable, giving a reddish tinge to the whole of the precipitate, previously white or yellowish white, and the appearance of this red tinge marks the completion of the reaction. Since silver chromate is soluble in acid, it is important that the reacting solutions should be neutral.

When a ferrous salt is titrated with bichromate solution the end of the reaction is reached when all the ferrous salt

has been converted to ferric salt. As long, therefore, as ferrous salt remains in the liquid the end of the titration has not been attained. *Freshly made* solution of potassium ferricyanide gives a blue precipitate with ferrous salts, but not with ferric, and is therefore suitable as an indicator in this case (solution of this salt that has been made some time contains some ferrocyanide, which gives a blue precipitate with ferric salts also). It would not do to add the solution to the liquid for titration, as the ferrous salt would be precipitated. A number of drops of the ferricyanide solution are put out on a porcelain tile, and as the titration proceeds single drops are taken out from the liquid from time to time with a glass rod and added to the ferricyanide on the porcelain. Any blue precipitate produced is very noticeable against the white background, and indicates that the reaction is not completed. When no further blue (or green, from the effect of the yellow solution and a very little blue) is produced in this way the burette reading is taken, and a second titration is then performed. In this titration almost the full amount of bichromate required, as found from the former result, is added at once; after one or two tests of drops with the ferricyanide the end-point is quickly reached. In this way the error that is introduced by taking out portions of the liquid before the reaction is complete is reduced to quite negligible dimensions.

When ferrous salt or any other reducing substance is titrated with permanganate, the addition of an indicator is not necessary; as soon as all the reducing substance has been oxidised, the addition of one more drop of permanganate solution gives a pink colour to the liquid. The first appearance of a pink colour that remains on shaking is therefore the sign that the end-point has been reached in any titration with permanganate.

Similarly in titrating with iodine solution, as soon as all the reducing substance has been oxidised, a further addition of iodine gives a yellow tinge to the liquid, and this tinge indicates that the end-point has been reached. In titrating iodine with thiosulphate or arsenious acid, the disappearance of colour shows the completion of the reaction. But as in both these cases the presence of a little extraneous coloured substance would make it impossible to detect a slight colour of iodine, it is convenient to add a little starch mucilage, which gives a deep blue colour with free iodine, and so furnishes a very sharp and well-marked indication of the end-point. In titrating iodine with a reducing solution, the starch should not be added till the colour of iodine has nearly disappeared. A convenient mucilage is obtained by boiling one part of starch with about 200 parts of water and cooling; a deposit forms on standing, and the clear

liquid is poured off; two or three drops are sufficient in a titration.

Equivalence of Solutions.

It has already been stated that normal solutions are prepared of such a strength that 1 litre contains one equivalent in grammes of the reacting element or radical; *i.e.*, that chemical or radical which enters into reaction with the substance for the determination of which the solution is to be used. Decinormal solutions are of one-tenth of the strength of normal, and centinormal solutions one-hundredth of the strength of normal. Students may be reminded that the equivalent of any element is the number of parts by weight that combine with one part by weight of hydrogen, or take the place of one part by weight of hydrogen in a combination; equivalent, therefore, = atomic weight ÷ valency. Thus a normal solution of an oxidising agent would yield one equivalent in grammes—*i.e.*, 8 Gm. of oxygen from 1 litre; a normal acid solution would contain 1·008 Gm. of replaceable hydrogen per litre, or 1 litre would combine with 23·05 Gm. of sodium, if presented in some alkaline combination. It will now be evident that, with occasional exceptions, all normal solutions are equivalent among themselves, 1 Ml. to 1 Ml., and decinormal and centinormal solutions are respectively equivalent to any other decinormal and centinormal solutions. The exceptions occur, of course, when one substance can be acted on in more than one way; for instance, to convert a gramme-molecule (*i.e.*, a molecular weight in grammes) of ferrous chloride to ferric chloride one equivalent of chlorine is required, or one equivalent of oxygen in presence of hydrochloric acid. Thus 1 litre of normal solution of either potassium permanganate or bichromate would have to be used; but if it were desired to determine the chlorine in ferrous chloride, then for one gramme-molecule of the salt, 2 litres of normal silver nitrate would be necessary, since two equivalents of chlorine are present. This may be expressed differently by saying that 1 litre of decinormal (since decinormal is the strength in general use) permanganate or bichromate is equivalent to 12·68 Gm. (one-tenth of molecular weight) of ferrous chloride, while 1 litre of decinormal silver nitrate is equivalent to 6·34 Gm. only. In such a case, however, since any one solution can only react with a given substance in one way, to name a particular volumetric solution in relation to a substance is to show by implication what the reaction is that is intended. Thus, in the above example, to state that 1 litre of decinormal silver nitrate is equivalent to 6·34 Gm. of ferrous chloride implies that it is sufficient to withdraw all the chlorine from that amount of the salt, since silver nitrate cannot act on it in any other way.

Use of Factors.

If these facts are fully understood it will be readily seen that in working out the result of a titration it is not necessary to take into consideration the nature or quantity of the substance contained in the standard solution, but only its strength in regard to the reacting constituent. To take an example. Suppose a titration has been made of ferrous sulphate with decinormal (commonly written N/10) permanganate, and 1 Gm. of the salt has been found to use 30 Ml.; if it is required from this result to find the percentage of iron in the ferrous state, it is only needful to recollect that to convert one atomic weight of iron (Fe = 55·9) from the ferrous to the ferric state one equivalent of oxygen is necessary, as shown by the equation :—

$$2FeSO_4 + H_2SO_4 + O = Fe_2(SO_4)_3 + H_2O.$$

In other words, 1 litre of the N/10 solution represents 5·59 Gm. of iron in the ferrous state, or 1 Ml. = 0·00559. We therefore multiply the number of mils used by this factor to find the weight of iron oxidised, 0·00559 × 30 = 0·1677, and since this weight of ferrous iron is contained in 1 Gm. of the sample, the latter contains 16·77 per cent. We have here not introduced any consideration of the molecular weight of potassium permanganate, this having been done once for all when the standard solution was prepared, nor of the equivalence between permanganate and ferrous sulphate, nor of the molecular weight of the latter; but we have calculated directly from the number of Ml. of solution used to the weight of the substance which we wish to determine, in this case iron. Students are advised to make a practice of doing such calculations in the shortest and most direct manner; nothing is gained by more roundabout methods. It is, of course, of prime importance that correct equivalents should be employed, and the equation representing the actual change that is being measured, like the one given above, should always be written.

Most of the titrations required in the quantitative testing of official articles are simple and straightforward, and will be readily understood and carried out by anyone who has carefully followed and understood the descriptions we have given of the principles and processes involved. Volumetric methods may, however, be conveniently employed in many other cases, often less simple, and one or two of these will now be described as illustrations.

Special Applications.

To determine the amount of available oxygen in manganese dioxide. The manganese dioxide of pharmacy is by no means

the pure substance represented by MnO_2, but much Mn_3O_4 is present in it. A suitable quantity is added to some hydrochloric acid and heated in a retort or flask, and the evolved gas and vapour led into a solution of potassium iodide; iodine is liberated in accordance with the equations given below, and its amount is determined by titration with N/10 sodium thiosulphate.

$$MnO_2 + 4HCl = MnCl_2 + 2H_2O + Cl_2$$
$$Cl_2 + 2KI = 2KCl + I_2$$
$$MnO_2 = 55{\cdot}0 + (2 \times 16{\cdot}0) = 87{\cdot}0;$$

therefore 43·50 Gm. of the dioxide cause the liberation of one Gm.—equivalent of iodine or each Ml. of N/10 thiosulphate used represents 0·00435 Gm. of manganese dioxide in the amount of substance taken. Since $Mn_3O_4 = 2MnO{\cdot}MnO_2$, and this compound liberates the amount of chlorine equivalent to the dioxide it contains, it is usual to express the strength of the medicinal dioxide in terms of the true dioxide it contains, whether free or in combination as Mn_3O_4.

Carbon and Bicarbonate in Admixture.

To determine the respective amounts of carbonate and bicarbonate in a mixture of the two. When an acid acts on a carbonate, the decomposition of the latter occurs in two stages, thus:—

$$Na_2CO_3 + HCl = NaCl + NaHCO_3$$
$$NaHCO_3 + HCl = NaCl + H_2O + CO_2.$$

Carbonic acid, or carbon dioxide in solution, behaves like the stronger acids to phenol-phthalein, and discharges the colour produced by alkalies. If, therefore, this indicator is added to a solution containing carbonate and bicarbonate of an alkali metal, and normal acid then added from a burette, the pink colour produced by the carbonate remains until the first of the reactions is complete—*i.e.*, the carbonate is all converted to bicarbonate; the slightest further addition of acid then liberates carbon dioxide, and the pink colour disappears. Methyl orange, unlike phenol-phthalein, is unaffected by carbon dioxide; if a little methyl orange is added to the now colourless solution, it gives the yellow colour which indicates alkalinity of the liquid, and this colour remains until all the bicarbonate is converted to chloride (or sulphate, as the case may be). When this conversion is complete, the slightest further quantity of mineral acid remains as free acid, and the methyl orange indicates by its change of colour that the end-point is reached. Burette readings must be taken at the commencement and at the end of each of the two stages of

the titration. The number of mils of acid used in the first stage must be doubled to find the number of mils used in neutralising the carbonate present, since in the first stage it was only half neutralised, or converted to bicarbonate, while the bicarbonate originally present was unaffected. This doubled number deducted from the total number of mils used in the whole operation leaves the number used in neutralising the original bicarbonate, and from these numbers the carbonate and bicarbonate are respectively found by multiplying by

0·05305 $\left(\frac{Na_2CO_3}{2} = 53·05\right)$ and by 0·084058 ($NaHCO_3 = 84·058$).

In the first stage the liquid must be dilute, and kept in motion, and the acid added gradually and cautiously; otherwise some carbonate might be completely neutralised in one part of the liquid, with loss of carbon dioxide as gas.

VOLUMETRIC ANALYSIS WITH THE NITROMETER.

The processes of volumetric analysis in which an ordinary burette is employed have been previously described in the Student's columns. Most of the processes of gas analysis are, strictly speaking, volumetric, since the quantities of the gases dealt with are determined by measuring, and not by weighing, but this branch of work is usually termed gasometric, as distinguished from volumetric analysis, and for the most part it is not of immediate interest or importance to pharmaceutical students. In one class of operations, however, the substances taken for analysis are in the form of liquids which are measured with a burette or pipette while the product of the reaction which is brought about is a gas; and such operations, therefore, occupy an intermediate position between ordinary volumetric and gasometric analysis. It happens that most of the analyses conducted in this way are of direct pharmaceutical importance, and a short account of such analysis will now occupy us.

The Nitrometer.

The apparatus employed is known as a nitrometer. This consists essentially of a graduated tube, much like an ordinary burette, but not fitted with a tap at the bottom; a short portion at the top of the tube is separated from the rest of it by a tap, and thus forms a sort of cup distinct from the body of

the tube. The cup is graduated from the tap upwards, usually to 5 or 10 mils, and the body of the tube is graduated from the tap downwards, usually to 50 mils. The lower end of the graduated tube is connected by means of a length of india-rubber tubing with the lower end of another tube about equal in size to the first, so that liquids can pass freely from one to the other; this second tube has neither graduation nor tap. The gas which is formed in the analytical operation is generated in the graduated tube and measured there. It is sometimes desirable to be able to deal with a larger volume than 50 mils of gas, and this tube may be expanded in the upper portion into a bulb of such a size that the first gradation on the tube is 50 or 100 mils, and the total amount that can be measured is then 100 or 150 mils. In this case the other tube must also be furnished with a bulb of approximately the same size.

In the very useful form of instrument known as Lunge's nitrometer, instead of a simple tap between the cup and graduated tube there is a three-way tap, so that connection may be made at will between the graduated tube and the cup, or between the graduated tube and a side tube leading to the outside air, or the graduated tube may be closed altogether. With one form of tap connection can also be opened between the cup and the side tube, leaving the graduated tube closed.

Method of Using.

To use the nitrometer it has first to be filled with a liquid, which in most cases is not required to take any part in the reaction. For some purposes mercury is best, while for others water is suitable; but as a rule a strong solution (nearly saturated) of either common salt or magnesium sulphate is employed. The graduated tube is supported in a clamp-stand, and the tap at the top is opened; the brine is then poured into the plain tube and passes through the flexible connection into the graduated one until the latter is full to the tap, which is then closed. If the plain tube is raised to a higher level than the other, when the latter is full of brine, the former will only contain a small quantity in its lower part. The apparatus is then ready for use. A small quantity of the liquid to be analysed is measured in the cup, and on cautiously opening the tap it runs into the burette, an equal measure of the brine passing into the plain tube; the specific gravity of the brine being high, the liquid thus introduced does not mix with it but remains as a distinct layer at the top. The liquid or liquids required to act upon it are then placed in the cup and introduced by means of the tap, care being taken whenever the latter is opened that no air is admitted. Reaction then takes place between the substances that have been introduced, with

production of a gas, more of the brine being displaced by the latter and passing into the plain tube by means of the india-rubber connection. The volume of the gas is subsequently read off on the graduations on the tube.

Corrections for Temperature and Pressure.

Since a given quantity of any gas occupies different volumes under different conditions of temperature and pressure, it is necessary to take these into account in any measurement of a gas. A temperature of 0° C., and a pressure equal to that of a column of mercury 760 millimetres in height are taken as the normal conditions; it is not necessary, however, to actually bring the gas to this temperature and pressure, but only to ascertain its temperature and the pressure upon it at the time when its volume is read: its volume at normal temperature and pressure (usually abbreviated to "N.T.P.") can then be calculated by means of the laws of Charles and Boyle. The reaction which takes place in the nitrometer usually generates more or less heat, and therefore before the volume of gas is read enough time must be allowed to elapse for it to cool down to the temperature of the room; this cooling is complete when two readings of the measure of the gas with an interval of five minutes between them show no alteration in its volume; the temperature is ascertained by hanging a thermometer beside the nitrometer. To read the volume of the gas, the plain tube of the apparatus is taken from the clamp and held close beside the graduated tube, and raised or lowered until the liquid in the two tubes is exactly level. The pressure on the gas is then equal to the pressure of the atmosphere at the time, which is ascertained by reading a barometer in the room. The gas so measured, however, does not consist solely of the gas evolved in the reaction, but since it is confined over water or an aqueous solution it is saturated with aqueous vapour. A correction can be made for this by ascertaining from a table what the *pressure* in (Mm. of mercury of aqueous vapour is at the temperature of the gas, and *deducting* this pressure from the barometric pressure, since the aqueous vapour increases the volume of the gas to the same extent as it would be increased by diminishing the pressure upon it by that amount.

By the law of Charles, the volume of a gas, under constant pressure, is proportional to its temperature on the absolute scale, which is a scale in which the degrees are the same as those of the centigrade scale, but the zero of which is −273° C. 0° C. is, therefore, 273° absolute, and if the temperature of the gas is t° C., it is 273+t° absolute. The

volume actually read multiplied by $\frac{273}{273 + t^\circ}$ will, therefore,

give the volume of the gas at 0° C. Boyle's law tells us that the volume of a gas is inversely proportional to the pressure; therefore, if the height of the barometer at the time of the experiment is B millimetres, and the vapour pressure of water at the prevailing temperature is equal to p millimetres of mercury, the volume read must be multiplied by $\frac{760}{B-p}$ to give the equivalent volume at normal pressure. The two factors may, of course, be combined, and the correction made by multiplying by $\frac{273 \times 760}{(273 + t°) \times (B-p)}$.

Applications of the Method.—1. Nitrous Ether.

We may first consider an official test in which the nitrometer is required, namely, the testing of spirit of nitrous ether for the amount of ethyl nitrite which it contains. The decomposition of the latter is effected by means of potassium iodide and dilute sulphuric acid, and the nitric oxide which is evolved is measured; the equation representing the reaction is :—

$$C_2H_5NO_2 + KI + H_2SO_4 = C_2H_5OH + KHSO_4 + I + NO,$$

which shows that 75 grammes of ethyl nitrite yield 30 grammes of nitric oxide. To change from the volume of a gas to its weight, it is necessary to remember that 1 litre of hydrogen at N.T.P. weight, 0·0896 gramme, or 1 gramme, measures 11·2 litres. Nitric oxide is fifteen times as heavy as hydrogen ($NO = 14 + 16 = 30$; $H_2 = 2$), therefore 1 litre of it weighs $15 \times 0{\cdot}0896 = 1{\cdot}344$ grammes; since 30 grammes represent 75 of ethyl nitrite, 1 litre of the gas will represent—

$$\frac{1{\cdot}344 \times 75}{30} = 3{\cdot}36,$$

or 1 mil will represent 0·00336 gramme of ethyl nitrite, so that from the volume of gas evolved it is quite easy to ascertain the percentage of ethyl nitrite in the spirit. For the B.P. test, however, this calculation is not necessary, the requirement being that the spirit shall yield not less than five times its own volume of nitric oxide.

The nitrometer is first filled with brine, and the plain tube (or levelling tube), containing only a little brine, being clamped at a low level, a quantity of 3, 4, or 5 mils of the spirit is measured in the cup, and run into the nitrometer by cautiously turning the tap; a few mils each of solution of potassium iodide and dilute sulphuric acid are then intro-

duced in succession in the same way; reaction takes place at once, and after cooling the levelling tube is adjusted until the liquid is at the same height in both tubes, and the volume of gas read off and corrected in the manner described above. In order to prove the identity of the gas, a saturated solution of ferrous sulphate may be introduced; this absorbs nitric oxide, and if the gas is pure the liquid will therefore rise until it fills the graduated tube right up to the tap.

2. Other Nitrites.

It must be borne in mind that this does not really prove the presence of a definite quantity of ethyl nitrite, but only of a nitrite; any nitrite may be decomposed in the same way, and the quantity of sodium nitrite, for instance, in a solution may be determined by this means. Amyl nitrite, as usually met with, contains about 80 per cent. of real amyl nitrite, $C_5H_{11}NO_2$. In order to determine its strength by the nitrometer about 5 grammes should be weighed or measured into a 100-mil flask, and dissolved in enough alcohol to make 100 mils; 5 mils of this solution should then be introduced into the nitrometer and decomposed in the same way as the spirit of nitrous ether.

3. Nitrates.

Nitrates in solution may be determined in a somewhat similar way to nitrites. For this purpose the nitrometer must be filled with mercury, not brine. The solution of nitrate (which should be as strong as possible) is then introduced through the cup, and followed by a little strong sulphuric acid. No action takes place just at first. The nitrometer is then shaken in such a way that the upper portion of the mercury becomes mixed with the acid liquid, and the reaction indicated by the following equation then takes place :—

$$2KNO_3+4H_2SO_4+3Hg=3HgSO_4+K_2SO_4+2NO+4H_2O.$$

4. Determination of Urea.

The percentage of urea in urine may be found with fair accuracy by means of the nitrometer. The apparatus is filled with brine and 4 or 5 mils of the urine then introduced, followed by 20 or 25 mils of solution of sodium hypobromite (made by adding 2·5 mils of bromine to 25 mils of a solution of 1 part of caustic soda in 2·5 parts of water). Reaction occurs at once and nitrogen is liberated. The principal reaction is represented by the equation :—

$$CO(NH_2)_2+3NaBrO=3NaBr+CO_2+N_2+2H_2O,$$

the CO_2 at once combining with the excess of caustic soda present in the hypobromite solution. In practice, only 92 per cent. of the nitrogen is evolved, and the quantity obtained

must therefore be multiplied by 1·087. Instead of proceeding in the manner described, the hypobromite solution is sometimes put into a small flask, and the urine into a small tube, which is placed in the flask so that the liquids are not in contact, and the flask closed with a cork carrying a tube. A nitrometer with a three-way tap is necessary, and the tap is so turned as to make connection between the graduated tube and the side tube, the nitrometer being filled with brine or water. The side tube is then connected to the tube passing through the cork of the flask; on tilting the flask the urine runs out of the small tube and is decomposed, and a volume of gas is collected in the nitrometer equal to the volume of nitrogen liberated. By this method the urine and hypobromite solution can be shaken together better than if they are mixed in the nitrometer itself.

If 5 mils of urine and 20 mils of soda solution (1 of NaOH to 2·5 of water) are placed together in the flask, and about 1 mil of bromine in the small inner tube and the flask connected to the nitrometer as before, on tilting the flask so that the bromine runs out of the tube, a similar decomposition occurs, but in this case the whole of the nitrogen is evolved instead of only 92 per cent. of it.

Ammonium salts may be decomposed by hypobromite solution in the same way as urea, in accordance with the equation $2NH_4Cl+3NaBrO=3NaBr+2HCl+3H_2O+N_2$; the gas actually obtained is 97·5 per cent. of the theoretical quantity.

5. Hydrogen Peroxide.

The strength of commercial hydrogen peroxide solution is usually determined by titrating it with permanganate solution in presence of sulphuric acid, the decomposition being represented by the equation :—

$$5H_2O_2+2KMnO_4+3H_2SO_4=K_2SO_4+2MnSO_4+8H_2O+5O_2$$

The decomposition may also be effected in a nitrometer and the volume of oxygen measured; it must be remembered that only half the oxygen comes from the peroxide. When proceeding in this way a better result is obtained if bichromate is used instead of permanganate. Two mils of the peroxide of hydrogen solution if of "10 volume" strength, or 1 mil of "20 volume," is introduced into the nitrometer, which must be previously filtered with solution of magnesium sulphate and not of sodium chloride, and followed by 5 mils of a 5 per cent. solution of potassium bichromate strongly acidified with sulphuric acid. After the reaction is complete the oxygen is allowed to come to the temperature of the room, and the volume read off is corrected in the manner described above.

VOLUMETRIC TESTS.

The part played by volumetric analysis in the chemical testing of substances to be used in medicine is a constantly increasing one, and the reason for this is not difficult to find. In order to obtain adequate information with regard to the state of purity of a given substance, it is not usually sufficient to show by qualitative tests that undesirable impurities are absent, but it is necessary also to ascertain by quantitative tests how much of the true substance is present. Thus with increasing knowledge and increasing stringency of requirements, the employment of quantitative tests steadily increases. Quantitative tests may, of course, be either gravimetric or volumetric; but whereas gravimetric tests are usually rather troublesome and tedious and require a good deal of time, volumetric tests are convenient and simple, and can very often be completed in a few minutes, while on the score of accuracy they are usually in no way inferior to gravimetric tests, and in some cases they are decidedly more accurate.

For the perfectly satisfactory employment of volumetric tests an adequate knowledge and understanding of the theoretical basis of the method is a *sine quâ non*. In addition to this it is a great advantage to have at hand for ready reference compact tables of working details, equivalents, etc. The principles of volumetric analysis are dealt with in the preceding section. In the present chapter are given the necessary data for the ready employment of the volumetric method in a considerable variety of analyses, including not only those which students should carry out by way of practice, but all those at all likely to be wanted by the practising pharmacist and chemist; the reader is accordingly assumed to have a general knowledge of the principles of the subject.

In calculating the data here given, the atomic weights agreed on by representatives of the principal countries, and known as the "International Atomic Weights," have been employed. These are calculated with reference to oxygen as 16, and not to hydrogen as 1; the atomic weight of hydrogen on this basis is 1·008. The atomic weights of the British Pharmacopœia are referred to hydrogen as 1, and data calculated from them differ slightly therefore from those given below. This will not, however, invalidate the use of these data in performing pharmacopœial tests, provided the International weights are used consistently, both in preparing the volumetric solutions and in calculating from the result of a titration the amount of reacting substance present. But in the Pharmacopœia the requirements are usually not put in the form that a certain percentage of substance should be indicated by titration, but that a certain

quantity of the substance shall require a certain measure of the appropriate volumetric solution; and if the latter were prepared in accordance with different atomic weights, its strength would be somewhat different and the amount required would differ accordingly. This may be made clearer by an example: under Citric Acid, the B.P. states "each gramme dissolved in water should require for neutralisation 14·3 cubic centimetres of the volumetric solution of sodium hydroxide"; this corresponds to the presence of 99·38 per cent. of real citric acid. If, however, the volumetric solution of sodium hydroxide had been prepared in accordance with International atomic weights, one gramme of the same citric acid would only require 14·19 cubic centimetres; but the percentage of real citric acid calculated from this result by means of the International atomic weights would still be 99·38. To meet the difficulty here indicated two methods are available; the first and simplest is to deal only with percentages of the substances examined; a table is accordingly given below showing the percentages corresponding to the B.P. requirements in all those cases in which a certain measure of a volumetric solution is named; the titration can then be carried out with the volumetric solution made according to the International weights, and the result calculated to actual amount or percentage by aid of the factors given in the subsequent tables, which are derived from the same weights. The alternative method is to employ, in B.P. tests, solutions prepared according to the B.P.; and in the case of volumetric solutions which are official, the B.P. strength as well as the International is accordingly mentioned in the tables.

Indicators.

Litmus.—A solution may be prepared from commercial litmus as follows:—Powder the litmus, and extract several times with successive portions of hot alcohol, rejecting these liquids; digest the residue in cold dilute acid, pour or filter off, and reject this liquid also; then boil the residue with five times its weight of water, filter, and use the filtrate as indicator.

Litmus gives a blue colour with alkalies, and a red with acids. Carbonic acid behaves as an acid to litmus, and therefore in a titration in which carbonate is present, all carbon dioxide must be removed by boiling before the end-point is taken. Litmus is not generally suitable for use with weak acids or alkalies; quinine, morphine, and strychnine are neutral to it, and the acid in their salts can therefore be titrated with litmus as indicator, as though no base were present.

Lacmoid.—An artificially made substance, consisting chiefly of diazo-resorcin; the indicator solution is made by dissolving 0·2 Gm. in 100 mils of dilute alcohol. Its behaviour as an indicator closely resembles that of litmus.

Rosolic Acid, also known as Aurin or Corallin.—A suitable solution is made by dissolving 1 part in 100 parts of 60 per cent. alcohol. It gives a rose-red with alkalies and a yellow with acids. Carbon dioxide must be removed by boiling as with litmus. It is not suitable for use in presence of ammonia.

Methyl Orange.—A 1 per cent. aqueous solution is suitable for use. This is a most useful indicator in the titration of fairly strong acids and alkalies; it gives a red with acids, yellow with alkalies, and orange in neutral solutions. Carbon dioxide does not affect it, and alkali carbonates or bicarbonates can, therefore, be titrated without boiling. It is not suitable for use with organic acids (except oxalic). Acid phosphates, such as NaH_2PO_4, are neutral to methyl orange.

Cochineal.—The official tincture may be used as an indicator. It gives a deep crimson with alkalies, and a yellowish-red with acids. It is very suitable for use in titrating alkaloids with mineral acids, the alkaloids giving the same colour as mineral alkali. It is not suitable for use with organic acids. Acid phosphates are neutral to cochineal.

Phenolphthalein.—One Gm. dissolved in 50 mils of alcohol and diluted to 100 mils with water makes a suitable solution. It gives a deep red colour with alkalies and no colour at all with acids. It is usually the best indicator to use in titrating organic acids, but is not suitable for use with ammonia. Carbon dioxide discharges the colour, hence in titrating the alkali in carbonates the carbon dioxide must be removed by boiling; but in such cases it is better to use methyl orange.

Iodeosin.—An aqueous solution of the strength of 0·01 per cent. is suitable for use. When the indicator is employed, 10 to 20 mils of ether must be added, so as to form an ethereal layer above the aqueous liquid. Alkalies give a rose-red colour in the aqueous liquid, acids a yellow colour in the ethereal layer. This indicator is very suitable for titrating minute amounts of alkali with centinormal (or weaker) acid, and for small quantities of alkaloids, which react alkaline towards it.

Starch—One part of starch boiled with 200 of water yields a suitable indicator. After standing, the clear liquid is poured off from the sediment. This indicator is used to show free iodine in titrations of or with iodine in which the colour of the liquid prevents the tint of the iodine itself being observed.

Potassium Chromate.—A cold saturated aqueous solution is suitable. This indicator is only used in titrations with silver nitrate, the end-point being shown when the red silver chromate, formed by the silver nitrate dropping into the liquid, does not disappear on gently shaking or stirring.

Potassium Ferricyanide.—A 1 per cent. aqueous solution is suitable, and it must be freshly prepared. This indicator is only used in titrating ferrous iron with bichromate solution; a series of drops of the indicator are put on a white plate, and

small drops of the iron solution are removed from time to time as the titration proceeds and tested by adding to the ferricyanide; the end-point is reached when a blue or green colour is no longer produced.

FERRIC SULPHATE.—A 10 per cent. aqueous solution is suitable. It may be made by oxidising ferrous sulphate with nitric acid, and driving off nitrous fumes by evaporating with excess of sulphuric acid; a saturated solution of iron alum is also suitable. This indicator is only used in titrating silver solutions with ammonium or potassium thiocyanate, the red colour of ferric thiocyanate only appearing after all the silver is precipitated. About 2 mils of the indicator should be used.

Tables of Volumetric Solutions and Equivalents.

In the following tables, the factors are given for N/1 or N/10 solutions, according to which is the more frequently used. The factors for N/10 solutions are, of course, obtainable from those for N/1 solutions, or *vice versâ*, by merely moving the decimal point.

STANDARD ACID SOLUTIONS: NORMAL.

Sulphuric Acid, 49·038 Gm. H_2SO_4 in 1,000 mils (B.P. 48·67).
Hydrochloric Acid, 36·458 Gm. HCl in 1,000 mils.
Nitric Acid, 63·018 Gm. HNO_3 in 1,000 mils.
Oxalic Acid, 63·024 Gm. $H_2C_2O_4 2H_2O$.
Indicator:—Methyl orange, litmus, lacmoid, rosolic acid, phenolphthalein, or cochineal.

One mil N/1 acid is equivalent to—

Sodium Hydroxide, NaOH	0·040058 Gm.
Potassium Hydroxide, KOH	0·056158 Gm.
Ammonia, NH_3	0·017034 Gm.
Ammonium Hydroxide, NH_4OH	0·035050 Gm.
Sodium Carbonate, Anhydrous, Na_2CO_3	0·053050 Gm.
Sodium Carbonate, Cryst., $Na_2CO_3 10H_2O$	0·143130 Gm.
Potassium Carbonate, K_2CO_3	0·069150 Gm.
Ammonium Carbonate, $(NH_4)_2CO_3$	0·048042 Gm.
"Ammonium Carbonate, B.P.," $N_3H_{11}C_2O_5$	0·052373 Gm.
Lithium Carbonate, Li_2CO_3	0 037030 Gm.
Calcium Carbonate, $CaCO_3$	0·050050 Gm.
Sodium Bicarbonate, $NaHCO_3$	0·084058 Gm.
Potassium Bicarbonate, $KHCO_3$	0 100158 Gm.
Ammonium Bicarbonate, NH_4HCO_3	0·079050 Gm.
Quicklime, CaO	0·028050 Gm.
Slaked Lime, $Ca(OH)_2$	0·037058 Gm.
Magnesia, MgO	0·020180 Gm.
"Magnesium Carbonate, B.P.," $Mg_4(OH)_2(CO_3)_3 4H_2O$	0·047940 Gm.
Borax, $Na_2B_4O_7 10H_2O$	0·191130 Gm.
Potassium Acetate (ignited), $KC_2H_3O_2$	0·049087 Gm.
Sodium Acetate (ignited), $NaC_2H_3O_2 3H_2O$	0·136122 Gm.

Potassium Citrate (ignited), $K_3C_6H_5O_7$	0·102163 Gm.
Lithium Citrate (ignited), $Li_3C_6H_5O_7 \cdot 4H_2O$	0·094065 Gm.
Potassium Tartrate (ignited), $(K_2C_4H_4O_6)_2H_2O$..	0·117670 Gm.
Potassium Acid Tartrate (ignited), $KHC_4H_4O_6$..	0·188190 Gm.
Sodium Potassium Tartrate (ignited), $KNaC_4H_4O_6,4H_2O$	0·141148 Gm.
Sodium Phosphate (with methyl orange), $Na_2HPO_412H_2O$	0·358300 Gm.

Examples:—(1) 2·0 Gms. sodium bicarbonate was dissolved in water and titrated with N/1 HCl, using methyl orange as indicator: the volume required was 23·1 mils.

$$23{\cdot}1 \times 0{\cdot}084058 = 1{\cdot}9417. \quad \frac{1{\cdot}9417}{2} \times 100 = 97{\cdot}085 \text{ per cent.}$$

$$NaHCO_3 + HCl = NaCl + H_2O + CO_2$$
$$84{\cdot}058 \qquad 36{\cdot}458 \ (= 1 \text{ lit. N/1}).$$

(2) 0·3 Gm. lithium citrate was ignited, and the ash dissolved in water and titrated with N/10 H_2SO_4; 29·6 mils were required.

$$29{\cdot}6 \times 0{\cdot}0094065 = 0{\cdot}2784. \quad \frac{0\ 2784}{0{\cdot}3} \times 100 = 92{\cdot}8 \text{ per cent.}$$

$$2(Li_3C_6H_5O_7 \cdot 4H_2O) + 9O_2 = 3Li_2CO_3 + 9CO_2 + 13H_2O$$
$$[2 \times 282{\cdot}194 = 564{\cdot}388] \qquad [3 \times 74{\cdot}06 = 222{\cdot}18]$$
$$3Li_2CO_3 + 3H_2SO_4 = 3Li_2SO_4 + 3H_2O + 3CO_2$$
$$222{\cdot}18 \qquad [3 \times 98{\cdot}076 = 294{\cdot}228]$$

564·388 lithium citrate consume 294·228 H_2SO_4

∴ 9·4065 lithium citrate consume 4·9038 (=1 lit. N/10)

Standard Alkali Solutions: Normal.

Caustic Soda, 40·058 Gm. NaOH in 1,000 mils (B.P., 39·76)
Caustic Potash, 56·158 Gm. KOH in 1,000 mils.

Indicator:—Methyl orange, litmus, lacmoid, rosolic acid, or phenolphthalein.

One mil N/1 alkali is equivalent to—

Sulphuric Acid, H_2SO_4	0·049038 Gm.
Hydrochloric Acid, HCl	0·036458 Gm.
Nitric Acid, HNO_3	0·063018 Gm.
Oxalic Acid, $H_2C_2O_42H_2O$	0·063024 Gm.
Acetic Acid, $HC_2H_3O_2$	0·060032 Gm.
Citric Acid, $H_3C_6H_5O_7H_2O$	0·070027 Gm.
Hydrobromic Acid, HBr	0·080968 Gm.
Hydriodic Acid, HI.....	0·127978 Gm.
Lactic Acid, $HC_3H_5O_3$	0·090048 Gm.
Sulphurous Acid, H_2SO_3	0·041038 Gm.
Tartaric Acid, $H_2C_4H_4O_6$	0·075024 Gm.
Potassium Acid Tartrate, $KHC_4H_4O_6$	0·188190 Gm.
Boric Acid, H_3BO_3	0·062024 Gm.

Phosphoric Acid (with methyl orange), H_3PO_4 0·098024 Gm.
Phosphoric Acid(with phenolphthalein), H_3PO_4 0·049012 Gm.

Example:—3 Gm. of a solution of lactic acid required 17·85 mils of N/1 NaOH, using phenolphthalein as indicator.

0·090048 × 17·85 = 1·6074. $\frac{1·6074}{3} \times 100 = 53·58$ per cent.

$HC_3H_5O_3 + NaOH = NaC_3H_5O_3 + H_2O$
90·048 40·058 (= 1 lit. N/1)

STANDARD ALKALI SOLUTIONS: DECINORMAL.

Sodium Carbonate .. 14·313 Gm., $Na_2CO_3 10H_2O$ in 1,000 mils.
Ammonia ..... 1·7034 Gm., NH_3 in 1,000 mils.
Barium Hydroxide .. 8·5708 Gm., $Ba(OH)_2$ in 1,000 mils.

Indicator:—Methyl orange, or cochineal.

Equivalents, one-tenth of those given above for N/1 solutions

STANDARD PERMANGANATE SOLUTION: DECINORMAL.

Potassium Permanganate, 3·163 Gm.. $KMnO_4$ in 1,000 mils.

Indicator:—The pink colour produced by one drop of the solution itself in excess of requirement.

STANDARD BICHROMATE SOLUTION.—DECINORMAL.

Potassium Bichromate, 4·9083 Gm. $K_2Cr_2O_7$ in 1,000 mil (B.P. 4·87).

Indicator:—Potassium Ferricyanide.

1 mil N/10 $KMnO_4$ or $K_2Cr_2O_7$ is equivalent to:—

Iron, Fe″	0·005590 Gm.
Ferrous Sulphate, $FeSO_4 7H_2O$	0·027807 Gm.
Ferrous Sulphate (dried), $FeSO_4 H_2O$	0·016998 Gm.
Ferrous Ammonium Sulphate, $FeSO_4(NH_4)_2 SO_4 6H_2O$	0·039220 Gm.
Ferrous Phosphate, $Fe_3(PO_4)_2 8H_2O$	0·016728 Gm.
Ferrous Arsenate, $Fe_3(AsO_4)_2 6H_2O$	0·018460 Gm.
Ferrous Carbonate, $FeCO_3$	0·011590 Gm.
Oxalic Acid, $H_2C_2O_4 2H_2O$	0·006302 Gm.
Hydrogen Peroxide, H_2O_2	0·001701 Gm.

Example:—1·0 of a Blaud's Pill mass required 14·7 mils of N/10 bichromate.

14·7 × 0·011590 = 0·1704 = 17·04 per cent. of ferrous carbonate.

$6FeCO_3 + K_2Cr_2O_7 + 13H_2SO_4 = 3Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + 13H_2O + 6CO_2$.
6 × 115·9 294·5.
11·59 4·9083 (= 1 lit. N/10).

STANDARD IODINE SOLUTION: DECINORMAL.

Iodine, 12·697 Gm. in 1,000 mils (B.P. 12·59).

Indicator:—Starch.

One mil N/10 Iodine is equivalent to:—

Sulphurous Acid, H_2SO_3	0·004104 Gm.
Sulphur Dioxide, SO_2	0·003203 Gm.

Sodium Sulphite, Cryst., $Na_2SO_3 7H_2O$	0·012614 Gm.
Sodium Sulphite, Anhydrous, Na_2SO_3	0·006308 Gm.
Sodium Bisulphite, $NaHSO_3$	0 005206 Gm.
Potassium Metabisulphite, $K_2S_2O_5$	0·005560 Gm.
Sodium Thiosulphate, $Na_2S_2O_3 5H_2O$	0·024830 Gm.
Arsenious Oxide, As_4O_6	0·004950 Gm.
Antimonious Oxide, Sb_4O_6	0·007210 Gm.
Tartar Emetic $(KSbOC_4H_4O_6)_2H_2O$	0·016619 Gm.

Example :—0·3 Gm. of crystallised sodium sulphite required 18·35 mils N/10 iodine.

·012614 × 18·35 = 0·2315. $\frac{0·2315}{0·3}$ × 100 = 77·17 per cent.

$$Na_2SO_3 7H_2O + I_2 + H_2O = Na_2SO_4 + 2HI + 7H_2O$$
252·27 253·94
12·614 12·697 (= 1 lit. N/10)

STANDARD THIOSULPHATE SOLUTION: DECINORMAL.

Sodium Thiosulphate, 24·83 Gm., $NaS_2O_3 5H_2O$ in 1,000 mils (B.P., 24·644).

STANDARD ARSENIOUS ACID: DECINORMAL.

Arsenious Anhydride, 4·95 Gm., As_4O_6 in 1,000 mils.

For titration of iodine, free, or liberated from KI.

Indicator :—Starch.

1 mil N/10 thiosulphate or arsenious acid is equivalent to—

Iodine, I	0·012697 Gm.
Bromine, Br	0·007996 Gm.
Chlorine, Cl	0·003545 Gm.
Iron, Fe'''	0·005590 Gm.
Ferric Oxide, Fe_2O_3	0·007990 Gm.
Chromic Anhydride CrO_3	0·003337 Gm.
Potassium Bichromate, $K_2Cr_2O_7$	0·004908 Gm.
Potassium Chromate, K_2CrO_4	0·006480 Gm.

Example :—1·0 Gm. of scale ferric phosphate liberated iodine which required 21·5 mils of N/10 thiosulphate.

21·5 × 0·00559 = 0·1202 Fe''' = 12·02 % of iron in ferric state.

$$6FePO_4 + 6KI + 2HCl = 2Fe_3(PO_4)_2 + 2K_2HPO_4 + 2KCl + 3I_2$$
[6 × 55·9 = 335·4 Fe] [6 × 126·97 = 761·82]

$$3I_2 + 6Na_2S_2O_3 5H_2O = 6NaI + 3Na_2S_4O_6 + 30H_2O$$
761·82 [6 × 248·3 = 1489·8]

∴ 335·4 Fe = 1489·8 cryst. thiosulphate
5·59 Fe = 24·83 cryst. thiosulphate (= 1 lit. N/10)

STANDARD SILVER SOLUTION: DECINORMAL.

Silver Nitrate, 16·994 Gm. in 1,000 mils (B.P. 16·869).

Indicator :—Potassium Chromate.

One mil N/10 silver nitrate is equivalent to—

Ammonium Chloride, NH_4Cl	0·005349 Gm.
Potassium Chloride, KCl	0·007460 Gm.
Sodium Chloride, NaCl	0·005850 Gm.

mmonium Bromide, NH_4Br	0·009800 Gm.
otassium Bromide, KBr	0·011911 Gm.
odium Bromide, NaBr	0·010301 Gm.
mmonium Iodide, NH_4I	0·014501 Gm.
otassium Iodide, KI	0·016612 Gm.
odium Iodide, NaI	0·015002 Gm.
ydrochloric Acid, HCl	0·003646 Gm.
ydrobromic Acid, HBr	0·008097 Gm.
ydriodic Acid, HI	0·012798 Gm.
hlorine, Cl	0·003545 Gm.
romine, Br	0·007996 Gm.
odine, I	0·012697 Gm.
Hydrocyanic Acid, HCN	0·005404 Gm.
Potassium Cyanide, KCN	0·012032 Gm.
errous Chloride, $FeCl_2$	0·006340 Gm.
errous Bromide, $FeBr_2$	0·010791 Gm.
errous Iodide, FeI_2	0·015492 Gm.
rontium Bromide, $SrBr_26H_2O$	0·017781 Gm.
rontium Iodide, SrI_26H_2O	0·022482 Gm.

(*Chromate indicator not required; see below.)

Example :—0·3 Gm. sodium bromide required 28·5 mils N/10, $AgNO_3$. $28{\cdot}5 \times 0{\cdot}010301 = 0{\cdot}2936$. $\frac{0{\cdot}2936}{0{\cdot}3} \times 100 = 97{\cdot}87$ per cent. NaBr.

$NaBr + AgNO_3 = NaNO_3 + AgBr.$

103·01 169·94

10·301 16·994 (= 1 lit. N/10).

STANDARD THIOCYANATE SOLUTION: DECINORMAL.

Potassium Thiocyanate, 9·722 Gm. or Ammonium Thiocyanate, 7·6112 Gm., in 1,000 mils.

Indicator :—Ferric Sulphate.

One mil N/10 thiocyanate is equivalent to :—

lver, Ag	0·010793 Gm.
lver nitrate, $AgNO_3$	0·016994 Gm.

Notes.

BORIC ACID.—To titrate boric acid, a little methyl orange is be added, and the liquid neutralised, then boiled to expel any rbonic acid. After cooling, an equal volume of glycerin is lded, and a little phenolphthalein, and the liquid titrated ith standard alkali until the red colour appears; the yellow lour due to the methyl orange does not interfere at all. The nount of glycerin must be enough to form not less than one-ird of the volume of the liquid when the titration is com-eted; the number of mils of alkali used in the titration with henolphthalein shows the boric acid. Phosphate must be esent or allowed for.

Both the alkali and the boric acid in borax can be determined using this method.

PHOSPHATE.—Phosphoric acid or alkali phosphate can be determined in the presence of some other substances of an acid or alkaline nature by first neutralising with methyl orange as indicator, when NaH_2PO_4 or a corresponding salt will be present, then adding phenolphthalein, and titrating with alkali until the red colour appears, when Na_2HPO_4 has been formed. One equivalent of alkali used in the titration with phenolphthalein represents one PO_4.

CARBONATE AND BICARBONATE.—Carbonate and bicarbonate may be determined in one solution as follows:—Add phenolphthalein and titrate with acid until the red colour disappears; the carbonate is then all changed to bicarbonate; then add methyl orange and continue the titration until the end point is reached with this indicator. Double the number of mils used in the first stage represents the carbonate, and the difference between this double number and the total number of mils used represents the bicarbonate originally present. The liquid must be dilute and must be kept *gently* moving so as to prevent loss of CO_2 in the first stage.

IRON IN FERRIC STATE.—A suitable quantity of the compound, usully 0·5 Gm. to 1·0 Gm., is dissolved in about 15 mils water, and 2 mils ordinary strong hydrochloric acid and 1·0 potassium iodide added. The flask or bottle must then be stoppered and the whole kept at a temperature of 40° C. for just half an hour. It is then cooled and the free iodine titrated.

CYANIDE.—When potassium cyanide is titrated with silver nitrate no precipitate is formed until after half the salt has become converted to silver cyanide, which combines with the remainder, forming the double salt, KCNAgCN. The addition of one drop more of the silver solution causes a turbidity, indicating the end-point. Hydrocyanic acid must be first converted to a cyanide. It is best to add a little phenolphthalein and caustic alkali until the red colour appears. On running in silver nitrate the red colour soon disappears and more alkali must be added until it is restored, when the titration is continued. The addition of alkali is repeated as often as is necessary, so that the liquid is alkaline when the end-point is reached with the silver solution.

THIOCYANATE SOLUTION.—In titrating with this free nitric acid should be present. It is useful not only for the direct titration of silver in solutions, but also for determination of substances precipitable by silver in an acid liquid. For example, to titrate HCl in a mixture of HCl and HNO_3, or HCl and H_2SO_4, without neutralising; add excess of N/10 $AgNO_3$, and then, without filtering out the AgCl, add ferric sulphate, and titrate the excess of silver by means of thiocyanate; the difference between the volume of the latter used and the volume of $AgNO_3$ added gives the amount used up by the HCl.

PERCENTAGES CORRESPONDING TO B.P. TESTS.

Substance.	B.P. Requirement.	Corresponding Percentage.
Acid. Acetic	1·0 req. 5·5 mils N/1 NaOH	32·77 per cent. $C_2H_4O_2$
Acid. Acetic. Dil.	1·0 req. 7·1 mils N/10 NaOH	4·23 per cent. $C_2H_4O_2$
Acid. Acetic. Glacial..	1·0 req. 16·6 mils N/1 NaOH	98·90 per cent. $C_2H_4O_2$
Acid. Arsenios	0·25 req. 50·8 to 50·9 mils N/10 I.....	98·89 to 100·09 per cent. As_4O_6
Acid. Citric.....	1·0 req. 14·3 mils N/1 NaOH	99·38 per cent. $C_6H_8O_7 \cdot H_2O$
Acid. Hydrobrom. Dil.	4·0 req. 4·98 mils N/1 NaOH ..... 4·0 req. 49·8 mils N/10 $AgNO_3$	10·00 per cent. HBr
Acid. Hydrochlor ..	1·0 req. 8·7 mils N/1 NaOH ..... 0 1 req. 8·7 mils N/10 $AgNO_3$	31·48 per cent. HCl
Acid. Hydrochlor. Dil.	1·0 req. 2·9 mils N/1 NaOH	10·49 per cent. HCl
Acid. Hydrocyan. Dil.	1·0 req. 3·7 mils N/10 $AgNO_3$	1·99 per cent. HCN
Acid. Lactic	1·0 req. 8·3 mils N/1 NaOH	74·18 per cent. $C_3H_6O_3$
Acid. Nitric.....	1·0 req. 11·1 mils N/1 NaOH	69·46 per cent. HNO_3
Acid. Nitric Dil.	1·0 req. 2·7 mils N/1 NaOH	16·90 per cent. HNO_3
Acid. Sulphuric	1·0 req. 20·1 mils N/1 NaOH.....	97·83 per cent. H_2SO_4
Acid. Sulphuric Dil...	1·0 req. 2·8 mils N/1 NaOH	13·63 per cent. H_2SO_4
Acid. Sulphurous	1·0 req. 15·7 mils N/10 I	6·39 per cent. H_2SO_3
Acid. Tartaric	1·0 req. 13·3 mils N/1 NaOH	99·03 per cent. $C_4H_6O_6$

Belladonna alkaloids; when using solutions prepared by International atomic weights, the factor 0·00289 must be used instead of 0·00287. Morphine in assay of opium and its preparations; the factor 0·0287 must be used instead of 0·0285.

PERCENTAGES CORRESPONDING TO B.P. TESTS.

Substance.	B.P. Requirement.	Corresponding Percentage.
Ammon. Bromid	0·5 req. 51·1 to 51·8 mils N/10 $AgNO_3$	99·43 to 100·79 per cent. NH_4Br
Ammon. Carbonas....	1·0 req. 18·7 mils N/1 H_2SO_4.....	97·26 per cent. $N_3H_{11}C_2O_5$
Antim. Oxid.	0·5 req. 70 mils N/10 I	99·97 per cent. Sb_4O_6
Antim. Tart.	1·0 req. 60·2 to 60·7 mils N/10 I	99·20 to 100·02 per cent. $(KSbOC_4H_4O_6)_2H_2O$
Borax	1·0 req. 5·2 mils N/1 H_2SO_4	98·57 per cent. $Na_2B_4O_710H_2O$
Chloral Hydras.....	4·0 req. 24 mils N/1 NaOH	98·49 per cent. $CCl_3CH(OH)_2$
Ferri Arsenas	1·0 req. 6·7 mils N/10 $K_2Cr_2O_7$	9·89 per cent. $Fe_3(AsO_4)_2$
Ferri Carb. Sacch.....	1·0 req. 29 mils N/10 $K_2Cr_2O_7$	16·12 per cent. Fe″
Ferri Phosph.	1·0 req. 28·2 mils N/10 $K_2Cr_2O_7$	46·86 per cent. $Fe_3(PO_4)_28H_2O$
Ferri Sulph.	1·0 req. 36 mils N/10 $K_2Cr_2O_7$	99·40 per cent. $FeSO_47H_2O$
Ferri Sulph. Exsicc...	1·0 req. 54·6 mils N/10 $K_2Cr_2O_7$	92·18 per cent. $FeSO_4H_2O$
Ferrum Redact.....	0·25 req 33·7 mils N/10 $K_2Cr_2O_7$	74·95 per cent. Fe (metal)
Iodum.....	1·0 req. 78·4 mils N/10 $Na_2S_2O_3$	98·71 per cent. I
Liq. Ammon.	1·0 req. 5·9 mils N/1 H_2SO_4	9·99 per cent. NH_3
Liq. Ammon. Fort. ..	1·0 req. 19·1 mils N/1 H_2SO_4.....	32·36 per cent. NH_3
Liq. Arsenicalis .... / Liq. Arsenici Hydroch	25 mils req. 50·8 to 50·9 mils N/10 I ..	0·999 to 1·00 As_4O_6 in 100 fl.
Liq. Calcis	24 mils req. 10 mils N/10 H_2SO_4	0·15 $Ca(OH)_2$ in 100 fl.
Liq. Calcis Chlorinat.	1·0 req. 5·6 mils N/10 $Na_2S_2O_3$	1·97 per cent. Cl
Liq. Calcis Sacch.....	10·0 req. 6·3 mils N/1 H_2SO_4.....	2·31 per cent. $Ca(OH)_2$
Liq. Plumbi Subacet. Fort.....	1·0 req. 17 mils N/10 H_2SO_4	34·9 per cent. Pb
Liq. Potassæ	9 mils req. 10 mils N/1 H_2SO_4	5·85 per cent. KOH

Liq. Sod. Chlorinat. ..	3·5 req. 25 mils N/10 $Na_2S_2O_3$	2·51 per cent. Cl
Potass. Caustic	1·0 req. 16·1 mils N/1 H_2SO_4	89·69 per cent. KOH
Potass. Bicarb.	1·0 req. 10 mils N/1 H_2SO_4	99·38 per cent. $KHCO_3$
Potass. Bichrom.	1·0 req. 5·66 ferrous sulphate	99·87 per cent. $K_2Cr_2O_7$
Potass. Bromid.	1·0 req. 83·7 to 85·4 mils N/10 $AgNO_3$..	98·92 to 100·93 per cent. KBr
Potass. Carbonas	1·0 req. 11·9 mils N/1 H_2SO_4	81·64 per cent. K_2CO_3
Potass. Citras.....	Ash of 1·0 req. 9·7 mils N/1 H_2SO_4	98·33 per cent. $K_3C_6H_5O_7$
Potass. Iodid.....	1·0 req. 59·5 to 61·9 mils N/10 $AgNO_3$..	99·01 to 101·97 per cent. KI
Potass. Permang.	1·0 req. 31·2 mils N/1 $H_2C_2O_4$	97·89 per cent. $KMnO_4$
Potass. Tartras	Ash of 1·0 req. 8·4 mils N/1 H_2SO_4	101·83 per cent. $K_2C_4H_4O_6H_2O$ [=98·07 $(K_2C_4H_4O_6)_2H_2O$]
Potass. Tartras Acid..	1·0 req. 5·2 mils N/1 NaOH	97·11 per cent. $KHC_4H_4O_6$
Quinin. Hydroch. Acid	1·0 req. 2·5 mils N/1 NaOH	9·05 per cent. HCl in excess of neutral salt
Sapo Animal. ..... Sapo Durus ..... Sapo Mollis	5·0 req. 3 mils N/10 H_2SO_4	0·32 per cent. Na_2CO_3
Sod. Tartarat.	Ash of 1·0 req. 7 mils N/1 H_2SO_4.....	98·05 per cent. $NaKC_4H_4O_64H_2O$
Sod. Bicarb.	1·0 req. 11·8 to 11·9 mils N/1 H_2SO_4 ..	98·45 to 99·28 per cent. $NaHCO_3$
Sod. Bromid.....	1·0 req. 95·8 to 97·8 mils N/10 $AgNO_3$..	97·94 to 99·98 per cent. NaBr
Sod. Carb. (Cryst.) ..	1·0 req. 6·9 mils N/1 H_2SO_4	98·02 per cent. $Na_2CO_310H_2O$
Sod. Iodid.....	1·0 req. 66·5 mils N/10 $AgNO_3$	98·94 per cent. NaI
Sod. Sulphis	1·0 req. 77·7 to 81·7 mils N/10 I	97·27 to 102·28 per cent. $Na_2SO_37H_2O$
Syr. Ferri Iodid.	2·5 mils req, 16 to 16·5 mils N/10 $AgNO_3$	9·84 to 10·14 FeI_2 in 100 fl. oz.

Belladonna alkaloids; when using solutions prepared by International atomic weights, the factor 0·00289 must be used instead of 0·00287. Morphine in assay of opium and its preparations; the factor 0·0287 must be used instead of 0·0285.

DICTIONARY OF SYNONYMS.

IN this list synonyms are referred, whenever practicable, to standard names, such as those given in the British Pharmacopœia and The British Pharmaceutical Codex. Vegetable drugs are referred to botanical names, synthetic remedies are referred either to their best known names or to the systematic chemical names, and officinal preparations are referred to a typical formula in some standard formulary. Where a synonym is found to refer to a poisonous or otherwise dangerous substance, the pharmacist should take great care to assure himself that it has not been used in error. Most of the abbreviations used in the list explain themselves. *Reg.* indicates that the name is a trade-mark registered in the United Kingdom; *Pat.* indicates a patented preparation; *Approx.* indicates an approximate substitute for the preparation specified; *Exam.* signifies that the explanation given is an example of what is intended by the name under consideration. *Am.* = American common name; *Eng.* = English common name; *Obs.* = Obsolete. B.P. = British Pharmacopœia, 1898; B.P.C. = British Pharmaceutical Codex; P.L. = London Pharmacopœia; P.E. = Edinburgh Pharmacopœia; P.D. = Dublin Pharmacopœia; U.S.P. = Pharmacopœia of the United States; P.G. = Pharmacopoea Germanica; N.F. = National Formulary; P.J.F. = Pharmaceutical Journal Formulary.

NOTICE.—Certain names which are registered (*Reg.*) as trade-marks are included in this list, but it should be noted that it is an actionable infringement to treat them as synonyms in practice, as an action for damages may arise out of the substitution of an identical preparation by another maker, where a trade-mark description has been used. Occasionally careless prescribers attach wrong initials to a trade-mark; it is wiser in these cases to ignore the initials, since a trade-mark is a property enjoying specific legal protection, whereas the use of initials to indicate a maker is merely a custom.

ABATIA	Leaves of *Abatia rugosa*, used as a black dye.
A. B. C. Liniment.....	Linimentum Aconiti Compositum, B.P.C.
Abele	White Poplar.
Abernethy's Mixture	Mistura Sennæ Composita (*approx.*).
Abernethy's Pills	Pilulæ Colocynthidis et Hydrargyri, B.P.C.
Abies Bark.....	Hemlock Spruce Bark, from *Abies canadensis*.
Abies Canadensis	Hemlock Spruce, *Pinus canadensis*.
Abrastol	Asaprol (*Reg.*).
Abrus	Jequirity Seeds.
Absinthium	Wormwood, the Leaves and Flowering Tops of *Artemisia Absinthium*.

ccroides	Gum from *Xanthorrea arborea*.
.. C. E. Mixture	Vapor Chloroformi Compo., B.P.C.
cetaldehyde	Aldehyde.
cetanilide	Phenyl-acetamide ; Antifebrin.
cetannin	Diacetyl-Tannin ; Tannigen (*Reg.*).
cetate of Ethyl	Ethyl Acetate.
cetic Ether	Ethyl Acetate.
cetomorphine	Diacetyl-Morphine ; Heroin (*Reg.*).
cetone Chloroform	Chloroform prepared from Acetone.
cetophenone	Phenyl Methyl Acetone.
cetopyrin (*Reg.*)	Antipyrine Acetosalate.
cetosalic Acid	Acetyl-Salicylic Acid.
cetosella	Wood Sorrel.
cet-phenetidin	Phenacetin.
cetum	Vinegar.
cetum Aromaticum	Aromatic Vinegar,
cetum Epispasticum	Acetum Cantharidis.
cetum Fuscum	Malt Vinegar.
cetum Gallicum	French Wine Vinegar.
cetum Plumbi	Strong Solution of Lead Subacetate.
cetum Prophylacticum	Toilet Vinegar.
cetum Rubi Idæi	Raspberry Vinegar.
cetum Saturni	Liquor Plumbi Subacet. Fort.
cetyl-salicylic Acid	Acetosalic Acid.
cetyl-tannic Acid	Acetannin.
cetysal	Acetosalic Acid.
cid Bath	Diluted Nitrohydrochloric Acid, 1 Water, 320.
cid Carbonate	Bicarbonate.
cid Elixir, Haller's	Alcohol, 1 ; Sulphuric Acid, 1 ; both by weight.
cid Elixir of Vitriol	Aromatic Sulphuric Acid.
cid Linctus	Linctus Acidus, B.P.C.
cid Mixture	Mistura Acida, B.P.C.
cid of Sugar	Oxalic Acid.
cid Sulphate	Bisulphate.
cid Tartrate	Bitartrate.
cid Whey	Cow's Milk deprived of Cream, boiled with a little Cream of Tartar, and coagulated with Vinegar or Lemon Juice.
cidol (*Reg.*)	Betaine Hydrochloride.
cidum Aceticum Aromat.	Aromatic Acetic Acid, B.P.C.
cidum Aceticum Fort.	Acetic Acid, B.P.
cidum Acetosalicum	Acetyl-salicylic Acid.
cidum Arseniosum	White Arsenic.
cidum Benzoicum	Benzoyl Hydrate.
cidum Boracicum	Boric Acid.
cidum Carbazoticum	Picric Acid

Acidum Carbolicum.....	Phenol.
Acidum Citrosalicum	Novaspirin (*Reg.*).
Acidum Cresylicum	Crude Cresol.
Acidum Fluoricum	Hydrofluoric Acid.
Acidum Hydrobromicum Fothergill	Diluted Hydrobromic Acid (*approx.*)
Acidum Hydrocyanicum..	Hydrocyanic Acid, 2 per cent.
Acidum Hydrocyanicum, Scheele	Acidum Hydrocyanicum Fortius B.P.C.
Acidum Hydrosulphuricum	Sulphuretted Hydrogen.
AcidumMetaphosphoricum	Glacial Phosphoric Acid.
Acidum Muriaticum.....	Hydrochloric Acid.
Acidum Phenicum	Carbolic Acid.
Acidum Phenylicum	Carbolic Acid.
Acidum Prussicum	Hydrocyanic Acid.
Acidum Pyroligneum	Impure Acetic Acid.
Acidum Sacchari	Oxalic Acid.
Acidum Stearicum	Stearin.
Acidum Valerianicum....	Isovaleric Acid.
Acidum Vitriolic	Sulphuric Acid.
Acoin (*Reg.*).....	Guaincaine.
Acor Aceticus.....	Glacial Acetic Acid.
Actæa Root	Rhizome and Roots of *Cimicifuga racemosa.*
Actol (*Reg.*)	Silver Lactate.
Adder Oil	See Oil of Vipers.
Adeps Anseris	Goose-grease.
Adeps Lanæ	Wool Fat.
Adeps Myristicæ	Expressed Oil of Nutmeg.
Adeps Ovillus.....	Prepared Suet.
Adeps Suillus.....	Lard.
Adhesive Plaster	Resin Plaster.
Adnephrin	Adrenine.
Adonis.....	Leaves and Stalks of *Adonis vernalis.*
Adrenine	Adrenalin; Adnephrin; Adrin; Epirenan; Hæmostasin; Hemisine (*Reg.*); Epinephrine; Nephridine; Paranephrin; Renostypticin; Suprarenin (*Reg.*); Suprarenalin; Styptirenal (*Reg.*); Vasoconstrictine.
Adrin	Adrenine.
Ærugo	Verdigris; Copper Subacetate.
Ærugo Crystallizata	Copper Subacetate in Crystalline Masses.
Æther Rectificatus	Ether, B.P.
Æther Sulphuricus	Ether; Ethyl Ether.

Æthiops Mineralis	Hydrarg. Sulph. cum Sulph.
Æthiops Vegetabilis	Residue left on incinerating *Fucus vesiculosis* in a closed vessel.
Agar Agar	Japanese Isinglass.
Agurin (*Reg.*)	Theobromine-Sodium Acetate.
Airol (*Reg.*)	Bismuth Iodogallate.
Alcohol	Ethyl Alcohol, 90 per cent.
Alcohol, Ammoniated	See Ammoniated Alcohol.
Alcohol Ethylicum	Ethyl Hydroxide; Absolute Alcohol.
Alcohol Methylicum.....	Rectified Wood Spirit.
Alcohol Sulphuris.....	Carbon Bisulphide.
Aldehyde.....	Acetaldehyde.
Alder Buckthorn	*Rhamnus frangula.*
Aletodin	Acetosalic Acid.
Algaroth's Powder	Antimony Oxychloride.
Alkaline Bath	Balneum Alkalinum, B.P.C.
Alkanet	Root and Rhizome of *Anchusa tinctoria.*
Allspice	Pimento.
Almond Emulsion	Mistura Amygdalæ.
Alphacaine	Alpha-Eucaine (*Reg.*).
Alum Root.....	Root of *Geranium maculatum.*
Alumen Ustum	Burnt Alum; Alumen Exsiccatum.
Alumen Romanum	Roche Alum.
Alumen Rubrum	Roche Alum.
Alumina	Aluminium Oxide.
Alumnol (*Reg.*)	Aluminium-Naphthol Sulphonate.
Alypin (*Reg.*).....	Amydricaine.
Amber Seed	Seed of the Musk Mallow.
American Ashes	Crude Potassium Carbonate Potash.
American Elder	*Sambucus canadensis.*
American Hellebore.....	*Veratrum viride.*
American Olibanum	Oleoresin from *Juniperus phœnicea.*
American Pennyroyal	*Hedeoma pulegioides.*
American Senna	*Cassia marilandica.*
American Turpentine	Oil of Turpentine.
Amidol (*Reg.*)	Diamidophenol Hydrochloride.
Aminoform	Formamine.
Amidopyrine	Pyramidon (*Reg.*).
Ammonaldehyde	Formamine,
Ammonia, Rock	Ammonium Carbonate.
Ammonia Water	Solution of Ammonia.
Ammoniated Alcohol	Alcohol Ammoniatum, B.P.C.
Ammoniæ Hydrochloras..	Ammonium Chloride.
Ammoniæ Murias	Ammonium Chloride.
Ammoniæ Sesquicarbonas	Ammonium Carbonate.
Ammonio-Chloride of Mercury.....	Ammoniated Mercury.

Ammonio-Formaldehyde	Formamine.
Ammonium Ichthosulphonate	Ichthyol (*Reg.*).
Ammonium Sulphide	Ammonium Hydrosulphide.
Ammonium Sulphydrate	Ammonium Hydrosulphide.
Ammonium Sulphoichthyolate	Ichthyol (*Reg.*).
Amydricaine	Alypin (*Reg.*).
Amyl Hydrate	Amylic Alcohol.
Amylocaine	Stovaine (*Reg.*).
Amyloform (*Reg.*)	Formamylum.
Anæsthesin (*Reg.*)	Benzocaine.
Analgésine (*Reg.*)	Antipyrine.
Andeer's Lotion	Resorcin, 40 grains; Water, 1 fl. oz.
Angelica Root	Root of *Angelica archangelica.*
Angelica Seed	Seed of *Angelica atropurpurea.*
Angustura Bark	Cusparia Bark.
Animal Oil	Bone Oil; Dippel's Oil.
Aniseed Cordial	Aniseed Water, 4; Sugar, 1.
Annatto	Fruit Pulp of *Bixa orellana.*
Annotto	Annatto
Anodyne Balsam	Opium Liniment.
Anodyne Drops	Hoffman's Anodyne.
Anodyne Electuary	Confection of Opium, B.P.
Anodyne Liniment	Opium Liniment.
Anodynin	Antipyrine.
Antifebrin	Acetanilide.
Antimonii Oxysulphuret	Sulphurated Antimony.
Antimonii Potassio-Tart	Tartarated Antimony.
Antimonii Sulph. Aureum	Sulphurated Antimony.
Antimonii Sulph. Præcip	Sulphurated Antimony.
Antimonium Crudum	Black Antimony.
Antimonium Tartarizatum	Tartarated Antimony.
Aqozem	A Decoction.
Aqua	Distilled Water.
Aqua Aluminosa	Alum and Zinc Sulphates, each 1; Water, 80.
Aqua Ammoniæ	Solution of Ammonia.
Aqua Ammoniæ Acetatis	Solution Ammonium Acetate.
Aqua Amygdalæ Amaræ	Oil of Bitter Almond, 1; Water, 999.
Aqua Anthos	Rosemary Water.
Aqua Benedicta Comp.	Aqua Calcis Comp., P.D.
Aqua Calcis	Lime Water.
Aqua Chlori	Solution of Chlorine.
Aqua Coloniensis	Spiritus Coloniensis, B.P.C.
Aqua Fontana	Tap Water.
Aqua Dulcis	Chloroform Water.
Aqua Fortis	Strong Impure Nitric Acid

Aqua Lactucæ	Flowering Lettuce, 1; Water, 2. Distil half.
Aqua Lithiæ Effervescens	Lithia Water.
Aqua Mellis	Honey Water, B.P.C.
Aqua Menthæ	Peppermint Water.
Aqua Menthæ Sativæ	Spearmint Water.
Aqua Menthæ Vulgaris ..	Spearmint Water.
Aqua Naphæ	Orange Flower Water.
Aqua Phagedænica	Lotio Hydrarg. Flav.
Aqua Phagedænica Mitis..	Lotio Hydrarg. Nigra.
Aqua Picis	Tar Water.
Aqua Plumbi	Diluted Solution of Lead Subacetate.
Aqua Potassæ Effervescens	Potash Water.
Aqua Rabelli	Alcohol, 3; Sulphuric Acid, 1.
Aqua Raphani Comp.	Spiritus Armoraciæ Co.
Aqua Regia	Acidum Nitro-Hydrochloricum, B.P.C.
Aqua Saturni.....	Aqua Plumbi.
Aqua Sedativa	Spirit of Camphor, 10; Solution of Ammonia, 60; Sodium Chloride, 60; Distilled Water, 1000.
Aqua Sodæ Effervescens ..	Soda Water.
Aqua Styptica	Sol. Cupr. Sulph. Co., P.E.
Aqua Tiliæ.....	Lime Flower Water.
Aqua Vitæ	Brandy.
Archil	Purplish Liquid prepared from Lichens.
Argentum Vivum.....	Mercury.
Argol	Crude Cream of Tartar.
Aristol (*Reg.*)	Diiodo-thymol
Arnica Opodeldoc	Linimentum Arnicæ, B.P.C.
Arnicæ Radix	Arnica Rhizome.
Aromatic Confection	Confectio Aromat., B.P.C.
Aromatic Powder.....	Pulv. Aromat. Co., B.P.C.
Arrhenal (*Reg.*).....	Sodium Metharsenite.
Arsenic	Arsenious Anhydride.
Arsenicum Album.....	White Arsenic.
Arsenious Acid	White Arsenic.
Arsenious Anhydride	White Arsenic.
Asaprol (*Reg.*)	Calcium Naphthol-Sulphonate.
Asceptol	Sulphocarbolic Acid.
Ash, Manna	*Fraxinus Ornus.*
Ash, Prickly	*Xanthoxylum americanum.*
Asiatic Pill.....	Arsenic, $\frac{1}{12}$ gr.; Black Pepper, $\frac{3}{4}$ gr.
Aspirin (*Reg.*)	Acetosalic Acid.
Atramentum Nigrum....	Black Ink.
Atramentum Heberdenii..	Mist. Ferri Aromat., B.P.C.
Attar	Otto or Essential Oil.

Avena Decorticata	Groats.
Avenæ Farina	Oatmeal.
Avenæ Semina	Oats.
Axunge or Axungia	Lard.
Azadirach, Indian	Neem Bark; Margosa Bark.
Babul Bark	Acacia Bark.
Bael, Indian	Fruit of *Ægle Marmelos.*
Baking Soda	Sodium Bicarbonate.
Balm Drops	Friar's Balsam.
Balm of Gilead	Oleoresin of *Balsamodendron* sp.
Balsam Fir	*Abies balsamea.*
Balsam of Copaiba	Copaiba.
Balsam of Fern	Liquid Extract of Male Fern.
Balsam of Fir	Canada Balsam or Turpentine.
Balsam of Life	Compound Decoction of Aloes.
Balsam of Soap	Soap Liniment.
Balsam of Storax	Prepared Storax.
Balsam of Sulphur	Sulphur, 1; Olive Oil, 4 or 9 (heated together till they combine).
Balsamum Commendatoris	Compound Tincture of Benzoin.
Balsamum Dipterocarpi	Gurjun Oil.
Balsamum Styracis	Prepared Storax.
Balsamum Terebinthinæ	Dutch Drops.
Balsamum Tranquillans	Compound Oil of Hyoscyamus, N.F.
Balsamum Traumaticum	Compound Tincture of Benzoin.
Balsamum Universale	Camphor, 1; Lead Acetate, 6; Beeswax, 16; Rape Oil, 48.
Barbados Tar	Bitumen or Mineral Tar.
Barbaloin	Aloin from Barbados Aloes.
Barley Water	Decoction of Barley.
Baryta or Barytes	Barium Oxide.
Basham's Mixture	Liq. Ferri et Ammon. Acet., U.S.P.
Basilicon Ointment	Resin Ointment.
Bassora Gum	Hog Tragacanth.
Baume de Vie	Compound Decoction of Aloes.
Bay Berries	Fruit of *Laurus nobilis.*
Bayberry	*Myrica cerifera.*
Bay, English	*Laurus nobilis.*
Bay Laurel	*Myrcia acris.*
Bay Rum	Spiritus Pimentæ, B.P.C.
Bay Salt	Sea Salt.
Bay, Sweet (*Am.*)	*Magnolia virginiana* or *Pimenta acris.*
Bay, Sweet (*Eng.*)	*Laurus nobilis.*
Beaume de Mecca	Balm of Gilead.
Bebeeru Bark	Bark of *Nectandra Rodiæi.*

Benjamin	Benzoin.
Benne Oil	Sesame Oil.
Benzene	Purified Benzol.
Benzin	Petroleum Spirit or Ether.
Benzol	Impure Benzene.
Benzoline	Petroleum Spirit.
Benzocaine	Anæsthesin (*Reg.*); Para-Amido-Benzoic Acid Ethyl Ester.
Benzocaine Sulphophenate	Subcutin (*Reg.*).
Benzosol (*Reg.*)	Benzoyl Guaiacol.
Benzoyl Hydrate	Benzoic Acid.
Benzylmorphine	Benzyl-Morphine Hydrochloride; Peronin (*Pat.*).
Bertoni's Ether	Tertiary Amyl Nitrite.
Betacaine	Beta-Eucaine (*Reg.*).
Beta-Naphthol	Naphthol, B.P.
Betel	Leaves of *Piper Betle*.
Betel Nuts	Areca Nuts.
Betol (*Reg.*)	Naphthol Salicylate.
Biborate of Soda	Borax.
Biniodide of Mercury	Red Mercuric Iodide.
Binoxide	Dioxide.
Biogen	Manganese Peroxide.
Birch Tar Oil	Oil from Wood of *Betula alba*.
Bird Pepper	Capsicum devoid of pungency.
Bikh or Bish	Root of *Aconitum ferox*.
Bismuth Nitrate	Bismuth Subnitrate.
Bismuth Oxycarbonate	Bismuth Carbonate.
Bismuth Oxynitrate	Bismuth Subnitrate.
Bismuth Subcarbonate	Bismuth Carbonate.
Bismuthose (*Reg.*)	Bismuth Albuminate.
Bismuthum Album	Bismuth Subnitrate.
Bisulphate of Potash	Acid Potassium Sulphate.
Bitartrate of Potash	Acid Potassium Tartrate.
Bitter Apple	Colocynth Pulp.
Bittersweet, False (*Am.*)	*Celastrus scandens*.
Bittersweet, False (*Eng.*)	*Solanum Dulcamara*.
Bitter Wood	Quassia.
Black Antimony	Black Antimony Sulphide.
Black Bryony	*Tamus communis*.
Black Cohosh	*Cimicifuga racemosa*.
Black Draught	Compound Mixture of Senna.
Black Drop	Acetum Opii, B.P.C.
Black Haw	*Viburnum prunifolium*.
Black Jam	Confection of Senna.
Black Lead	Graphite.
Black Liquorice	Liquorice Extract in Sticks.
Black Oxide of Iron	Magnetic Oxide of Iron.

Black Oxide of Mercury ..	Mercurous Oxide.
Black Snake Root.....	*Cimicifuga racemosa.*
Black Sugar	Liquorice Extract in Sticks.
Black Sulphur	Impure Native Sulphur.
Black Wash	Lotio Hydrargyri Nigra.
Bladder Wrack	*Fucus vesiculosus.*
Blanc de Baleine	Spermaceti.
Blanc d'Espagne	Precipitated Bismuth Oxychloride.
Blanc de Fard	Bismuth Oxychloride.
Blanc de Perle	Precipitated Bismuth Oxychloride, or a mixture of Zinc Oxide, 1, Bismuth Oxychloride, 1.
Blanchard's Pills	Pil. Ferri Iodidi (*approx.*).
Blaud's Pills	Pilula Ferri, B.P.
Bleaching Liquid	Solution of Chlorinated Lime.
Bleaching Powder	Chlorinated Lime.
Blistering Flies or Beetles	Cantharides.
Blistering Liquid	Liquor Epispasticus.
Blood Root.....	*Sanguinaria canadensis.*
Blue Butter	Blue Ointment.
Blue Copperas	Copper Sulphate.
Blue Gum Tree.....	*Eucalyptus Globulus.*
Blue Ointment or Unction	Ung. Hydrarg. Dil., B.P.C.
Blue Pill.....	Mercury Pill.
Blue Stone or Vitriol	Copper Sulphate.
Boiled Oil	Linseed Oil boiled with Litharge.
Boldo	Leaves and Young Twigs of *Peumus fragrans.*
Bole, Armenian or Red ..	Native Ferric Oxide.
Bole, White	Kaolin; China Clay.
Bolus*	A large soft Pill, weighing from 10 to 20 grains.
Bolus Alba	Kaolin.
Bone Ash or Earth	Crude Calcium Phosphate.
Bone Black.....	Crude Animal Charcoal.
Bone Marrow, Red	Marrow of Young Calf Bones.
Bone Oil.....	Oil distilled from Bones, Horn, etc.
Boracic Acid	Boric Acid.
Boral	Aluminium Borotartrate.
Borate of Soda	Borax.
Boric Honey	Mel Boricum, B.P.C.
Boro-Glyceride	See Boroglycerinum, B.P.C.
Branalcane.....	Boric Acid Preservative.
Brandish's Solution	Impure Solution of Potash.

* Boluses were often taken wrapped in tissue paper or enclosed in the skin of a raisin. Sometimes they were made very soft, and the patient was directed to *lick* them from the paper.

Brandy	A Spirituous Liquid distilled from Wine, containing not less than 36½ per cent. by weight of Alcohol.
Brandy, Indian	See Indian Brandy.
Brandy Mixture	Mistura Spiritus Vini Gallici, B.P.
Brazil Wax	Carnauba Wax.
Brazil Wood	Wood of *Cæsalpinia tinctoria* and other species.
Breakstone	*Alchemilla arvensis*; Parsley Piert.
Brimstone	Sublimed Sulphur.
British Gum	Dextrin.
Bromalin (*Reg.*)	Bromethylformine.
Brominol	Sesame Oil with 10 or 33 per cent. of Bromine.
Bromipin (*Reg.*)	Brominol.
Bromoform	Formyl Tribromide.
Bromol	Tribromphenol.
Brown Soap Plaster	Soap Plaster, B.P.
Brown-Sequard's Fluid	Spermin.
Browning	Burnt Sugar.
Bryony	*Bryonia alba*; *B. dioica*.
Bryony, Black	*Tamus communis*.
Buckbean	*Menyanthes trifoliata*.
Buckthorn	*Rhamnus catharticus*.
Burgundy Pitch	Resin from *Picra excelsa*.
Burnett's Disinfectg. Fluid	Solution of Zinc Chloride, B.P.
Burnt Alum	Alum Exsiccatum
Burow's Solution	Aluminium Acetate Solution (7½ to 8 per cent.).
Butea Gum	Kino from *Butea frondosa*.
Butipyrine	Trigemin.
Butter of Antimony	Solution of Antimony Chloride, B.P.C.
Butter of Zinc	Zinc Chloride.
Butyl-Amidopyrine	Trigemin.
Byne or Bynes	Malt.
Cabardine Musk	Inferior Musk from Thibet.
Cabbage Oil	Oil of Elder (*approx.*).
Cacao Butter	Oil of Theobroma.
Cacodylic Acid	Dimethylarsinic Acid.
Calabar Bean	Seed of *Physostigma venenosum*.
Calamine	Native Zinc Carbonate.
Calamine, Artificial	Calamina Factitia, B.P.C.
Calamus Root	Rhizome of *Acorus Calamus*.
Calcined Gypsum	Plaster of Paris
Calcined Magnesia	Magnesium Oxide.
Calcined Mercury	Red Mercuric Oxide.

Calcinol	Calcium Iodate.
Calendula	Common Marigold.
Calomel	Mercury Subchloride.
Calx	Lime; Calcium Oxide.
Calx Avis	Bird Lime
Calx Chlorata	Chlorinated Lime.
Calx Sulphurata	Impure Calcium Sulphide.
Cambogia	Gamboge.
Campeachy Wood	Logwood.
Camphine	Oil of Turpentine.
Camphire	Camphor.
Campho-Phenique	Camphor, 1; Phenol, 1.
Camphor, Bromated	Monobromated Camphor.
Camphor, Carbolated	Camphor, 1; Phenol, 1.
Camphor,Compnd.Spirit of	Paregoric without Opium.
Camphor Julep or Mixture	Camphor Water.
Camphor, Tincture of	Spirit of Camphor.
Camphorated Oil	Liniment of Camphor.
Camphorated Spirit	Spirit of Camphor.
Camphossil	Camphor Salicylate.
Camwood	Wood of *Baphia nitida.*
Canada Balsam	Canada Turpentine.
Canadian Fleabane	*Erigeron canadense.*
Canadian Hemp	*Apocynum cannabinum.*
Canary Seed	Seed of *Phalaris canariensis.*
Canna Starch	Starch from Root of *Canna edulis.*
Canton's Phosphorus	Calcium Sulphide.
Caoutchouc	India-rubber.
Capillaire	*Adiantum capillus veneris.*
Capivi	Copaiba.
Capsicin	Oleo-resin of Capsicum.
Capsulæ Amylaceæ	Wafer Cachets.
Caramania Gum	Inferior Tragacanth.
Caramel	Burnt Sugar.
Carbasus	Gauze.
Carbazotic Acid	Picric Acid.
Carbolic	Carbolic Acid.
Carbolic Oil	Oleum Carbolicum, B.P.C.
Carbon, Disinfecting	Naphthalene in Blocks.
Carbonate of Iron	Ferri Oxidum Præcipitatum Rubrum.
Carbonate of Calcium	Prepared Chalk.
Carbonate of Potash*	Potassium Bicarbonate.
Carbonate of Soda†	Sodium Bicarbonate.

* For medicinal purposes Carbonate of Potash means Bicarbonate. In other cases the meaning is doubtful.

† For medicinal and domestic purposes Carbonate of Soda means Bicarbonate. Technical workers and photographers, on the other hand generally mean the Carbonate.

Carnauba Wax	Wax from Leaves of *Corypha cerifera.*
Carolina Pink	Indian Pink.
Carpathian Balsam	Riga Balsam.
Carrageen	Irish Moss.
Carron Oil	Linseed or Olive Oil, mixed with its own volume of lime water.
Cascara Sagrada	Bark of *Rhamnus purshianus.*
Cascaras	Cascara Tablets.
Cascarillo	Cascarilla Bark.
Cashew Nut	Seed of *Anacardium occidentale.*
Castile Soap	Hard Olive Oil Soap.
Castor Oil Lozenges	Calomel Lozenges.
Castor Oil Pills*	Aperient Pills (*e.g.*, Compound Rhubarb) containing Castor Oil.
Cataplasma	Poultice.
Catechu, Black	Cutch; Pegu Catechu.
Catechu, Pale	Gambier; Terra Japonica.
Caustic Potash	Potassium Hydroxide.
Caustic Soda	Sodium Hydroxide.
Cedrat, Oil of	Oil of Citron Peel.
Celandine, Wild (*Am.*)	*Impatiens aurea.*
Celandine, Wild (*Eng.*)	*Ranunculus Ficaria.*
Celloidin	Concentrated Collodion.
Centimil	One-hundredth part of a Mil or Millilitre.
Cera Alba Placent.	White Beeswax in Cakes.
Cerate	A hard Ointment containing Wax.
Ceratum Album	Spermaceti Ointment.
Ceratum Cantharidis	Unguentum Cantharidis.
Ceratum Resinæ	Unguentum Resinæ.
Ceratum Rosatum	Rose Lip Salve.
Ceratum Sabinæ	Unguentum Sabinæ, B.P.C.
Cereoli	Anthophores; Medicated Bougies.
Ceresin	Earth Wax.
Cerevisiæ Fermentum	Beer Yeast.
Cetaceum	Spermaceti.
Cetraria	Iceland Moss.
Cevadilla	Seeds of *Schœnocaulon officinale.*
Chalybeate Plaster	Emplastrum Ferri, B.P.C.
Chamomile	Flowers of *Anthemis nobilis.*
Chamomiles, German	Flowers of *Matricaria Chamomilla.*
Chamomiles, Roman	Flowers of *Anthemis nobilis.*
Charas	Resin of Indian Hemp.
Charta Epispastica	Blistering Paper, P.J.F.

* This is an example of the use of a drug's name as a synonym for its properties. Castor oil pills do not necessarily mean pills containing castor oil, but it is advisable to include a little. Pil. Hyd. Subchlor. Co. may be supplied.

Charta Fumifera	Asthma Paper.
Charta Nitrata	Nitre Paper.
Charta Picea	Poor Man's Plaster.
Charta Sinapis	Mustard Paper.
Chaubert's Oil	Oil of Turpentine, 3; Oil of Hartshorn, 1.
Chaulmoogra Oil	Oil of *Taraktogenos Kurzii*.
Chelsea Pensioner	Conf. Guaiaci Co., B.P.C.
Chemical Food	Syr. Ferri Phosph. Co., B.P.C.
Cheltenham Salts	Sodium Sulphate, 34; Magnesium Sulphate, 23; Sodium Chloride, 50.
Chian Turpentine	Oleo-resin from *Pistacia Terebinthus*
Cherry Laurel	*Prunus Laurocerasus*.
Chicory	Root of *Cichorium intybus*.
Chili Saltpetre	Sodium Nitrate.
Chillie Paste	Capsicum Ointment.
Chillie Pods, or Chillies	Fruit of *Capsicum minimum*
China	Cinchona.
China Clay	Kaolin.
Chinæ Cortex	Cinchona Bark.
Chinese Cinnamon	Cassia.
Chinese Red	Cinnabar.
Chininum	Quinine.
Chinoidin	Quinoidine.
Chinolin	Quinoline.
Chinosol (*Reg.*)	Potassium Oxyquinoline Sulphonate.
Chirata or Chirayta	Chiretta.
Chlor-Zinc Iodine	Schulze's Solution.
Chloral	Chloral Hydrate.
Chloral cum Camphora	Chloral Camphoratum, B.P.C.
Chloralamide (*Reg.*)	Chloramide
Chloralose	Glucochloral, B.P.C.
Chloramide	Chloral Formamide.
Chloratum	Chloride.
Chlorbutol	Chlorbutyl Alcohol; Chloretone (*Reg.*).
Chlorhydric Acid	Hydrochloric Acid.
Chloric Ether	Spirit of Chloroform.
Chloride of Lime	Chlorinated Lime.
Chlorine Water	Solution of Chlorine.
Chlorodyne	Chlorodynum, B.P.C.
Chlorodyne Lozenges	Trochisci Chlorodyni, B.P.C.
Chloroform, Acetone	Chloroform made from Acetone.
Chloroform, Methylated	Chloroform made from Methylated Spirit.
Chloryl Anæsthetic	Ethyl Chloride.
Chrisma (*Reg.*)	A variety of Soft Paraffin.

Chrismaline (*Reg.*)	A variety of Liquid Paraffin.
Christison's Pill	Pil. Coloc. et Hyoscyami, 2½ grains.
Christmas Rose.....	*Helleborus niger*.
Chrome Orange	Lead Oxychromate.
Chrome Yellow	Lead Chromate.
Chromic Acid.....	Chromic Anhydride.
Chrysarobin, Crude	Araroba; Goa Powder.
Cicutine	Coniine.
Cinæ Semen	Santonica.
Cinchona, Pale	Bark of *Cinchona officinalis*.
Cinchona, Red	Bark of *Cinchona succirubra*.
Cinchona, Yellow	Bark of *Cinchona Calisaya*.
Cineol	Eucalyptol.
Cinnabar	Native Mercuric Sulphide.
Citarin (*Reg.*).....	Sodium Anthydromethylene Citrate
Citrine or Citron Ointment	Mercuric Nitrate Ointment.
Citrophen (*Reg.*)	Phenetidin Citrate.
Citrosalic Acid	Methylene-citryl-salicylic Acid; Novaspirin (*Reg.*).
Clemens's Solution	Liquor Arsenii Bromidi.
Clutton's Febrifuge Spirit	Spiritus Ætheris Muriaticus.
Clysma, or Clyster.....	Enema.
Coccus	Cochineal.
Cocoa (Cacao) Butter	Oil of Theobroma.
Coco Nut Oil	Fixed Oil from fruit of *Coccus nucifera*.
Colcothar	Ferric Oxide.
Cold Cream.....	Ceratum Galeni, B.P.C.
Colic Root	Aletris; Star Grass.
Collargol (*Reg.*).....	Colloid Silver.
Collodium Cantharidatum	Blistering Collodion.
Collodium Elasticum	Flexible Collodion.
Collodium Stypticum	Styptic Colloid.
Colloxylinum.....	Pyroxylin.
Colocynth and Henbane Pill	Pil. Coloc. et Hyoscyami.
Cologne Spirit	Spirit of Wine for Perfumery.
Colombo Root	Calumba Root.
Colophony	Common Resin.
Colourless Iodine	Tinct. Iodi Decolorata, B.P.C.
Colza Oil.....	Rape Oil.
Commander's Balsam	Tinct. Benzoini Co., B.P.
Common Salt.....	Sodium Chloride.
Cones	Suppositories or Pessaries.
Confectio Amygdalæ.....	Pulv. Amygdalæ Co., B.P.
Confectio Aromatica	Aromatic Confection, B.P.C.
Confectio Damocratis*....	Mithridate.

* An ancient electuary containing over fifty ingredients, many of which it is almost impossible to obtain nowadays. Conf. Aromat. cum Opio, with a little guaiacum, myrrh, and syrup, may be substituted.

Confectio Thebaica	Confection of Opium.
Conine	Coniine.
Conserva Amygdalarum	Pulv. Amygdalæ Comp.
Conserve	Confection.
Convolvulin	Scammonin.
Copaiva, or Copivi	Copaiba.
Copperas	Iron Sulphate.
Copperas, Blue	Copper Sulphate.
Copperas, Green	Iron Sulphate.
Copperas, White	Zinc Sulphate.
Cornu Cervi	Hartshorn.
Cornutine	Impure Ergotoxine.
Corrosive Sublimate	Mercuric Chloride.
Corymbenine	Yohimbenine.
Corymbine	Yohimbine (*Reg.*).
Corynanthine	Yohimbenine.
Corynine	Yohimbine (*Reg.*).
Cosmetic Bismuth	Bismuth Oxychloride.
Cosmetic Mercury	Ammoniated Mercury.
Cosmoline	A variety of Soft Paraffin.
Coster's Paste	Pigmentum Picis cum Iodo.
Couch Grass	*Triticum repens.*
Cough Pill	Pil. Ipecac. cum Scilla.
Count Palma's Powder	Magnesium Carbonate.
Countess Powder	Cinchona Bark in Powder.
Cowage, or Cowitch	Hairs on fruit of *Mucuna pruriens*
Cowrie Gum	Gum Dammar.
Crab Ointment	Blue Ointment.
Crabs' Eyes	Prepared Chalk.
Cramp Bark	Bark of *Viburnum opulus.*
Cream of Tartar	Acid Potassium Tartrate.
Cream of Tartar, Soluble	Potassium Borotartrate.
Cremor Magnesiæ	Emulsio Magnesiæ, B.P.C., with 2 per cent. of light magnesia added.
Cremor Zinci	Perfumed White Soft Paraffin, with 15 per cent. of Zinc Oxide.
Creosotal (*Reg.*)	Creosote Carbonate.
Cresol	Cresylic Acid.
Crespigny's Pills, Lady	Pilulæ Aloes et Mastiches, B.P.C.
Creta Gallica	French Chalk, Talc.
Creta Fullonica	Fullers' Earth.
Creyat	Andrographis.
Crocus	Saffron ; Ferric Oxide.
Crocus in Placentâ	Cake Saffron, usually adulterated.
Crocus Martis	Ferric Oxide.
Crocus Metallorum	Sulphurated Antimony.
Crocus of Antimony	Sulphurated Antimony.
Crosswort (*Am.*)	*Eupatorium perfoliatum.*

Crosswort (*Eng.*)	*Galium Cruciata.*
Crotoon Chloral Hydrate ..	Butyl Chloral Hydrate.
Crystalli	Tartaric Acid in Crystals.
Cubeb Paste	Powdered Cubebs mixed with Copaiba.
Cubic Nitre.....	Sodium Nitrate.
Cuprea Bark	Bark of *Remijia* sp.
Cuprol	Copper Nucleinate.
Cusso	Flowers of *Brayera anthelmintica.*
Cutch	Black Catechu.
Cutol (*Reg.*)	Aluminium Naphthol-sulphonate.
Cydonium	Quince Seed.
Cystamine (*Reg.*).....	Formamine.
Cystogen (*Reg.*)	Formamine.
DAFF	Condition Powder for Horses.
Daffy's Elixir.....	Tr. Sennæ Co. (*approx.*).
Damiana	Leaves of *Turnera* sp.
Decimil	One-tenth of a Mil or Millilitre.
Decoctum Amyli	Mucilage of Starch.
Decoctum Senegæ.....	Infusum Senegæ.
Decoctum Uvæ Ursi	Infusum Uvæ Ursi.
Deodorised Alcohol.....	Rectified Spirit.
Depilatory	Barium Sulphide, 2; Starch, Orris Root, in powder, 1.
Dermatol (*Reg.*).....	Bismuth Subgallate.
De Valangin's Solution ..	A solution of 1½ grains of Arsenious Acid in 30 minims of Hydrochloric Acid and sufficient Distilled Water to produce 1 fluid ounce.
Devil's Dung	Asafetida.
Dextrose	Grape Sugar.
Diacodium	Syrup of Poppies.
Diachylon Plaster.....	Lead Plaster.
Dialysed Iron.....	Liq. Ferri Dialysat., B.P.C.
Diapente.....	Gentian Root in powder, 8; Bayberries in powder, 1.
Diethyl Sulphonal	Tetronal (*Reg.*).
Digallic Acid	Tannic Acid.
Diiodoform (*Reg.*).....	Ethylene Periodide.
Dinitrocellulose.....	Pyroxylin.
Dionin (*Reg.*).....	Ethyl-morphine.
Diosma	Buchu.
Dippel's Acid Elixir.....	Acid. Sulph. Aromat., B.P.
Dippel's Oil	Bone Oil.
Dispensing Syrup.....	Glycerin, Syrup, Alcohol, and Mucilage of Acacia, equal volumes.
Distilled Vinegar	Diluted Acetic Acid.

Dita Bark	Bark of *Alstonia scholaris.*
Diuretic Salt	Potassium Acetate.
Diuretin (*Reg.*)	Theobromine Sodio-salicylate.
Dolichi Pubes	Cowhage.
Dolichos Pruriens	Cowhage.
Donovan's Solution	Liq. Arsen. et Hydr. Iod., B.P.
Dover's Powder	Pulv. Ipecacuanhæ Comp., B.P.
Draconis Resina	Dragon's Blood.
Dragees	Sugar-coated Pills.
Drawing Ointment	Unguentum Resinæ, B.P.
Dried Alum	Exsiccated Alum.
Dugong Oil	Oil from *Halicore australis* and *H. Dugong.*
Duodenin	Secretin.
Duotal (*Reg.*)	Guaiacol Carbonate.
Dusting Powder	Zinc Oxide, 3; Salicylic Acid, 1; Starch, 12.
Dwarf Elder	See Elder, Dwarf.
Earl Warwick's Powder	Pulv. Scammonii Co., B.P.
Earth Nut Oil	Oleum Arachis, B.P.C.
Easton's Elixir	Elixir Ferri et Quininæ et Strychninæ Phos., B.P.C.
Easton's Pills	Pilulæ Ferri Phosphatis cum Quinina et Strychnina, B.P.C.
Easton's Syrup	Syr. Ferri Phos. c. Quin. et Strych.
Eau de Goudron	Tar Water.
Eau de Javelle	Chlorinated Potash Solution.
Eau de Laitue	Aqua Lactucæ.
Eau de Luce	Tinct. Ammoniæ Comp., B.P.C.
Eau de Naphe	Orange-Flower Water.
Eau de Rabel	Sulphuric Acid, 1; Rectified Spirit, 3; by weight, mixed with caution.
Eau de Raspail	Aqua Sedativa.
Eau de Vie	Brandy.
Eau Sedative	Aqua Sedativa.
Eeosote	Creosote Valerianate.
Elastic Collodion	Flexible Collodion.
Elaterin	Active principle of Elaterium.
Elaterium	Dried Sediment from Juice of *Ecballium Elaterium.*
Elder	*Sambucus nigra.*
Elder, Dwarf (*Am.*)	*Aralia hispida.*
Elder, Dwarf (*Eng.*)	*Sambucus Ebulus.*
Elecampane	*Inula helenium.*
Electuarium Piperis	Confectio Piperis.
Electuary	Confection.
Elixir de Vie	Elixir of Aloes.

ixir of Aloes	Tinct. Aloes Co., B.P.C.
ixir ad Longam Vitam	Elixir of Aloes.
ixir of Longevity	Elixir of Aloes.
ixir of Vitriol	Aromatic Sulphuric Acid.
ixir Potato	Tinct. Aloes Co., B.P.C.
ixir Proprietatis	Tinct. Aloes Co., B.P.C.
ixir Salutis	Tinct. Sennæ Co.
ixir Stomachicum	Tinct. Gentianæ Co.
ixir Traumaticum	Tinct. Benzoini Co.
mplastrum Album	Calomel Plaster, 20 per cent.
mplastrum Cephalicum	Emplastrum Picis.
mplastrum Cerati Saponis	Emp. Saponis Fuscum, B.P.C.
mplastrum Commune	Lead Plaster.
mplastrum Epispasticum	Cantharides Plaster.
mplastrum Gummosum	Galbanum Plaster, B.P.C.
mplastrum Lithargyri	Lead Plaster.
mplastrum Lyttæ	Cantharides Plaster.
mplastrum Roborans	Emplastrum Ferri, B.P.C.
mplastrum Thuris	Emplastrum Roborans.
mulsio Amygdalæ	Almond Mixture.
mulsio Guaiaci	Guaiacum Mixture.
mulsio Scammonii	Scammony Mixture, B.P.C.
mulsio Simplex	Almond Mixture.
nema Catharticum	Enema Magnes. Sulph., B.P.C.
nema Fœtidum	Enema Asafetidæ, B.P.C.
nglish Salt	Smelling Salt.
pinephrine	Adrenine.
pirenan	Adrenine.
psom Salt	Magnesium Sulphate.
rgot of Rye	Ergot, B.P.
rgotin	Extract of Ergot, B.P.
rgotoxine	Purified Cornutine.
rythrol (*Reg.*)	Bismuth-Cinchonidine Iodide.
serine	Physostigmine.
ssence of Bergamot	Oil of Bergamot.
ssence of Bigarade	Oil of Bitter-Orange Peel.
ssence of Camphor	Rubini's Essence of Camphor.
ssence of Ginger	Tinct. Zingib. Fort., B.P.C.
ssence of Lemon	Oil of Lemon
ssence of Mirbane	Nitrobenzol.
ssence of Portugal	Essence of Sweet-Orange Peel.
ssence of Ratafia	Essence of Almonds (*approx.*).
ssence of Viper	Tincture of Cantharides
ther, Hydrobromic	Ethyl Bromide.
ther, Hyponitrous	Ethyl Nitrite.
ther, Rectified	Ether, B.P.
ther, Sulphuric	Ether, B.P.
ther, Methylated	Ether prepared from Methylated Spirit.

Ethereal Oil	Oleum Æthereum, B.P.C.
Ethocaine	Novocaine (*Reg.*).
Ethyl Acetate	Acetic Ether.
Ethyl Hydroxide	Absolute Alcohol.
Ethylic Alcohol	Absolute Alcohol.
Ethyl-Methyl Sulphonal	Trional.
Ethylmorphine	Ethyl-Morphine Hydrochloride; Dionin (*Reg*).
Eucaine (*Reg.*)	Betacaine.
Euchinin (*Reg.*)	Quinine Ethyl Carbonate.
Euonymin	Extractum Euonymi, B.P.C.
Everlasting Pills	Pills of Metallic Antimony.
Exalgin (*Reg.*)	Methyl Acetanilide.
Exeter Oil	Oil of Elder, mixed with Euphorbium, Mustard, etc.
Exodin	Rufigallic Acid Hexamethyl Ester.
Extract of Henbane	Ext. Hyoscyami.
Extract of Lead	Liquor Plumbi Subacet. Fort.
Extract of Scammony	Resin of Scammony.
Extractum Aloes Aquosum	Ext. Aloes Soc., B.P.C.
Extractum Belladonnæ	Ext. Bellad. Viride, B.P.
Extractum Catharticum	Ext. Coloc. Comp.
Extractum Colchici Cormi	Extractum Colchici.
Extractum Cubebæ	Oleo-resin of Cubebs, B.P.C.
Extractum Elaterii	Elaterium, B.P.
Extractum Filicis Æth-erum	Ext. Filicis Liquidum.
Extractum Frangulæ	Ext. Rhamni Frangulæ.
Extractum Humuli	Ext. Lupuli.
Extractum Hyoscyami	Ext. Hyoscyami Viride.
Extractum Rhamni Pur-shiani	Ext. Cascaræ Sagradæ.
Extractum Saturni	Liquor Plumbi Subacet. Fort.
Extractum Thebaicum	Extractum Opii.
Extractum Uncariæ	Catechu.
Eye Ointment	Ung. Hyd. Ox. Flav. *vel* Rub.
Fæx Sacchari	Treacle.
False Bittersweet	See Bittersweet, False.
Family Pills	Aperient Pills.
Farina	Flour; Potato Starch.
Febrifuge Salt	Potassium Chloride.
Fel Tauri Inspissatum	Purified Ox Bile.
Female Pills	*Exam.* Pil. Aloes et Ferri.
Fermented Oil	Oil from Fermented Olives.
Ferri Ammonio-Citras	Ferri et Ammonii Citras.
Ferri Carbonas	Ferri Oxidum Præcipitatum Rubrum.

Ferri Carb. cum Saccharo	Saccharated Iron Carbonate.
Ferri Citras	Ferri et Ammonii Citras.
Ferri Filum	Iron Wire.
Ferri Limatura	Iron Filings.
Ferri Oxidum Nigrum....	Magnetic Oxide of Iron.
Ferri Oxidum Rubrum ..	Ferric Oxide.
Ferri Peroxidum	Ferric Oxide.
Ferri Peroxidum Humidum	Ferric Oxide.
Ferri Peroxidum Hydratum	Ferric Oxide.
Ferri Potassio-Tartras....	Tartarated Iron.
Ferri Pulvis	Reduced Iron.
Ferri Sesquichloridum....	Ferric Chloride.
Ferri Sesquioxidum	Ferric Oxide.
Ferri Subcarbonas	Ferric Oxide.
Ferric Oxyhydrate	Ferric Oxide.
Ferrier's Snuff	Insufflatio Bism. et Morph., B.P.C.
Ferro-Alumen	Iron Alum.
Ferrochloride of Ammonia	Ammonio-Chloride of Iron, P.L.
Ferrocitrate of Ammonia	Ferri Ammon. Cit., B.P.
Ferrocyanate	Ferrocyanide.
Ferrocyanide of Iron	Prussian Blue.
Ferropyrin (*Reg.*)	Antipyrine and Ferric Chloride.
Ferrugo	Ferric Oxide.
Ferrum Tartarizatum	Tartarated Iron.
Fever Drops	Compound Tincture of Cinchona.
Fiddle Gum	Tragacanth.
Fir Wool Oil	Oil of *Pinus sylvestris*.
Fish Berries	*Cocculus indicus*.
Fistula Armata	Enema Apparatus.
Fixature	Cosmetic.
Flake White	White Lead.
Flax Seed	Linseed.
Fleming's Tinct. of Aconite	Tinctura Aconiti Fortis, B.P.C.
Florence Oil	Olive Oil imported from Leghorn.
Flores Naphæ	Orange Flowers.
Flowers of Arsenic	Arsenious Anhydride.
Flowers of Benjamin	Benzoic Acid.
Flowers of Benzoin	Benzoic Acid.
Flowers of Brimstone	Sublimed Sulphur.
Flowers of Camphor	Camphor in Crystalline Powder.
Flowers of Sulphur	Sublimed Sulphur.
Flowers of Zinc.....	Zinc Oxide.
Fluid Magnesia	Liquor Magnesii Carbonatis.
Fluoric Acid	Hydrofluoric Acid.
Fly Blister	Cantharides Plaster.
Ford's Laudanum.....	Vinum Opii, B.P.C. (*approx.*).
Formaldehyde	Formic Aldehyde.
Formalin (*Reg.*).....	Formic Aldehyde, 40 per cent. solution.

Formamine	Hexamethylene-amine, Urotropine (*Reg.*).
Formamint (*Pat.*)	Compound of Formic Aldehyde and Lactose.
Formamol	Formamine-Methylene Citrate; Helmitol (*Reg.*); Neurotropine (*Reg.*); Uropurgol.
Formin	Formamine.
Fousel or Fusel Oil	Crude Amylic Alcohol.
Fowler's Solution	Liquor Arsenicalis.
Frangula Bark	Bark of *Rhamnus frangula.*
Frankincense	Olibanum.
Frankincense, Common	Thus Americanum.
Frankincense Plaster	Emplastrum Ferri, B.P.C.
Freezing Salt	Crude Sodium Chloride.
Friar's Balsam	Compound Tincture of Benzoin.
Fruit Lozenges	Black Currant Lozenges.
Fumus Potassæ Nitratis	Nitre Paper.

Galangal, Lesser	Rhizome of *Alpinia officinarum.*
Galen's Cerate	Cold Cream.
Gallæ Tinctoriæ	Galls.
Gallipoli Oil	Inferior Olive Oil.
Gallo-Tannic Acid	Tannic Acid.
Gambier or Gambir	Pale Catechu.
Gamgee Tissue	Absorbent Gauze and Cotton Wool.
Ganja	Indian Hemp.
Garlic	Bulbs of *Allium sativum.*
Gascoigne's Powder	Pulv. Cretæ Arom., B.P.C. (*approx.*)
Gavelle's Extract	Extract of *Malva sylvestris.*
Gelanthum	A Mixture of Gelatin, Tragacanth Glycerin, and Water.
Gelatina Vituli	Calf's Foot Jelly.
Gelatum Petrolei	Soft Paraffin.
Genoa Oil	Fine Olive Oil.
Gentian (*Am.*)	*Gentiana saponaria.*
Gentian (*Eng.*)	*Gentiana lutea.*
Geosot (*Reg.*)	Guaiacol Valerianate.
Gingelli Oil	Sesame Oil.
Ginger, Wild (*Am.*)	*Asarum canadense.*
Ginger, Wild (*Eng.*)	*Zingiber officinale.*
Gingerine	Oleo-resin of Ginger.
Ginseng	Root of *Panax quinquefolium.*
Glandulæ Lupuli	Lupulin.
Glandulæ Rottleræ	Kamala.
Glandulæ Suprarenales	Suprarenal Glands.

Glandulæ Thymeæ	Thymus Glands.
Glandulæ Thyroideæ	Thyroid Glands.
Glass, Soluble	Sodium Silicate.
Glauber's Salt	Sodium Sulphate.
Globuli Prunellæ	Potassium Nitrate in Balls.
Glonoin	Nitroglycerin.
Glucose	Grape Sugar.
Glucusimide	Gluside.
Glutol (*Reg.*)	Gelatin Formaldehyde.
Glyceritum	Glycerin (of Starch, etc.).
Glycerole	Glycerin (of Pepsin, etc.).
Goa Powder	Araroba Powder.
Godfrey's Cordial	Treacle, Water, Sassafras Oil, Alcohol, and Laudanum 1 per cent.
Golden Hair Dye	Hydrogen Peroxide.
Golden Ointment	Ung. Hyd. Ox. Flav. *vel* Rub.
Golden Seal	Rhizome of *Hydrastis canadensis*.
Gossypium Fulminans	Pyroxylin.
Goudron	Norwegian Tar.
Goulard Powder	Lead Acetate.
Goulard Water	Liquor Plumbi Subacet. Dil.
Goulard's Cerate	Lead Subacetate Ointment.
Goulard's Extract	Liquor Plumbi Subacet. Fort.
Goulard's Ointment	Lead Subacetate Ointment.
Grain Oil	Crude Amylic Alcohol.
Grains d'Ambrette	Musk Seeds.
Grains of Paradise	Seeds of *Amomum Melegueta*.
Granulæ Dioscoridis	Arsenic Granules, 1 Mgm.
Grape Sugar	Dextrose.
Graphite	Plumbago.
Gratia Dei	Emplastrum Picis (*approx.*).
Grease Paint	Powdered French Chalk, tinted with Carmine, Burnt Sienna, Burnt Umber, etc., and sometimes mixed with Glycerin, Lard, or Pomade, to form a paste.
Green Copperas	Iron Sulphate.
Green Mercury Iodide	Mercurous Iodide.
Green Oil	Oil of Elder.
Green Ointment	Elder Ointment.
Green Vitriol	Iron Sulphate.
Greenheart Bark	Nectandra Bark.
Gregory's Pill	Pil. Colocynth. Comp., B.P.
Gregory's Powder	Pulvis Rhei Comp., B.P.
Gregory's Powder, Improved	Pulvis Rhei cum Magnesia, B.P.C.
Grey Lotion	Lotio Hydrarg. Nigra, B.P.
Grey Oil	Oleum Cinereum, B.P.C.
Geneva	Gin.

Gin	A Spirituous Liquid distilled from Malted Grain and flavoured with Juniper Fruit.
Glycocaine	Nirvanin (*Reg.*).
Grey Ointment	Blue Ointment.
Grey Powder	Hydrarg. cum Creta, B.P.
Griffith's Mixture	Mistura Ferri Comp., B.P.
Griffith's Pill	Pil. Ferri cum Myrrha, P.L.
Ground Nuts	Seeds of *Arachis hypogæa*.
Grutellum	Groats.
Guanicaine	Acoin (*Reg.*).
Guarana	Roasted and Powdered Seeds of *Paullinia Cupana*.
Guaranine	Caffeine.
Guaza	Indian Hemp.
Guido's Balsam	Liniment of Opium.
Guimauve	Marshmallow.
Guinea Grains	Grains of Paradise.
Guinea Pepper	Capsicum Fruit.
Gum Animi	Copal.
Gum Arabic	Gum Acacia.
Gum Benjamin	Benzoin.
Gum Cambogiæ	Gamboge.
Gum Camphor	Camphor.
Gum Catechu	Catechu.
Gum Dragon	Tragacanth.
Gum Elemi	Manila Elemi.
Gum Guaiacum	Guaiacum Resin.
Gum Juniper	Sandarac.
Gum Sanguis Draconis	Dragon's Blood.
Gum Scammony	Scammony.
Gum Thus	Common Frankincense.
Gun Cotton	Trinitrocellulose.
Gunjah	Indian Hemp.
Gurjun Balsam or Oil	Oleo-Resin of *Dipterocarpus turbinatus*.
Gutti	Gamboge.
Gynocardiæ Oleum	Chaulmoogra Oil.
Gypsum	Calcium Sulphate.
Gypsum, Calcined	Plaster of Paris.
Haarlem Oils	Dutch Drops.
Hæmostasin	Adrenine.
Hahnemann's Mercury	Black Oxide of Mercury.
Haller's Acid Elixir	Sulphuric Acid and Alcohol, equal weights, mixed gradually.
Halviva	Chiretta.

Hamilton's Pill.....	See under Pil. Coloc. et Hyos., B.P.C.
Hartshorn and Oil	Liniment of Ammonia.
Hartshorn Powder	Prepared Chalk (*approx.*).
Hartshorn, Spirit of.....	Solution of Ammonia.
Hasting's Naphtha	Wood Spirit ; Methyl Alcohol.
Haustus Sennæ Co.	Mistura Sennæ Co., B.P.
Haw, Black.....	Bark of *Viburnum prunifolium.*
Hay Saffron	Saffron, B.P.
Hazeline (*Reg.*)	Distilled Extract of Witch-hazel.
Heavy Magnesia	Heavy Magnesium Oxide.
Heberden's Ink or Mixture	Mist. Ferri Aromat., B.P.C.
Hebra's Ointment.....	Unguentum Diachyli, B.P.C.
Hellebore, Green	*Veratrum viride.*
Hellebore, White	*Veratrum album.*
Helmitol (*Reg.*).....	Formamol.
Hemisine (*Reg.*).....	Adrenine.
Hemlock	*Conium maculatum.*
Hemlock (*Am.*)	*Tsuga canadensis.*
Hemlock (*Eng.*)	*Conium maculatum.*
Hemlock Gum or Pitch ..	Exudation from *Pinus canadensis*
Hemlock Spruce Fir.....	*Pinus canadensis.*
Hemp Resin	Extract of Indian Hemp.
Henbane.....	*Hyoscyamus niger.*
Hepar Antimonii Calcareum	Sulphurated Antimony.
Hepar Sulphuris	Sulphurated Potash.
Hepatic Aloes	Liver-coloured Aloes.
Heroin (*Reg.*)	Aceto-morphine.
Hetraline (*Reg.*)	Formamol.
Hiera Picra.....	Pulvis Aloes et Canellæ, B.P.C.
Hippo Wine	Ipecacuanha Wine.
Hips.....	Fruit of the Dog Rose.
Hirudo.....	Leech.
Hoffman's Anodyne	Compound Spirit of Ether.
Hog Gum	Inferior Tragacanth.
Homberg's Salt	Boric Acid.
Hop	*Humulus lupulus.*
Hopogan.....	Magnesium Peroxide.
Hordeum Decorticatum ..	Pearl Barley.
Horsemint (*Am.*)	*Monarda fistulosa* or *M. punctata.*
Horsemint (*Eng.*).....	*Mentha aquatica.*
Hungary Water	Spirit of Rosemary, 1 in 50 (*approx.*)
Huxham's Tincture of Bark	Tinct. Cinchonæ Co., B.P.
Hydrargyri Ammonio-Chloridum	Ammoniated Mercury.
Hydrargyri Bichloridum..	Mercuric Chloride.
Hydrargyri Biniodidum ..	Mercuric Iodide.
Hydrargyri Chloridum....	Calomel.

Hydrargyri Chlor. Mite ..	Calomel.
Hydrargyri Iodidum	Green Mercurous Iodide.
Hydrargyri Murias	Calomel.
Hydrargyri Nitrico-Oxidum	Red Mercuric Oxide.
Hydrargyri Oxidum Cinereum	Mercurous Oxide.
Hydrargyri Oxyd. Sulph.	Turpeth Mineral.
Hydrargyri Oxymurias....	Mercuric Chloride.
Hydrargyri Permurias....	Mercuric Chloride.
Hydrargyri Proto-ioduret	Green Mercurous Iodide.
Hydrargyri Submurias....	Calomel
Hydrargyri Suboxidum ..	Black Oxide of Mercury.
Hydrargyri Sulphas	Persulphate of Mercury.
Hydrargyri Sulphuretum cum Sulphure	Ethiops Mineral.
Hydrargyri Supermurias..	Mercuric Chloride.
Hydrargyrum Corrosivum Sublimatum	Mercuric Chloride.
Hydrargyrum Præcipitatum Album.....	Ammoniated Mercury.
Hydrate	Hydroxide.
Hydriodate	Iodide.
Hydriodic Ether	Ethyl Iodide.
Hydrobromate	Bromide.
Hydrobromic Ether	Ethyl Bromide.
Hydrocarbon Oil	Paraffinum Liquidum.
Hydrochinon	Hydroquinone ; Hydrokinone.
Hydrochlorate	Hydrochloride.
Hydroergotinine	Ergotoxine.
Hydrogen Orthophosphate	Phosphoric Acid.
Hydrokinone	Hydroquinone.
Hydroxide	Hydrate.
Hyperosmic Acid	Osmic Acid.
Hypnal (*Reg.*)	Antipyrine and Chloral Hydrate.
Hypnogen (*Reg.*)	Malourea.
Hypnone	Acetophenone.
Hypo	Sodium Hyposulphite.
Hyposulphite of Soda	Sodium Hyposulphite.
Hyrgolum	Colloid Mercury.
Iceland Moss	*Cetraria islandica.*
Ichthalbin (*Reg.*)	Albumen Ichthosulphonate.
Ichthammon (*Reg.*)	Ammonium Ichthosulphonate.
Ichthammonium	Ammonium Ichthosulphonate Ichthyol (*Reg.*).
Ichthocalcium	Calcium Ichthosulphonate.
Ichthoferrum.....	Iron Ichthosulphonate.

Ichthosodium	Sodium Ichthosulphonate.
Ichthosulphonic Acid	Product of the action of Sulphuric Acid upon Crude Ichthyol.
Ichthozincum	Zinc Ichthosulphonate.
Ichthyocolla	Isinglass.
Ichthyol (*Reg.*)	Ammonium Ichthosulphonate.
Ichthyol, Crude	Oil from Tyrolese Bituminous Schist.
Ichtoform (*Reg.*)	Formaldehyde Ichthosulphonate.
Indian Blistering Flies	*Mylabris phalerata* and other species.
Indian Brandy or Tincture	Spirit of Nitrous Ether, 1; Compound Tincture of Rhubarb, 1; Syrup, 1.
Indian Cerate	Ung. Plumbi Acet. (*approx.*).
Indian Pink	*Spigelia marilandica.*
Indian Sarsaparilla	Hemidesmus Root.
Indigotin	Indigo Blue.
Infusion of Tar	Tar Water.
Infusum Diosmæ	Infusum Buchu.
Infusum Sennæ Comp.	Infusum Sennæ.
Insect Powder	Powdered unexpanded Flower-heads of *Pyrethrum cinerariæfolium.*
Iodatum	Iodide.
Iodhydric Acid	Hydriodic Acid.
Iodine Blister (*veterinary*)	Ung. Hydrarg. Iod. Rubr. 1-7.
Iodine Paint	Liquor Iodi Fortis.
Iodinium	Iodine.
Iodinol (*Reg.*)	See Iodipin.
Iodipin (*Reg.*)	Sesame Oil with 10 or 25 per cent. of Iodine.
Iodoform Aromaticum	Iodoform, 49; Coumarin, 1.
Iodoformogen (*Reg.*)	Iodoform Albuminate.
Iodol (*Reg.*)	Tetra-Iodo-Pyrrol.
Iodolen (*Reg.*)	Iodopyrrol Albuminate.
Iodopyrin (*Reg.*)	Iodoantipyrine.
Ioduretted Oil	Solution of Iodine in Almond Oil, 0·5 per cent.
Iridin	Powdered Extract of Iris.
Iris (*Am.*)	*Iris versicolor.*
Iris (*Eng.*)	*Iris Florentina.*
Irish Moss	*Chondrus crispus.*
Irisin	Iridin.
Iron Plaster	Emplastrum Ferri, B.P.C.
Iron Rust	Ferric Oxide.
Isarol (*Reg.*)	Ammonium Ichthosulphonate.
Isinglass, Japanese	Agar Agar.
Isotonic Salt Solution	Solutio Salina, B.P.C.

Issue Peas	Orange Berries.
Itrol (*Reg.*)	Silver Citrate.
Ivory Black	Fine Bone Black.
Izal (*Reg.*)	Distillate from Coke.
Jalapin	Chief Constituent of Jalap Resin.
Jalapin, False or German	Scammonin.
Jamaica Pepper	Pimento.
Jambul	Seeds of *Eugenia Jambolana.*
James's Powder	Antimonial Powder (*approx.*).
Japan Earth	Catechu.
Japanese Aconite	*Aconitum Fischeri.*
Japanese Drops	Japanese Peppermint Oil.
Japanese Isinglass	Agar Agar.
Jarisch's Ointment	Pyrogallic Acid, 1; Lard, 7.
Jaune Brilliant	Cadmium Sulphide.
Jequirity Seeds	Seeds of *Abrus precatorius.*
Jesuits' Bark	Cinchona Bark.
Jesuits' Drops	Comp. Tincture of Benzoin (*approx.*)
Jeweller's Rouge	Finest Calcined Ferric Oxide.
Jonas' Salve	Emplastrum Ferri.
Julep	A Mixture.
Juniper Tar Oil	Oil of Cade.
Kaladana	Seeds of *Ipomœa hederacea.*
Kali, Lemon	Sherbet.
Kalium	Potassium.
Kaposi's Ointment	Unguentum Naphtholis, B.P.C.
Kermes Grains	Cochineal (*approx.*).
Kermes Mineral	Antimonium Sulphuratum.
Kerosene	Paraffin Oil.
Kino	Dried Exudation from *Pterocarpus Marsupium.*
Kino, Australian	Eucalyptus Kino.
Kino, Bengal	Butea Gum.
Kino, Botany Bay	Eucalyptus Kino.
Kino, Eucalyptus	Dried Exudation from *Eucalyptus* sp.
Kino, Madras	Butea Gum.
Kokum Butter	Oil from Seeds of *Garcinia purpurea*
Kola Nut	Seeds of *Cola acuminata.*
Kombé Seeds	Strophanthus Seeds.
Kousso or Kosso	Cusso.
Kreat or Kiryat	*Andrographis paniculata.*
Labarraque's Solution	Liquor Sodæ Chlorinatæ.
Lac Ammoniaci	Mistura Ammoniaci.
Lac Amygdalæ	Mistura Amygdalæ

Lac Asafetidæ	Enema Asafetidæ, B.P.
Lac Fermentatum	Koumiss.
Lac Guaiaci	Mistura Guaiaci.
Lac Magnesiæ	Emulsio Magnesiæ, B.P.C.
Lac Sulphuris	Precipitated Sulphur.
Lacca	Shellac.
Lacmus	Litmus.
Lactin	Milk Sugar.
Lactose	Milk Sugar.
Lactophenin (*Reg.*)	Paraphenetidin Lactate.
Lactucarium	Dried Juice of *Lactuca virosa*.
Lanolin	Hydrous Wool Fat.
Lapis Calaminaris	Calamine.
Lapis Divinus	Cuprum Aluminatum.
Lapis Hibernicus	Irish Slate.
Lapis Infernalis	Silver Nitrate.
Lapis Pumicis	Pumice Stone.
Larch	*Larix europœa*.
Larch Turpentine	Venice Turpentine.
Laudanum	Tincture of Opium.
Laughing Gas	Nitrous Oxide.
Lavender Drops	Compound Tincture of Lavender.
Laxative Mixture	Mistura Cascaræ, B.P.C.
Lead Lotion	Liquor Plumbi Subacet. Dil.
Lemon Chrome	Lead Chromate.
Lenitive Electuary	Confection of Senna.
Lettuce Opium	Lactucarium.
Leucoline	Quinoline.
Levant Berries	Cocculus Indicus.
Lichen Islandicus	Iceland Moss.
Lignilanum	Wood Wool.
Lignum Febrium	Cinchona.
Lignum Sanctum	Guaiacum Wood.
Lignum Vitæ	Guaiacum Wood.
Lime, Caustic	Calcium Oxide.
Lime Flux	Limestone, chiefly Calcium Carbonate.
Lime, Quick	Calcium Oxide.
Lime, Slaked	Calcium Hydroxide.
Lime Water	Liquor Calcis.
Limes	Fruit of *Citrus acris*.
Limonade Purgative	Liquor Magnes. Cit., B.P.C.
Lini Farina	Crushed Linseed.
Lini Placenta	Linseed Cake.
Linimentum Album	White Oils.
Linimentum Anodynum	Linimentum Opii.
Linimentum Camph. Co.	Lin. Camph. Ammon., B.P.
Linimentum Cantharidis	Blistering Liquid, B.P.
Linimentum Capsici	Tinct. Capsici Fort.

Linimentum Domesticum	White Oils.
Linimentum Iodi	Liquor Iodi Fortis, B.P.
Linimentum Lyttæ	Blistering Liquid, B.P.
Linim. Saponis cum Opio	Linimentum Opii.
Linimentum Universale..	White Oils.
Linseed Meal	Ground Oil-cake.
Linseed Tea	Infusion of Linseed.
Liqueur de Goudron	Solution of Norwegian Tar.
Liqueur de Van Swieten..	Mercuric Chloride, 1; Alcohol (80 per cent.), 100, by weight; Distilled Water, 900.
Liquidamber	Prepared Storax.
Liquor	Solution or Concentrated Infusion.
Liquor Anodynus Mineralis	Spiritus Ætheris Comp.
Liquor Antim. Terchlor...	Liq. Antim. Chlor., B.P.C.
Liquor Bismuthi	Liq. Bismuthi et Ammon. Cit.
Liquor Collodii Co.	Collodium Salicylicum.
Liquor Ferri Oxychlor. ..	Liq. Ferri Dialysatus, B.P.C.
Liquor Fowleri	Liquor Arsenicalis.
Liquor Glonoini.....	Liquor Trinitrini.
Liquor Hydrargyri Bichloridi	Liq. Hydrarg. Perchlor.
Liquor Mindereri	Liquor Ammonii Acetatis.
Liquor Morphinæ.....	Liq. Morphinæ Hydrochlor.
Liquor Morphinæ Muriatis	Liq. Morphinæ Hydrochlor.
Liquor Opii Sedatio.....	Ext. Opii Liq. (*approx.*).
Liquor Plumbi	Liq. Plumbi Subacet. Fort.
Liquor Plumbi Diacetatis	Liq. Plumbi Subacet. Fort.
Liquor Plumbi Subacet.	Liq. Plumbi Subacet. Fort.
Liquor Potassæ Arsenitis	Liquor Arsenicalis.
Liquor Seriparus	Rennet Solution.
Liquor Sodæ Chloratæ ..	Solution of Chlorinated Soda.
Liquor Taraxaci	Succus Taraxaci or Ext. Tarax. Liq.
Liquor Volatilis Cornu Cervi	Solution of Ammonia (*approx.*).
Liquorice Juice.....	Extract of Liquorice in Sticks.
Liquorice Powder	Compound Liquorice Powder.
Lithargyrum or Litharge..	Lead Oxide.
Lithia Water.....	Liquor Lithiæ Effervescens, P.J.F.
Liver of Sulphur	Sulphurated Potash.
Logwood	Heartwood of *Hæmatoxylon campechianum.*
Lotio Flava	Lotio Hydrargyri Flava.
Lotio Nigra	Lotio Hydrargyri Nigra.
Lotio Plumbi.....	Liquor Plumbi Subacet. Dil.
Loxa Bark	Pale Cinchona Bark.
Lucca Oil	Olive Oil.
Lugol's Solution	Liquor Iodi Dilutus, B.P.C.
Lunar Caustic	Silver Nitrate.

Lund's Oil	Oleum Lubricans, B.P.C.
Lycine	Betaine.
Lytta	Cantharides.
Mace	Arillus of the Nutmeg.
Macquer's Salt	Potassium Arsenate.
Madar, or Mudar	Calotropis Bark.
Madder	Root of *Rubia tinctorum*.
Magendie's Solution	Liquor Morph. Sulph., 16 grs. per oz.
Magenta Crystals	Fuchsine.
Magistery of Bismuth	Bismuth Subnitrate.
Magistery of Lead	White Lead.
Magistery of Sulphur	Precipitated Sulphur.
Magnesia	Magnesium Oxide.
Magnesia, Calcined	Magnesium Oxide.
Maidenhair (*Am.*)	*Adiantum pedatum*.
Maidenhair (*Eng.*)	*Adiantum Capillus-Veneris*.
Malonal	Malourea.
Malonurea	Malourea.
Malourea	Diethyl-Malonyl Urea; Veronal (*Reg.*); Malonal; Hypnogen (*Reg.*).
Malthusian Cones	Quinine Pessaries.
Maltine (French)	Diastase.
Maltine (*Reg.*)	Extract of Malt.
Mandrake (*Am.*)	*Podophyllum peltatum*.
Mandrake (*Eng.*)	*Atropa Mandragora* or *Bryonia dioica*.
Marseilles Soap	Olive Oil Soap.
Marshall Hall's Pills	Pil. Aloes Dilutæ, B.P.C.
Marshmallow	*Althæa officinalis*.
Maté	Paraguay Tea.
Maw Seeds	Black Poppy Seeds.
May Apple	*Podophyllum peltatum*.
Meconium	Opium.
Mel Acetatum	Oxymel.
Mel Boracis	Borax Honey.
Mel Depuratum	Clarified Honey.
Mel Despumatum	Clarified Honey.
Mel Ægyptiacus	Linimentum Æruginis, P.L.
Mel Scillæ	Oxymel Scillæ.
Mercuric Oxide	Red Mercuric Oxide.
Mercury Resorbin	Mercury, 1; Resorbin, 2.
Mescal Buttons	Seeds of *Anhalonium Lewinii*.
Metaphosphoric Acid	Glacial Phosphoric Acid.
Metasulphite of Potash	Potassium Metabisulphite.
Methyl-Acetanilide	Exalgin (*Reg.*).
Methyl-Benzoyl	Acetophenone.

Methylated Ether	Ether from Methylated Spirit.
Methylated Spirit	Ethyl Alcohol mixed with one-ninth its volume of Wood Naphtha and ⅜ per cent. of Mineral Naphtha.*
Methyl Sulphonal	Trional (*Reg.*).
Methylic Alcohol	Rectified Wood Spirit.
Metramine (*Reg.*)	Formamine.
Mezereon (*Am.*)	*Dirca palustris.*
Mezereon (*Eng.*)	*Daphne Mezereum.*
Microcosmic Salt	Sodium - Ammonium - Hydrogen Phosphate.
Microl	Microlitre; 0·001 Millilitre.
Migrainin (*Reg.*)	Phenazone and Caffeine Citrate.
Mil	Millilitre; Cubic Centimetre.
Milk of Lime	Slaked Lime and Water in a thin Cream.
Milk of Sulphur	Precipitated Sulphur.
Mindererus Spirit	Liquor Ammonii Acetatis.
Mineral Oil	Petroleum.
Mint Water	Aqua Menthæ Viridis.
Mistletoe (*Am.*)	*Phoradendron flavescens.*
Mistletoe (*Eng.*)	*Viscum album.*
Mistura Acaciæ	Mucilage of Acacia.
Mistura Alba†	White Mixture.
Mistura Ammon. Acet.	Liquor Ammonii Acetatis.
Mistura Amygdalarum	Almond Mixture.
Mistura Asafetidæ	Enema Asafetidæ, B.P.C.
Mistura Camphoræ	Camphor Water.
Mistura Cretacea	Chalk Mixture.
Mistura Gentianæ	Gentian Mixture, B.P.C.
Mistura Nostra	Begbie's Mixture, P.J.F.
Mistura Tussi Rubra	Mistura Chloroformi Composita, B.P.C.
Mithridate	Confectio Damocratis.
Molasses	Treacle.
Monsell's Salt	Ferrous Ammonium Sulphate.
Moore's Ointment	Resin Ointment (*approx.*).
Morphacetin	Acetomorphine; Heroin (*Reg.*).
Morphiæ Murias	Morphine Hydrochloride.
Morton's Fluid	Glycerinum Iodi, B.P.C.
Moschus	Musk.
Mucilage	Mucilage of Acacia.

* Manufacturers and Pharmacists may, under certain conditions, use methylated spirit without mineral naphtha. See "Legal Information for Pharmacists," in 'The Pharmacist's Diary and Year-Book.'

† Infants' carminative containing magnesium carbonate; or a mixture containing magnesium sulphate and carbonate with peppermint water and, in some cases, spirit of chloroform; or, more rarely, a copaiba emulsion.

Mucilage of Gum Arabic..	Mucilage of Acacia.
Muriate	Chloride or Hydrochloride.
Muriate of Antimony	Liq. Antim. Chlor., B.P.C.
Muriate of Soda	Sodium Chloride.
Muriatic Acid.....	Hydrochloric Acid.
Musk Root	Sumbul.
Musk Seed.....	Seed of the Musk Mallow.
Mustard Bran	Mustard Seed Husks ground with a small proportion of the Seeds.
Mustard, Flour of.....	Sinapis, B.P.
Mustard Oil	Expressed Oil of Mustard.
Mustard Oil, Essential ..	Volatile Oil of Mustard.
Mylabris	Blistering Beetle.
Myristica.....	Nutmeg.
Myristicæ Adeps.	Expressed Oil of Nutmeg.
Myristicæ Nuclei	Nutmegs.
Myrobalans	Immature Fruit of *Terminalia Chebula*.
Myrobalans, Chebulic	Mature Fruit of *Terminalia Chebula*.
Naftalan (*Reg.*)	Anhydrous Soap and Mineral Naphtha.
Naphthalol (*Reg.*).....	Naphthol Salicylate.
Naphthamine	Formamine.
Naphthol.....	Beta-Naphthol.
Naphthol Ointment	Kaposi's Ointment.
Naphthosalol (*Reg.*)	Naphthol Salicylate.
Nargol.....	Silver Nucleinate.
Nataloin	Aloin from Natal Aloes.
Natrium	Sodium.
Natron or Natrum	Sodium Carbonate.
Natron Vitriolatum	Sodium Sulphate.
Neatsfoot Oil	Fixed Oil obtained by boiling Ox or Cow Feet in Water.
Neatsfoot Oil, Factitious..	Lard, 1 ; Colza Oil, 3.
Nebula.....	A Spray.
Nectandra Bark.....	Bebeeru Bark.
Neem Bark	Indian Azadirach.
Nephridine.....	Adrenine.
Nerve Oil	Neatsfoot Oil.
Nesbit's Specific	Mistura Santali Composita, B.P.C.
Nessler's Reagent.....	Solution of Potassio-Mercuric Iodide, B.P.
Neurotropine (*Reg.*)	Formamol.
Neutral Tartar	Potassium Tartrate.
Niccolum	Nickel.
Nitre	Potassium Nitrate.

Nitre Balls	Sal Prunella Balls.
Nitre, Chili or Cubic	Sodium Nitrate.
Nitric Oxide of Mercury	Red Mercuric Oxide.
Nitrous Ether	Ethyl Nitrite.
Nordhausen Sulphuric Acid	Fuming Sulphuric Acid
Norway Spruce	*Picea excelsa.*
Norwegian Tar	Tar, B.P.
Novaspirin (*Reg*)	Citrosalic Acid.
Novocaine (*Reg.*)	Ethocaine.
Nut Oil	Fixed Oil from Hazel Nuts.
Nutmeg Butter	Expressed Oil of Nutmeg.
Nutrose (*Reg.*)	Sodium Caseinate.
Nux Aromatica	Nutmeg.
Nux Moschata	Nutmeg.

Oak Galls	Galls.
Ochre	Coloured Earth.
Official	Approved by Authority; included in the National Pharmacopœia.
Officinal	Used or kept in the Shop; not necessarily official.
Oil of Adders	See Oil of Vipers.
Oil of Allspice	Oil of Pimento.
Oil of Aloes	Oil obtained from Socotrine Aloes.
Oil of Amber	Oil distilled from Amber.
Oil of Amber, Factitious	Oil distilled from Copal or Dammar.
Oil of Ants	Olive Oil in which Ants have been Digested.
Oil of Asarabacca	Oil obtained from Root of *Asarum europæum.*
Oil of Asphaltum	Oil obtained from Asphaltum.
Oil of Balm	Volatile Oil from *Melissa officinalis.*
Oil of Bay	Volatile Oil from Leaves of *Myrcia acris.*
Oil of Bay Berries	Oil expressed from Berries of *Laurus nobilis.*
Oil of Bay, Sweet	See Oil of Sweet Bay.
Oil of Been	Oil of Ben.
Oil of Behn	Oil of Ben.
Oil of Ben	Oil expressed from Seeds of *Moringa aptera.*
Oil of Benne	Sesame Oil.
Oil of Benjamin	Oil obtained from Benzoin, after sublimation of Benzoic Acid.
Oil of Birch, α	Volatile Oil, from *Betula lenta*, the Sweet Birch.

Oil of Birch, β	Empyreumatic Oil, from *Betula alba*, the White Birch.
Oil of Bitter Almonds	Essential Oil of Bitter Almonds.
Oil of Bitter Almonds, Synthetic	Benzaldehyde or Nitrobenzol
Oil of Bones	Oil obtained from Bones, Horn, etc.
Oil of Box	Oil obtained from Boxwood.
Oil of Bricks	Oil obtain'd by heati'g Bricks to redness, and quenching in Olive Oil.
Oil of Bricks, Factitious..	Mixture of Oil of Turpentine, 1, and Linseed Oil, 4, coloured with Alkanet or Tar.
Oil of Cabbage	Oil of Elder.
Oil of Cedrat	Oil obtained from Citron Peel.
Oil of Citronella.....	Oil obtained from *Andropogon nardus*.
Oil of Cocoa (Cacao).....	Theobroma Oil.
Oil of Cognac.....	Œnanthic Ether.
Oil of Colza.....	Rape Oil.
Oil of Cuscus	Oil of *Andropogon muricatus*.
Oil of Duty.....	Oil of Rhodium.
Oil of Earth Worms.....	Mixture of Olive Oil and White Wine, in which Earth-Worms have been Boiled.
Oil of Elder.....	Olive Oil in which Elder Leaves have been Boiled till Crisp.
Oil of Ergot.....	Residue left on Evaporating Ethereal Tincture of Ergot.
Oil of Exeter	Oil of Elder, mixed with Euphorbium, Mustard, etc.
Oil of Fern.....	Oil of Male Fern.
Oil of Foxglove	Olive Oil in which Fresh Leaves of Foxglove have been Digested.
Oil of Geranium	Oil obtained from *Pelargonium* sp.
Oil of Geranium, Rose ..	Oil of Geranium or Palmarosa.
Oil of Geranium, East Indian or Turkish	Oil of Palmarosa.
Oil of Gingelli	Sesame Oil.
Oil of Gingergrass.....	Inferior Oil of Palmarosa.
Oil of Grain	Fusel Oil.
Oil of Green Elder	Oil of Elder.
Oil of Hartshorn	Bone Oil.
Oil of Hemlock, α.....	Olive Oil in which fresh Leaves of *Conium maculatum* have been digested.
Oil of Hemlock, β.....	Volatile Oil, from *Pinus Canadensis*, the Hemlock Spruce.
Oil of Infernal Regions ..	Very Impure Olive Oil.
Oil of Jupiter.....	Oil of Juniper.

Oil of Laurel Berries, *α* ..	Butyraceous Oil, expressed from Berries of *Laurus nobilis.*
Oil of Laurel Berries, *β* ..	Volatile Oil, distilled from Berries of *Laurus nobilis.*
Oil of Liquid Pitch	Oil of Tar.
Oil of Lemongrass.....	Oil obtained from *Andropogon citratus*
Oil of Mace.....	Expressed Oil of Nutmeg (*approx.*).
Oil of Male Fern	Liquid Extract of Male Fern.
Oil of Man	Bone Oil.
Oil of Mucilages.....	Olive Oil Boiled with Decoction of Marshmallow Root, Linseed, and Fœnugreek Seeds.
Oil of Myrbane	Nitrobenzol.
Oil of Nerves	Neatsfoot Oil.
Oil of Origanum.....	Oil of Thyme.
Oil of Palma Christi	Castor Oil.
Oil of Palmarosa	Oil obtained from leaves of *Andropogon Schœnanthus.*
Oil of Paper	Oil obtained by Burning Paper on a Tin Plate.
Oil of Partridge Berry	Oil of Wintergreen.
Oil of Peter	Rock Oil, or a Mixture of Oil of Rosemary, 1; Oil of Turpentine, 4; and Barbados Tar, 4.
Oil of Petre	Oil of Peter.
Oil of Petitgrain	Oil obtained from the leaves, etc., of the Bitter Orange Tree.
Oil of Plum Stones	Oil obtained from Plum Kernels.
Oil of Pompilion	Ointment of Poplar Buds.
Oil of Pompilion, Factitious	Green Elder Ointment.
Oil of Portugal	Oil of Sweet Orange Peel.
Oil of Rhodium	Oil obtained from Root of *Genista canariensis.*
Oil of Rhodium, Factitious	Mixture of Sandal Wood Oil and Otto of Rose or Oil of Rose Geranium.
Oil of Scorpions	Oil in which Scorpions have been Digested; Adder Oil (*approx.*).
Oil of Spike	Volatile Oil from *Lavandula spica.*
Oil of Spike, Factitious ..	Mixture of Lavender Oil and Oil of Turpentine, coloured with Alkanet.
Oil of St. John	Oil of Elder (*approx.*).
Oil of St. John's Wort....	A Red Oil, obtained by digesting the flowering tops of *Hypericum perforatum* in warm olive oil.

Oil of Swallows.....	Formerly made from the bird of that name. Oil of Elder now generally substituted.
Oil of Sweet Bay	Volatile Oil, from Berries and Leaves of *Laurus nobilis*.
Oil of Sweet Flag	Oil obtained from Rhizome of *Acorus calamus*.
Oil of Tar	Creosote, or Reddish Limpid Fluid Distilled from Tar (*Veterinary*).
Oil of Tartar	Deliquesced Potassium Carbonate.
Oil of Tea	Oil obtained from Seeds of *Camellia* sp.
Oil of Theobroma	Cacao Butter.
Oil of Three Ingredients ..	Mixture of the Oils of Turpentine, Lavender, & Brick, in equal parts.
Oil of Thyme.....	Volatile Oil of *Thymus vulgaris*, the Wild Thyme.
Oil of Verbena	Oil obtained from *Verbena triphylla*.
Oil of Verbena, Factitious	Oil of Lemongrass.
Oil of Vetiver.....	Oil of Cuscus.
Oil of Vipers	The fat or oil of *Pelius Berus*, the Viper or Adder. Lard Oil, 3; Bone Oil, 1 (*approx.*).
Oil of Vitriol	Strong Sulphuric Acid.
Oil of Walnuts	Oil obtained from Walnuts.
Oil of Wax	Oil obtained from Beeswax.
Oil of Wheat	Oil obtained from Bruised Wheat.
Oil of Wine.....	Oleum Æthereum.
Oil of Wintergreen, Synthetic	Methyl Salicylate.
Oil of Wood Soot	Oil obtained from Wood Soot.
Oil of Wormseed	Oil obtained from *Chenopodium anthelminticum*.
Oil of Wormwood	Oil obtained from *Artemisia absinthium*.
Oil of Yolk of Eggs	Oil obtained from Hard-Boiled Yolks of Eggs.
Oleogen	A Mixture containing Oleic Acid, Liquid Paraffin, and Ammonia. See Parogen.
Oleo-Resina Aspidii	Liquid Extract of Male Fern.
Oleo-Resina Capsici	Capsicin.
Oleo-Resina Cubebæ.....	Extractum Cubebæ.
Oleo-Resina Zingiberis ..	Gingerine.
Oleum Amygdalæ Persic ..	Expressed Oil of Peach Kernels.
Oleum Anthos	Oil of Rosemary.
Oleum Arachis	Nut Oil.
Oleum Aurantii Florum ..	Oil of Orange Flowers.
Oleum Badiani	Oil of Star Anise.

Oleum Betulæ Albæ	Birch Tar Oil.
Oleum Betulæ Lentæ	Volatile Oil of Sweet Birch, consisting of Methyl Salicylate, and identical with Oil of Wintergreen.
Oleum Betulæ Pyroligneum	Birch Tar Oil.
Oleum Bromatum.....	Bromipin.
Oleum Camphoratum	Liniment of Camphor.
Oleum Ceti.....	Sperm Oil.
Oleum Cetacei	Sperm Oil.
Oleum Chloroformi	Chloroform, 3; Olive Oil, 2.
Oleum Cinereum	Grey Oil, B.P.C.
Oleum Cocainæ.....	Cocaine, 1; Almond Oil, 49.
Oleum Cornu Cervini	Bone Oil.
Oleum Fagi Pyroligneum .	Beech Tar.
Oleum Filicis Maris.....	Extractum Filicis Liquidum.
Oleum Gadus Morrhuæ ..	Oleum Morrhuæ.
Oleum Gurjun	Gurjun Oil.
Oleum Gynocardiæ	Chaulmoogra Oil
Oleum Iodatum.....	Iodipin.
Oleum Jecoris Aselli.....	Cod-Liver Oil.
Oleum Juniperi	Oil of Juniper Berries.
Oleum Junip.Empyreumat	Oil of Cade.
Oleum Juniperi Oxycedri..	Oil of Cade.
Oleum Lateritium.....	Oil of Bricks.
Oleum Lauri	Expressed Oil of Bay.
Oleum Lauri Essent.	Oil of Sweet Bay.
Oleum Macis	Expressed Oil of Nutmeg.
Oleum Melalucæ	Cajuput Oil.
Oleum Neroli.....	Oil of Orange Flowers.
Oleum Nucistæ	Expressed Oil of Nutmeg.
Oleum Palmarosæ	Oil of *Andropogon Schœnanthus*.
Oleum Petræ	Oil of Peter; Rock Oil.
Oleum Petrolatum	Paraffinum Liquidum.
Oleum Pimpinellæ	Oil of Aniseed.
Oleum Pini.....	Oleum Pini Pumilionis.
Oleum Populi	Olive Oil in which the buds of *Populus balsamifera* have been digested.
Oleum Rosæ	Otto of Rose.
Oleum Rusci	Russian Leather or Birch Tar Oil, obtained from *Betula alba*, not from *Ruscus aculeata*, Butchers' Broom.
Oleum Sulphuratum	Balsam of Sulphur.
Oleum Tiglii	Croton Oil.
Oleum Vini.....	Ethereal Oil.
Oleum Viride	Oil of Elder.
Opium Colatum.....	Extract of Opium.
Opodeldoc	Liniment of Soap.

Orchil	Archil.
Ordeal Bark	Bark of *Erythrophlœum guineense*.
Ordeal Bean	Calabar Bean.
Orleana	Annatto.
Orpiment	Yellow Arsenic Sulphide.
Orris Root	Rhizome of *Iris florentina*.
Orthocaine	New Orthoform (*Reg.*).
Orthoform, New (*Reg.*)	Orthocaine.
Orthophosphoric Acid	Concentrated Phosphoric Acid.
Oryza	Rice.
Os Ustum	Calcium Phosphate.
Otto	Essential Oil.
Ovi Albumen	White of Egg.
Ovi Vitellus	Yolk of Egg.
Ovolecithin	Lecithin.
Ox Gall	Ox Bile.
Oxycarbonate of Bismuth	Bismuth Carbonate.
Oxygenated Oil	Olive Oil through which Chlorine has been passed for several days.
Oxygenated Paraffin	Parogen.
Oxymel Æruginis	Linimentum Æruginis.
Oxymel Simplex	Oxymel, B.P.
Oxymuriate	Chlorate.
Oxyneurine	Betaine.
Oxynitrate	Subnitrate.
Ozonic Ether	Ethereal Solution of Hydrogen Peroxide.
Pagenstecher's Ointment	Ung. Hyd. Ox. Flav., 6¼ to 12½ per cent.
Palm Butter	Palm Oil.
Palm Spirit	Arrack.
Palmarosa Oil	Oil of *Andropogon Schœnanthus*.
Panama Bark	Quillaia Bark.
Pansecretin	Secretin; Duodenin.
Papayotin	Papain.
Paraffin Wax	Hard Paraffin.
Paraguay Tea	Leaves of *Ilex paraguayensis*.
Paraform	Paraformic Aldehyde.
Paranephrin	Adrenine.
Paregoric Elixir	Tinctura Camphoræ Composita.
Paregoric, Scotch	Tinctura Opii Ammoniata.
Paregoric, without Opium	Spiritus Camph. Comp., B.P.C.
Parenol, B.P.C.	Soft Paraffin, 65; Wool Fat, 15; Distilled Water, 20.
Parenol, Liquid, B.P.C.	Liquid Paraffin, 70; White Beeswax, 5; Distilled Water, 25.
Paris Black	Bone Black.
Paris Green	Scheele's Green.

Paris Red	Vermilion.
Parogen	Liquid Paraffin, 2; Oleic Acid, 2; Ammoniated Alcohol (5 p.c.), 1.
Parogen, Thick	Hard Paraffin, 6; Liquid Paraffin, 24; Oleic Acid, 15; Ammoniated Alcohol (10 p.c.), 5.
Parrish's Food	Syr. Ferri Phosph. Co., B.P.C.
Parrish's Syrup	Syr. Ferri Phosph. Co., B.P.C.
Parsley Piert	Breakstone; *Alchemilla arvensis.*
Passulæ	Raisins.
Pasta Bixæ	Annatto.
Pasta Caustica	Vienna Paste.
Pasta Gummi	Marshmallow Paste.
Pasta Londinensis	Caustic Soda, 1; Calcium Oxide, 1; Water, *q.s.*
Pastilles de Guimauve	Trochisci Althææ.
Pâte de Guimauve	Marshmallow Paste.
Peachwood	Brazil Wood.
Pear Oil	Amyl Acetate.
Pearl Ash	Potassium Carbonate.
Pearl White	Bismuth Oxychloride or Zinc Oxide
Pearson's Cerate	Lead Plaster, 4; Beeswax, 1; Almond Oil, 3.
Pearson's Arsenical Solution	See under Liquor Sodii Arsenatis, B.P.C.
Pectoral Powder	Compound Liquorice Powder
Pelosine	Beberine.
Pennyroyal (*Am.*)	*Hedeoma pulegioides.*
Pennyroyal (*Eng.*)	*Mentha Pulegium.*
Pepper Bark	Winter's Bark.
Perosmic Acid	Osmic Acid.
Persian Balsam	Compound Tincture of Benzoin.
Persian Powder	Insect Powder.
Persulphate of Copper	Copper Sulphate.
Peruvian Bark	Cinchona Bark.
Petrolatum	Soft Paraffin.
Petroleum Jelly	Soft Paraffin.
Petroleum Barbadense	Barbados Tar.
Petroleum Ether	Petroleum Spirit.
Petroleum, Stockholm	Stockholm Tar.
Phenacaine	Holocaine (*Reg.*).
Phenate	Carbolate.
Phenazone	Diphenylenazone; Antipyrine
Phenchizine	Phenyl - Dihydro - Quinazoline - Orexin (*Reg.*).
Phenic Acid	Phenol.
Phenic Alcohol	Phenol.
Phenol	Carbolic Acid.

Phenol Soda, or Sodique..	Liquor Sodii Carbolatis Compositus, B.P.C.
Phenocoll Salicylate.....	Salocoll (*Reg.*).
Phenyl Acetamide	Acetanilide.
Phenyl Hydrate	Phenol.
Phosote	Creosote Phosphate.
Phospholutein	Lecithin.
Phosphoric Acid, Syrupy..	Acidum Phosphoricum, B.P.C.
Phosphorus Salt	Sodii et Ammonii Phosphas.
Phosphotal	Creosote Phosphite.
Physiological Salt Solution	Solutio Salina, B.P.C.
Pickling Acid	Acetic Acid.
Picric Acid	Trinitrophenol.
Pigmentum Iodi	Liquor Iodi Fortis, B.P.
Pilewort (*Am.*)	*Scrophularia Marilandica.*
Pilewort (*Eng.*	*Ranunculus Ficaria.*
Pilula Aloes et Coloc.	Pil. Coloc. Comp.
Pilula Antimonii Co.....	Pil. Hydrg. Subchlor. Co.
Pilula Asafetidæ Composita	Pil. Galbani Co.
Pilula Calomelanos Composita	Pil. Hyd. Subchlor. Co.
Pilula Cathartica	Pil. Coloc. Co.
Pilula Cerulæa	Pil. Hydrargyri.
Pilula Cochia or Coccia ..	Pil. Coloc. Co. (*approx.*).
Pilula Communis	Pil. Aloes et Myrrhæ.
Pilula Ferri cum Myrrha	Pil. Ferri Co., P.L.
Pilula Diaphoretica	Pil. Hyd. Subchlor. Co.
Pilula Gummosa	Pil. Galbani Co.
Pilula Myrrhæ Co.	Pil. Galbani Co.
Pilula Opii*.....	Pil. Saponis Co.
Pilula Opii Co.	Pil. Saponis Co.
Pilula Plummeri	Pil. Hydrarg. Subchlor. Co.
Pilula Rudii	Pil. Coloc. Co.
Pilula Rufi	Pil. Aloes et Myrrhæ.
Pilula Saponis cum Opio..	Pil. Saponis Co.
Pilula Trium Phosphatum	Easton's Pill, B.P.C.
Pilula Valetti	Pil. Ferri Carb., B.P.C.
Pine Oil	Oleum Pini Pumilionis.
Pink Root	Root of *Spigelia marilandica.*
Pipsissewa	*Chimaphila umbellata.*
Pix	Pitch.
Pix Abietina or Alba	Burgundy Pitch.
Pix Carbonis	Coal Tar.
Pix Liquida	Stockholm Tar.
Pix Mineralis.....	Asphaltum.

* In the B.P. 1885, Pil. Opii was given as a synonym for Pil. Saponis Co., but Pil. Opii usually means a pill containing Opium only.

Pix Nigra	Black Pitch.
Pix Vegetabilis	Black Pitch.
Planche's Purgative	Mistura Scammonii, B.P.C.
Plasma	Glycerin of Starch.
Plaster of Paris	Anhydrous Calcium Sulphate.
Plumbago	Graphite.
Plummer's Pill	Pil. Hydrarg. Subchlor. Co.
Pod Pepper	Capsicum.
Podophylli Radix	Podophyllum Rhizome.
Podophyllin	Resin of Podophyllum.
Poison Nut	Nux Vomica.
Poke Root	Root of *Phytolacca decandra.*
Polychrest Salt	Potassium Sulphate.
Polychroit	Colouring Matter of Saffron.
Pomatum Saturni	Ung. Plumbi Acet.
Pondicherry Oil	Nut Oil.
Portland Arrowroot	Starch from *Arum maculatum.*
Pot Ashes	Crude Potassium Carbonate.
Potash Lozenges	Potassium Chlorate Lozenges.
Potash Pellets	Compressed Tablets of Potassium Chlorate.
Potash Soap	Soft Soap.
Potash Water	Liquor Potassæ Effervescens, P.J.F.
Potassa	Caustic Potash.
Potassa Fusa	Caustic Potash.
Potassæ Bitartras	Acid Potassium Tartrate.
Potassæ Citras Neutralis	Potassium Citrate.
Potassæ Hydras	Caustic Potash.
Potassæ Hydriodas	Potassium Iodide.
Potassæ Hydrobomas	Potassium Bromide.
Potassæ Prussias Flava	Potassium Ferrocyanide.
Potassæ Prussias Rubra	Potassium Ferridcyanide.
Potassæ Subcarbonas	Potassium Carbonate.
Potassæ Supersulphas	Potassium Bisulphate.
Potassæ Supertartras	Acid Potassium Tartrate.
Potassii Sulphuretum	Potassa Sulphurata.
Potassio-Tartrate of Iron	Tartarated Iron.
Potato Drops	Tinct. Aloes Co., B.P.C.
Potato Oil or Spirit	Crude Amylic Alcohol.
Potus Imperialis	Mistura Acida, B.P.C.
Poudre Savory	Seidlitz Powder.
Pounce	Powdered Sandarac.
Prayer Beads	Seeds of *Abrus precatorius.*
Precipitated Chalk	Calcii Carbonas Præcipitata.
Prepared Sulphuret of Antimony	Antimonium Nigrum Purificatum.
Preston Salts	Smelling Salts.
Protargol (*Reg.*)	Silver Protein.
Proto-Chloride of Mercury	Calomel.

Proto-Iodide of Mercury ..	Green Mercurous Iodide.
Protoxide of Antimony ..	Antimonii Oxidum.
Proto-Sulphate of Iron ..	Ferrous Sulphate.
Provence Oil	Finest (Aix) Olive Oil.
Prussian Blue	Ferric Ferrocyanide.
Prussic Acid	Diluted Hydrocyanic Acid.
Pulmentum	Gruel.
Pulsatilla (*Am.*)	*Anemone patens*, var. *Nuttalliana*.
Pulsatilla (*Eng.*)	*Anemone Pulsatilla*, or *A. pratensis*.
Pulvis Aërophorus Laxans	Seidlitz Powder.
Pulvis Alexiterius.....	Pulvis Ipecacuanhæ Comp.
Pulvis Aloeticus	Hiera Picra.
Pulvis Antimonii Co.	Pulvis Antimonialis,
Pulvis Aromaticus	Aromatic Powder, P.J.F.
Pulvis Basilicus.....	Pulv. Hydrarg. Subchlor. Co., B.P.C.
Pulvis Bismuthi Co.	Ferrier's Snuff.
Pulvis Catharticus	Pulvis Scammonii Co.
Pulvis Cretaceus	Pulvis Cretæ Aromat.
Pulvis Doveri.....	Pulvis Ipecacuanhæ Co.
Pulvis Effervescens Laxans	Seidlitz Powder.
Pulvis Gummosus.....	Pulvis Tragacanthæ Comp.
Pulvis Ipecac. cum Opio..	Pulvis Ipecacuanhæ Comp.
Pulvis Ipecac. Opiatus....	Pulvis Ipecacuanhæ Comp.
Pulvis Ipecac. Thebaicus..	Pulvis Ipecacuanhæ Comp.
Pulvis Jacobi	Pulvis Antimonialis (*approx.*).
Pulvis Kino cum Opio....	Pulvis Kino Comp.
Pulvis Rhei Salinus.....	Pulvis Rhei Comp.
Purgatol	Anthrapurpurin Diacetate.
Purified Aloes.....	Extract of Aloes.
Purple of Cassius	Gold Stannate.
Putty Powder	Commercial Oxide of Tin.
Pyramidon (*Reg.*).....	Amidopyrine.
Pyro.....	Pyrogallic Acid.
Pyroacetic Spirit	Acetone.
Pyrogallol	Pyrogallic Acid.
Pyroligneous Acid.....	Crude Acetic Acid.
Pyroligneous Spirit	Wood Naphtha.
Pyrosulphite of Potash ..	Potassium Metabisulphite.
Pyroxylic Spirit	Wood Naphtha.
Pyroxylin	Dinitrocellulose.
Pyrozone.....	Ozonic Ether.

QUEBRACHO	Bark of *Aspidosperma Quebracho*.
Queensland Fever Bark ..	Bark of *Alstonia constricta*.
Quercitron Bark	Bark of *Quercus tinctoria*.
Quevenne's Iron	Reduced Iron.
Quick Lime	Calcium Oxide.
Quicksilver	Mercury.

Quinalgen	Benzoyl Amido-Ethoxy-Quinoline; Analgen (*Reg.*).
Quinetum	Mixed Cinchona Alkaloids.
Quinine	Quinine Sulphate.
Quinine Disulphate	Quinine Sulphate.
Quinine Sulphate, Neutral	Acid Quinine Sulphate.
Quinine Sulphate, Soluble	Acid Quinine Sulphate.
Quinoidine	Amorphous Quinine.
Quinol	Hydroquinone.
Quinosol	Potassium Oxyquinoline Sulphonate.
Raddle	Armenian Bole.
Rag Oil	Oil of Paper.
Ragweed (*Am.*)	*Ambrosia artemisiæfolia.*
Ragweed (*Eng.*)	*Senecio Jacobœa.*
Rangoon Oil	Heavy Petroleum (*approx.*).
Rape Oil	Colza Oil.
Raspail's Solution	Aqua Sedativa.
Raspberry (*Am.*)	*Rubus strigosus.*
Raspberry (*Eng.*)	*Rubus Idæus.*
Ratafia	Essence of Almonds.
Ratsbane	Nux Vomica.
Rattlesnake Root	Root of *Polygala Senega.*
Realgar	Red Arsenium Sulphide.
Rectified Spirit	Alcohol, 90 per cent.
Red Arsenic	Realgar.
Red Blister	Ung. Hyd. Iod. Rub., 1 in 8.
Red Bole	Armenian Bole.
Red Bottle	Whitworth Bottle.
Red Chromate of Potash	Potassium Bichromate.
Red Crocus	Ferric Oxide.
Red Drops	Compound Tincture of Lavender.
Red Gum	Eucalyptus Gum.
Red Lavender	Compound Tincture of Lavender.
Red Lead	Red Oxide of Lead.
Red Oil	Olive Oil coloured with Alkanet.
Red Pepper	Capsicum.
Red Phosphorus	Amorphous Phosphorus.
Red Precipitate	Red Mercuric Oxide.
Red Prussiate of Potash	Ferridcyanide of Potassium.
Red Rub	Whitworth Bottle.
Red Rudd	Armenian Bole.
Reddle	Armenian Bole.
Red Sanders	Red Sandal Wood.
Regnauld's Anæsthetic	Chloroform, 4; Methylic Alcohol, 1.
Regulus of Antimony	Metallic Antimony.
Renaglandin	A proprietary extract of Suprarenal Glands.

Renostypticin	Adrenine.
Resina Cannabis	Extract of Indian Hemp.
Resorbin	A Mixture of Almond Oil and Beeswax, with Gelatin, Soap, and Hydrous Wool Fat.
Rhatany	Krameria Root.
Rhodomel	Honey of Roses.
Rhodosaccharum	Syrup of Roses.
Riga Balsam*	Oils of Lavender, Cloves, Cinnamon, Thyme, Mace, and Lemon, each 1; Balsam of Peru, 4: Oil of Sage, 1½; Tincture of Saffron, 2½; alcohol (90 per cent.), 250.
Rochdale Salt	Rochelle Salt.
Rochelle Salt	Tartarated Soda.
Roche Alum†	Iron Alum.
Rochi Gallis	Iron Alum.
Rock Ammonia	Ammonium Carbonate.
Rock Oil	Petroleum.
Rock Salt	Native Sodium Chloride.
Rodinal (*Reg.*)	Para-amido-phenol Hydrochloride.
Roman Alum	Roche Alum.
Roman Chamomile	Flower-heads of *Anthemis nobilis*.
Roman Ointment	A Mixture of Extract of Opium, Extract of Belladonna, Glycerin, and Resin Ointment.
Roman Vitriol	Copper Sulphate.
Rose Pink	Chalk tinted with Brazil Wood decoction.
Roseine	Fuchsine.
Rosin	Resin.
Rouge, Jeweller's	Calcined Ferric Oxide.
Rouge, Mineral	Calcined Ferric Oxide.
Rouge, Toilet	Carmine and Chalk.
Rouge, Toilet Vegetable	Diluted Carthamin.
R.S.T. Ointment	Unguentum Thymolis Compositum, B.P.C.
Rubini's Essence	Saturated Alcoholic Solution of Camphor.
Rue	*Ruta graveolens*.

* Chemists in East Coast seaports are frequently asked for Riga Balsam and it has been assumed that Friar's Balsam is intended, but true Riga Balsam contains neither benzoin nor aloes. It is a favourite all-round medicine in Riga, being especially esteemed as a stomachic, cold cure and pick-me-up. It is strongly spirituous and is sold in wine shops rather than by chemists. There are several makers. A sample examined for the purpose of this note was dark brown in colour with a pleasantly aromatic taste.

†It is usual to sell for Roche Alum ordinary Alum, dusted with red bole.

Rufus' Pill	Pilula Aloes et Myrrhæ.
Rum	A Spirituous Liquid distilled from Molasses and obtained largely from Jamaica.
Sabadilla	Cevadilla.
Sacchari Fæx	Treacle.
Saccharin	Gluside.
Saccharum Penidium	Barley Sugar.
Saccharum Ustum	Caramel.
Sacred Bark	Bark of *Rhamnus purshianus*.
Safflower	*Carthamus tinctorius*.
Saffron	Crocus, B.P.
Saffron, Meadow or Wild	*Colchicum autumnale*.
Saffron of Antimony	Sulphurated Antimony.
Sailor's Pepper	Cubebs.
Saint Ignatius', Beans	Seeds of *Strychnos Ignatii*.
Sal Acetosellæ	Potassium Quadroxalate or Binoxalate.
Sal Aëratus	Potassium Bicarbonate.
Sal Alembroth	Ammonio-Mercuric Chloride.
Sal Amarum	Magnesium Sulphate.
Sal Ammoniac	Ammonium Chloride.
Sal Anglicum	Magnesium Sulphate.
Sal Carolinum	Carlsbad Salt.
Sal Carolinum Factitium	Artificial Carlsbad Salt.
Sal Catharticum Amaræ	Magnesium Sulphate.
Sal Chalybis	Iron Sulphate.
Sal Culinaris	Sodium Chloride.
Sal Diureticus	Potassium Acetate.
Sal Enixum	Potassium Bisulphate.
Sal Glauberi	Sodium Sulphate.
Sal Marinus	Bay Salt.
Sal Perlatum	Sodium Phosphate.
Sal Polychrest	Potassium Sulphate.
Sal Prunella	Potassium Nitrate in Balls.
Sal Saturni	Lead Acetate.
Sal Sedativus	Boric Acid.
Sal Seignette	Tartarated Soda.
Sal Soda	Soda Ash.
Sal Succini	Succinic Acid.
Sal Vegetabile	Potassium Tartrate.
Sal Vitrioli	Zinc Sulphate.
Sal Volatile	Aromatic Spirit of Ammonia.
Salacetin	Acetosalic Acid; Aspirin (*Reg.*).
Salad Oil	Olive Oil.
Saleratus	Potassium Bicarbonate.
Saletin	Acetosalic Acid.

Saligallol	Pyrogallol Disalicylate.
Salipyrin (*Reg.*)	Phenazone Salicylate.
Salocoll (*Reg.*)	Phenocoll Salicylate.
Salophen (*Reg.*)	Acet-Amido-Salol.
Salt of Hartshorn	Ammonium Carbonate.
Salt of Lemon or Sorrel	Potassium Quadroxalate or Binoxalate.
Salt of Steel	Ferrous Sulphate.
Salt of Tartar	Potassium Carbonate.
Salt of Wormwood	Potassium Carbonate.
Salt of Vitriol	Zinc Sulphate.
Salt, Table	Sodium Chloride.
Saltpetre	Potassium Nitrate.
Salts	Magnesium Sulphate.
Salts of England	Epsom Salt.
Sandal Wood, Red	Wood of *Pterocarpus santalinus*.
Sandal Wood, White or Yellow	Wood of *Santalum album*.
Sandarac	Gum Juniper.
Sanders Wood	Red Sandal Wood.
Sanguisuga	Leech.
Santal Oil	Oil of Sandal Wood.
Sapo Animalis	Curd Soap.
Sapo Hispanicus	Castile Soap.
Sapo Kalinus	Soft Soap.
Sapo Kalinus, German	Soft Soap made with Linseed Oil.
Sapo Viridis	Green Soft Soap.
Sapocresol	Solutio Cresolis Saponatus, B.P.C.
Sassy Bark	Bark of *Erythrophlæum guineense*.
Scammony Milk	Scammony Mixture.
Scheele's Acid	Acid. Hydrocyanic., 4 per cent.
Scheele's Green	Copper Arsenite.
Schlippe's Salt	Sodium Sulphantimoniate.
Scotch Paregoric	Tinctura Opii Ammoniata.
Scotch Soda	Impure Sodium Carbonate.
Scott's Liniment	Linimentum Hydrargyri.
Scott's Ointment	Compound Ointment of Mercury.
Sea Salt	Bay Salt.
Sebum or Sevum	Prepared Suet.
Secale Cornutum	Ergot.
Sedative Salt	Boric Acid.
Seidlitz Powder	Pulv. Sodæ Tart. Effervescens.
Sel Anglais	Smelling Salt.
Sel d'Angleterre	Epsom Salt.
Semen Ambrette	Seeds of Musk Mallow.
Semen Amomi	Pimento.
Semen Badiani	Fruit of Star Anise.
Semen Calabariense	Calabar Bean.
Semen Cinæ	Santonica.

Semen Contra	Santonica.
Semen Sanctum	Santonica.
Semen Strychni	Nux Vomica.
Semen Zedoariæ	Santonica.
Serum Lactis	Whey.
Sesame Oil	Expressed Oil from Sesame Seeds.
Sesquicarbonate of Ammonia	Ammonium Carbonate.
Sesquicarbonate of Iron	Ferric Oxide.
Sesquicarbonate of Potash	Potassium Bicarbonate.
Sesquicarbonate of Soda	Sodium Bicarbonate.
Sesquichloride of Iron	Ferric Chloride.
Sesquioxide of Antimony	Antimonii Oxidum.
Sesquisulphuret of Antimony	Antimonium Nigrum Purificatum.
Sevum Præparatum	Prepared Suet.
Sherbet	Effervescent Lemon Kali.
Sicily Oil	Inferior Olive Oil.
Silent Spirit	Spirit of Wine.
Sinapism	Mustard Paper.
Skullcap (*Am.*)	*Scutellaria lateriflora.*
Skullcap (*Eng.*)	*Scutellaria galericulata.*
Slippery Elm	*Ulma fulva.*
Smoking Salts	Impure Hydrochloric Acid.
Snake-root, Virginian	Serpentary Rhizome.
Snake-root, Black	Rhizome of *Cimicifuga racemosa.*
Soap Bark	Quillaia Bark.
Soapstone	French Chalk.
Socaloin	Aloin from Socotrine Aloes.
Soda	Sodium Bicarbonate or Carbonate.
Soda, Caustic	Sodium Hydroxide.
Soda Crystals	Sodium Carbonate.
Soda, Washing	Sodium Carbonate.
Soda Water	Liquor Sodæ Effervescens, P.J.F.
Sodæ Biboras or Boras	Borax.
Sodæ et Potassæ Tartras	Tartarated Soda.
Sodæ Hydras	Caustic Soda.
Sodæ Potassio-Tartras	Tartarated Soda.
Sodæ Sesquicarbonas	Sodium Bicarbonate.
Sodæ Sub-Boras	Borax.
Sodæ Subcarbonas	Sodium Carbonate.
Solazzi Juice	A brand of Liquorice in Sticks.
Solomon's Seal	*Polygonatum multiflorum.*
Soluble Cream of Tartar	Potassium Boro-tartrate.
Soluble Glass	Sodium Silicate.
Soluble Tartar	Potassium Tartrate.
Solurol (*Reg.*)	Thyminic Acid.
Solvellæ	Soluble Tablets.
Spanish Juice	Liquorice in Sticks.

Spanish Fly	Cantharides.
Spanish Oil	Inferior Olive Oil.
Spanish Soap	Olive Oil Soap.
Spanish White	Prepared Chalk.
Spearmint	*Mentha viridis.*
Species	Powder.
Species Aromaticæ	Pulvis Cinnamomi Compositus.
Specificum Paracelsi	Potassium Sulphate.
Spermaceti Oil	Sperm Oil.
Spirit of Ammonia*	Liquor Ammoniæ.
Spirit of Bones	Liquor Ammoniæ.
Spirit of Hartshorn	Liquor Ammoniæ.
Spirit of Mindererus	Liquor Ammonii Acetatis.
Spirit of Myrcia	Bay Rum.
Spirit of Nitre	Spirit of Nitrous Ether.
Spirit of Red Lavender	Compound Tincture of Lavender.
Spirit of Sal Volatile	Spiritus Ammon. Aromat.
Spirit of Salt	Strong Impure Hydrochloric Acid.
Spirit of Scurvy Grass	Spiritus Armoraciæ Co. (*approx.*).
Spirit of Sweet Nitre	Spirit of Nitrous Ether.
Spirit of Turpentine	Oil of Turpentine.
Spirit of Verdigris	Acetic Acid.
Spirit of Vitriol	Diluted Sulphuric Acid.
Spirit of Vitriol, Sweet	Spirit of Ether.
Spirit of Wine	Rectified Spirit.
Spiritus Ætheris Chlorici	Spiritus Chloroformi.
Spiritus Ætheris Nitrici	Spirit of Nitrous Ether.
Spiritus Ammoniæ Comp.	Spiritus Ammoniæ Aromat.
Spiritus Ammon. Succin	Tinct. Ammon. Co. B.P.C.
Spiritus Camphoræ Fort.	Rubini's Essence of Camphor.
Spiritus Cochleariæ	Spiritus Armoraciæ Comp.
Spiritus Frumenti	Whisky.
Spiritus Glonoini	Liquor Trinitrini.
Spiritus Lavandulæ Comp.	Tinctura Lavandulæ Co.
Spiritus Mindereri	Liquor Ammonii Acetatis.
Spiritus Myrciæ	Bay Rum.
Spiritus Nitri Dulcis	Spirit of Nitrous Ether.
Spiritus Raphani	Spiritus Armoraciæ Comp.
Spiritus Sacchari	Rum.
Spiritus Vini Gallici	French Brandy.
Spiritus Vitrioli Dulcis	Spiritus Ætheris.
Spiritus Volatilis	Spiritus Ammoniæ Aromat.
Spiritus Volatilis Oleosus	Spiritus Ammoniæ Aromat.
Spiritus Volatilis Fetidus	Spiritus Ammoniæ Fetidus.
Spruce Fir	*Picea excelsa.*
Spurge Laurel	*Daphne Laureola.*

* This is a very common but a somewhat dangerous synonym; care should be taken to ensure that Spirit. Ammon. Aromat. is not meant.

Spurred Rye	Ergot.
Stannum	Tin.
Stannum Indicum	Zinc.
Starch Gum	Dextrin.
Starch Paste	Mucilage of Starch.
Steel Drops	Tinct. Ferri Perchloridi.
Steel Wine	Iron Wine.
Stibiated Tartar	Tartarated Antimony.
Stockholm Tar	Tar, B.P.
Stone Mercury	Mercuric Chloride.
Stovaine (*Reg.*)	Amylocaine.
Strapping	Sticking Plaster.
Strengthening Plaster	Emplastrum Ferri, B.P.C.
Strong Purging Pill	Pil. Coloc. et Hyos.
Strontia	Strontium Oxide.
Styptic Colloid	Collodium Stypticum, B.P.C.
Styptirenal (*Reg.*)	Adrenine.
Sub-borate of Soda	Borax.
Subcarbonate of Bismuth	Bismuth Carbonate.
Subcarbonate of Lead	Lead Carbonate.
Subcarbonate of Potash	Potassium Carbonate.
Subcarbonate of Soda	Sodium Carbonate.
Subcarbonate of Zinc	Zinc Carbonate.
Subchloride of Mercury	Calomel.
Subiodide of Mercury	Green Mercurous Iodide.
Subsulphate of Mercury	Turpeth Mineral.
Sublimate, Corrosive	Mercuric Chloride.
Sublime Olive Oil	Best Olive Oil.
Sublime Salad Oil	Best Olive Oil.
Succinum	Amber.
Sucrose	Cane Sugar.
Suction Gum	Powdered Gum Tragacanth.
Suction Powder	Powdered Gum Tragacanth.
Sugar of Lead	Lead Acetate.
Sugar of Milk	Lactose.
Sulfosot (*Reg.*)	Potassium Creosote Sulphonate.
Sulphocarbolic Acid	Aseptol.
Sulphide of Antimony	Antimonium Nigrum Purificatum.
Sulphur, Black	Crude Native Sulphur.
Sulphur Vivum	Crude Native Sulphur.
Sulphur Rotunda	Sulphur in Sticks.
Sulphur Vegetabile	Lycopodium.
Sulphurated Oil	Balsam of Sulphur.
Sulphuric Ether	Ether, B.P.
Sulphuris Chloridum	Sulphur Chloride.
Suprarenalin	Adrenine.
Suprarenin (*Reg.*)	Adrenine.
Surfeit Water	Liquor Ammonii Acetatis.
Sweet Bay	See Bay, Sweet.

Sweet Nitre	Spirit of Nitrous Ether.
Sweet Oil	Colza Oil, or, more rarely, Olive Oil.
Sweet Spirit of Nitre	Spirit of Nitrous Ether.
Sydenham's Laudanum	Tinctura Opii Crocata, B.P.C.
Syrup of Fox-lung	Syrup of Red Poppies (*approx.*).
Syrup of Poppies	Syrupus Papaveris, B.P.C.
Syrupus Acaciæ, B.P.C.	Acacia Mucilage, 1; Syrup, 3.
Syrupus Balsamicus	Syrup of Tolu.
Syrupus Capillaire	Syrup of Orange Flowers.
Syrupus Citri	Syrup of Lemon.
Syrupus Citri Aurantii	Syrup of Orange.
Syrupus Diacodii	Syrup of Poppies (*Approx.*).
Syrupus Epithymi	Syrup of Dodder (*Obs.*).
Syrupus Fuscus	Treacle.
Syrupus Meconii	Syrup of Poppies.
Syrupus Papaveris Albi	Syrup of Poppies.
Syrupus Phosph. Co	Syrupus Ferri Phosph. Co., B.P.C.
Syrupus Simplex	Syrupus, B.P.
Syrupus Stœchadis	Syrup of Lavender (*Obs.*).
Syrupus Symphyti	Syrup of Comfrey (*Obs.*).
SyrupusTriumPhosphatum	Easton's Syrup.
Syrupy Phosphoric Acid	Acidum Phosphoricum, B.P.C.

Tablettæ	Compressed Tablets.
Tabloid (*Reg.*)*	A Brand of Compressed Tablets. Surgical Dressings, etc.
Tailed Pepper	Cubebs.
Talc	French Chalk.
Tampico Jalap	Tubercules of *Ipomœa simuiqns*.
Tannacetin	Diacetyl Tannin; Tannigen.
Tannalbin (*Reg.*)	Tannin Albumin.
Tannigen (*Reg.*)	Acetannin.
Tannin	Tannic Acid.
Tannin Lozenges	Troch. Acidi Tannici, B.P.
Tannoform (*Reg.*)	Methylene Ditannin.
Tannopin (*Reg.*)	Naphthamine Tannate.
Tanocol (*Reg.*)	Gelatin Tannate.
Tar Tea	Tar Water.
Tartar	Crude Potassium Acid Tartrate.
Tartar Emetic	Tartarated Antimony.
Tartarine	Potassium Bisulphate.
Tartarus Depuratus	Potassium Acid Tartrate.
Tartarus Natronatus	Tartarated Soda.

* It should be noted that the word "tabloid" is simply a trade-mark, and not the name of anything having substantive existence. "Tabloids" are frequently asked for when compressed tablets of no particular make are required, in which case the position should be explained to the customer before the order is executed.

Tartarus Stibiatus.....	Tartarated Antimony.
Tartarus Tartarisatus	Potassium Tartrate.
Tasteless Salts	Sodium Phosphate.
Taurocholate of Sodium ..	Sodium Glycocholate.
Teel Oil	Sesame Oil.
Tennant's Salt	Chlorinated Lime.
Terebinthina	Crude Turpentine.
Terebinthina Cypria.....	Chian Turpentine.
Terebinthina Cocta	Resin.
Terebinthina Lagigna	Venice Turpentine.
Terebinthina Pistacina ..	Chian Turpentine.
Terebinthina Vulgaris	Crude Turpentine.
Terpene Hydrate	Derivative of Oil of Turpentine.
Terpine	Terpene Hydrate.
Terra Alba	China Clay.
Terra Cariosa	Rotten Stone.
Terra Japonica	Pale Catechu.
Terra Ponderosa	Barium Sulphate.
Terra Rosæ.....	Rose Pink.
Tersulphuret of Antimony	Antimonium Nigrum Purificatum.
Testæ	Oyster Shells.
Tetronal (*Reg.*)	Diethyl Sulphonal.
Thebaicum	Opium.
Theine.....	Caffeine.
Theocin (*Reg.*)	Methyl-Xanthine.
Theriaca Andromachi	Confectio Damocratis.
Thiocol (*Reg.*)	Potassium Guaiacol Sulphonate.
Thioform (*Reg.*).....	Bismuth Dithio-salicylate.
Thiosinamine.....	Allyl Thiocarbamide.
Thiosulphate of Sodium ..	Sodium Hyposulphite.
Thorn Apple	*Datura Stramonium.*
Thridace	Lactucarium.
Throat Balls	Sal Prunella Balls.
Thus, Gum.....	Common Frankincense.
Thymic Acid	Thymol.
Tic Plaster	Belladonna Plaster, 1 in. square.
Til Oil	Sesame Oil.
Tinctura Actææ.....	Tinctura Cimicifugæ.
Tinctura Aloes et Myrrh..	Tinctura Aloes Comp., B.P.C.
Tinctura Amara.....	Tinctura Gentianæ Comp.
Tinctura Ambrettæ	Tincture of Musk Seed.
Tinctura Antiperiodica ..	Warburg's Tincture.
Tinctura Aromatica.....	Tinct. Cinnamomi Comp., P.L.
Tinctura Asafetida Ammoniata	Spiritus Ammoniæ Fetidus.
Tinctura Balsamica.....	Tinct. Benzoini Comp.
Tinctura Balsami Tolutani	Tinct. Tolutani.
Tinctura Camphoræ	Spiritus Camphoræ.

Tinctura Camphoræ cum Opio	Tinct. Camphoræ Comp.
Tinctura Cardamoni	Tinct. Cardamomi, B.P.C.
Tinctura Cicutæ	Tinct. Conii.
Tinctura Colchici	Tinct. Colchici Seminum.
Tinctura Conii Fructus	Tinct. Conii.
Tinctura Ferri Ammon.	Tinct. Ferri Ammon. Chlor., P.L.
Tinctura Ferri Sesquichlor	Tinct. Ferri Perchloridi.
Tinctura Guaiaci	Tinct. Guaiaci, B.P.C.
Tinctura Guaiaci Comp.	Tinct. Guaiaci Ammoniata.
Tinctura Hieræ	Vinum Aloes, B.P.C.
Tinctura Humuli	Tinctura Lupuli.
Tinctura Iodinii Comp.	Tinctura Iodi.
Tinctura Japonica	Tinctura Catechu.
Tinctura Lauri Cinnam.	Tinctura Cinnamomi.
Tinctura Lobeliæ Inflatæ	Tinctura Lobeliæ, B.P.C.
Tinctura Lyttæ	Tinctura Cantharidis.
Tinctura Opii Benzoica	Tinct. Camphoræ Comp.
Tinctura Opii Camphorata	Tinct. Camphoræ Comp.
Tinctura Quiniæ Comp.	Tinctura Quininæ.
Tinctura Rhei	Tinctura Rhei, B.P.C.
Tinctura Sacra	Vinum Aloes, B.P.C.
Tinctura Saponis et Opii	Linimentum Opii.
Tinctura Secalis Cornuti	Tinctura Ergotæ, B.P.C.
Tinctura Sennæ	Tinct. Sennæ Comp.
Tinctura Stomachica	Tinct. Cardamomi Comp.
Tinctura Strychni	Tinct. Nucis Vomicæ.
Tinctura Thebaicæ	Tinctura Opii.
Tinctura Valerianæ	Tinctura Valerianæ, B.P.C.
Tinctura Valerianæ Comp.	Tinct. Valerianæ Ammon.
Tinctura Valerian Volatilis	Tinct. Valerianæ Ammon.
Tincture of Bark	Tincture of Yellow Cinchona, B.P.C.
Tincture of Henbane	Tincture of Hyoscyamus.
Tincture of Hiera Picra	Vinum Aloes, B.P.C.
Tincture of Steel	Tinct. Ferri Perchlor.
Tinnevelly Senna	East Indian Senna.
Tobacco Water	Infusion of Tobacco
Toilet Vinegar	Perfumed Acetic Acid.
Tonic Cups	Cups made of Quassia Wood.
Tonka, or Tonca	Tonquin Bean.
Toothache Jelly	Phenol and Collodion, equal parts.
Toothache Seeds	Henbane Seeds.
Tous-les-Mois	Starch from Tubers of *Canna edulis*.
Train Oil	Whale Oil.
Traumatic Balsam	Compound Tincture of Benzoin.
Traumaticin	Gutta Percha, 1; Chloroform (by weight), 10.
Tricalcic Phosphate	Calcium Phosphate.
Trigemin	Butyl-Amidopyrine.

Trimethylglycine	Betaine.
Trinitrin	Nitroglycerin.
Trinitrophenic Acid	Picric Acid.
Trinitrophenol	Picric Acid.
Trional	Ethyl-Methyl Sulphonal.
Triple Syrup	Easton's Syrup.
Trisnitrate of Bismuth	Bismuth Subnitrate.
Trochisci Althææ	Pastilles de Guimauve.
Trooper's Ointment	Blue Ointment.
Trotter Oil	Neat's Foot Oil.
Turkey Rhubarb	Rhubarb Root, B.P.
Turlington's Balsam	Tinctura Benzoini Comp. (*approx.*).
Turmeric	Rhizome of *Curcuma longa*.
Turnbull's Blue	Ferrous Ferridcyanide.
Turnbull's Tincture of Aconite	See under Tinct. Aconiti Fortis, B.P.C.
Turnbull's Tincture of Capsicum	Tinct. Capsici Fort., B.P.C.
Turner's Cerate	Calamine Ointment, B.P.C.
Turpentine	Oil of Turpentine.
Turpentine, Bordeaux	Oleoresin from *Pinus maritimes*.
Turpentine, Canada	Oleoresin from *Abies balsamen*.
Turpentine, Chian	Oleoresin from *Pistacia terebinthus*.
Turpentine Drops	Dutch Drops.
Turpentine, Venice	Oleoresin from *Larix europæa*.
Turpeth Mineral	Yellow Basic Mercury Sulphate.
Turps	Oil of Turpentine.
Tussol (*Reg.*)	Antipyrine Amygdalate.
Tutty Powder	Crude Zinc Oxide.

Unguentum Ægyptiacum	Linimentum Æruginis, B.P.C.
Unguentum Altheæ	Marshmallow Ointment.
Unguentum Balsamicum	Ung. Elemi, B.P.C.
Unguentum Basilicum	Resin Ointment.
Unguentum Cæruleum	Blue Ointment.
Unguentum Calomelanos	Ung. Hydrarg. Subchlor.
Unguentum Cereum	Ung. Simplex, B.P.C.
Unguentum Cerussæ	Ung. Plumbi Carb.
Unguentum Ceti	Ung. Cetacei.
Unguentum Citrinum	Ung. Hydrarg. Nitratis.
Unguentum Emolliens	Ung. Aquæ Rosæ, B.P.
Unguentum Galeni	Cold Cream.
Unguentum Gallæ Comp.	Ung. Gallæ cum Opio.
Unguentum Hydrarg. Fort.	Ung. Hydrargyri, B.P.
Unguent. Hydrarg. Mitius	Ung. Hydrarg. Dil., B.P.C.
Unguent. Hydrarg. Nit. Ox.	Ung. Hyd. Ox. Rub.
Unguentum Iodi Comp.	Unguentum Iodi.

Unguentum Leniens	Ung. Aquæ Rosæ, B.P.
Unguentum Lyttæ	Ung. Cantharidis.
Unguentum Ovillum	Prepared Suet.
Unguentum Plumbi.....	Unguentum Plumbi Carbonatis.
Unguentum Populeum* ..	Green Elder Ointment (*approx.*).
Unguentum Præcip. Albi	Ung. Hydrarg. Ammon.
Unguentum Rosæ Comp.	Ung. Aquæ Rosæ, B.P.
Unguentum Sambuci	Green Elder Ointment.
Unguent. Sambuci Viride	Green Elder Ointment.
Unguentum Saturni	Unguentum Plumbi Acetatis.
Unguentum Stibiatum ..	Unguent. Antim. Tart., B.P.C.
Unguentum Zinci Oxidi..	Unguentum Zinci.
Urisol	Formamine.
Uritone	Formamine.
Uropherin (*Reg.*)	Lithium Theobromine Salicylate.
Uropurgol	Formamol.
Urotropin (*Reg.*)	Formamine.
Uvæ Passæ	Raisins.
Uvæ Passæ Minores.....	Currants.
Valerianic Ether	Ethyl Valerianate.
Valerian (*Am.*)	*Cypripedium pubescens.*
Valerian (*Eng.*).....	*Valeriana officinalis.*
Validol (*Reg.*)	Menthol Valerianate.
Vallet's Pills	Pilula Ferri (*approx.*).
Valsol (*Pat.*)	Vasogen.
Vanilloes.....	Vanilla Pods.
Van Swieten's Solution ..	See Liqueur de Van Swieten.
Vaseline (*Reg.*)	A variety of Soft Paraffin.
Vasoconstrictine	Adrenine.
Vasogen (*Pat.*)	Oxygenated Petroleum (see Parogen).
Vasoliment.....	Parogen.
Vegetable Black	A very light Lamp-black.
Vegetable Calomel	Resin of Podophyllum.
Vegetable Sulphur	Lycopodium.
Venetian Red.....	Red Bole.
Venice Soap	Olive Oil Soap.
Venice Treacle	Confectio Damocratis.
Venice Turpentine	Oleoresin from *Larix europæa.*†
Verdigris.....	Copper Subacetate.
Vermilion	Red Mercuric Sulphide.
Veronal (*Reg.*)	Malourea.
Vervain (*Am.*)	*Verbena hastata.*
Vervain (*Eng.*)	*Verbena officinalis.*

*True Unguentum Populeum was prepared by digesting the buds of *Populus balsamifera* in melted lard.

† A mixture of Resin and Oil of Turpentine is usually given.

Vesaloine (*Reg.*)	Formamine.
Vichy Salt	Sodium Bicarbonate.
Vienna Mixture	Ether, 3; Chloroform, 1; by weight.
Vienna Paste	Pasta Potassæ et Calcis, B.P.C.
Vinegar	An acid liquid produced by the alcoholic and acetous fermentations of a vegetable juice or infusion; diluted acetic acid.
Vinegar, Brown	Malt Vinegar.
Vinegar, Distilled	Diluted Acetic Acid.
Vinegar, Malt	An acid liquid prepared from a mixture of malted and unmalted grain, by the acetous fermentation.
Vinegar, White	Diluted Acetic Acid.
Vinegar, White Wine	Vinegar prepared from White Wine.
Vinegar, Wine	Vinegar prepared from Red or White Wine.
Vinum Amarum	Vinum Gentianæ, P.E.
Vinum Carnis et Bynes	Beef and Malt Wine, P.J.F.
Vinum Chalybeatum	Vinum Ferri.
Vinum Martis	Vinum Ferri.
Vinum Opii Co	Vinum Opii, B.P.C.
Vinum Stibiatum	Vinum Antimoniale.
Violet Powder	Perfumed Starch Powder.
Violet Root	Orris Root.
Viper Oil	See Oil of Vipers.
Virgin Oil	Finest (Aix) Olive Oil, or the oil which separates spontaneously from the paste of crushed olives.
Vitriol	Sulphuric Acid.
Vitriol, Blue	Copper Sulphate.
Vitriol, Green	Ferrous Sulphate.
Vitriol, Roman	Copper Sulphate.
Vitriol, Salt of	Zinc Sulphate.
Vitriolic Acid	Sulphuric Acid.
Vol	Ammonium Carbonate.
Volatile Alkali	Ammonia.
Volatile Liniment	Liniment of Ammonia.
Volatile Salt	Ammonium Carbonate.
Wade's Drops	Compound Tincture of Benzoin.
Wahoo Bark	Root-bark of *Euonymus atropurpureus*.
Warburg's Tincture	Tinctura Antiperiodica, B.P.C.
Ward's Paste	Confection of Pepper.
Warming Plaster	Emplastrum Calefaciens.
Washing Crystals	Commercial Sodium Carbonate.

Washing Soda	Commercial Sodium Carbonate.
Water Glass	Sodium Silicate.
Wax	Beeswax.
Wax, Carnauba	Wax from *Copernicia cerifera*.
Wax, Japan	Wax from *Rhus succedaneum*.
Wax, White	White Beeswax.
Webster's, Lady, Pills	Pilulæ Aloes et Mastiches, B.P.C.
Wedel's Oil	Oil of Bergamot, 1 ; Camphor, 4 ; Oil of Almonds, 32.
Whisky, Whiskey	A Spirituous Liquid distilled from Malted Grain or other Saccharine material, and sometimes blended with Silent Spirit.
Whey, Acid	See Acid Whey.
White Arsenic	Arsenious Anhydride.
White Bismuth	Bismuth Subnitrate.
White Bole	Kaolin.
White Cerate	Spermaceti Ointment.
White Copperas	Zinc Sulphate.
White Diachylon Plaster.	Emplastrum Plumbi.
White Lac	Shellac bleached with Chlorine.
White Lead	Lead Carbonate.
White Oils	Oil of Turpentine, Yolk of Egg, Acetic Acid, and Water.
White Oxide of Arsenic	Arsenious Acid.
White Precipitate	Ammoniated Mercury.
White Precipitate Ointment	Ung. Hydrarg. Ammon.
White Soap Plaster	Emplastrum Saponis.
White Vitriol	Zinc Sulphate.
White Wash	Liquor Plumbi Subacet. Dil.
White Wax	White Beeswax.
White Wine Vinegar	Vinegar prepared from White Wine; diluted Acetic Acid (*approx.*).
Whitworth Red Bottle*	Oil of Origanum, 1 ; Compound Tincture of Lavender, 4 ; Alcohol, 8.
Wild Celandine	See Celandine, Wild.
Wild Ginger	See Ginger, Wild.
Wintergreen (*Am.*)	*Gaultheria procumbens*, or *Chimaphila umbellata*.
Wintergreen (*Eng.*)	*Pyrola rotundifolia*.
Winter's Bark	Bark of *Drimys Winteri*.
Witch Hazel	*Hamamelis virginiana*.
Wood Ether	Methylic Ether.
Wood Naphtha or Spirit	Crude Methyl Alcohol.

* Other formulæ will be found in the 'P.J.F.'

Wood Oil	Gurjun Oil.
Wood Tar	Pix Liquida.
Wool	Cotton Wool.
Woorare	Curare.
Worm Seed	Unexpanded flower-heads of *Artemisia maritima*.
Worm Seed, American	Fruit of *Chenopodium ambrosioides*.
Wurrus	Kamala.
Xanol (*Reg.*)	Caffeine Sodiosalicylate.
Xaxa	Acetosalic Acid.
Xeroform (*Reg.*)	Bismuth Tribromo-Phenylate.
Yeast	Cerevisiæ Fermentum.
Yeast Poultice	Cataplasma Fermenti, B.P.C.
Yellow Bark	Bark of *Cinchona Calisaya*.
Yellow Basilicon	Resin Ointment.
Yellow Iodide of Mercury	Mercurous Iodide.
Yellow Jasmine	Gelsemium.
Yellow Precipitate	Yellow Mercuric Oxide.
Yellow Wash	Yellow Mercurial Lotion.
Yellow Wood	Fustic Wood.
Yohimbenine	Corynanthine ; Corymbenine.
Yohimbine (*Reg.*)	Corynine ; Corymbine.
Zanaloin	Aloin of Zanzibar Aloes.
Zeæ Stigmata	Corn Silk.
Zedoariæ Semina	Santonica.
Zeller's Ointment	Ammoniated Mercury Ointment.
Zinc Powder	Zinc Oxide.
Zinc White	White Zinc Carbonate.
Zittmann's Mixture	See Zittmann's Mixture or Decoction, P.J.F.
Zittmann's Pill	See Zittmann's Pill, P.J.F.

THE TRAINING OF PHARMACISTS.

PRELIMINARY STUDIES.

PHARMACY as a career offers many advantages over many other trades or professions. It is clean work, interesting, may be made very lucrative, and affords unlimited scope for the exercise of brains. Although neither strictly a trade, nor a profession, it has the elements of both, and for this reason alone must appeal to the instincts of a large number of youths who have distinct commercial tendencies as well as brains and personality, which are usually associated with the practice of a profession. Given a good start in general education he has nothing to fear from his technical examinations. But it should be clearly understood that the better his educational equipment, the better use he will be enabled to make of the opportunities that will be offered him later on. Therefore, before actually throwing in his lot with pharmacy the future pharmacist should have passed one of the preliminary examinations approved by the Pharmaceutical Society of Great Britain—preferably the Matriculation Examination of London University. If, however, from various considerations, the candidate cannot do this, he should select the preliminary examination of that provincial university in whose neighbourhood he is placed. The certificate must include English, Latin, a modern foreign language, arithmetic, algebra, and Euclid. If the student, by industry and capacity, can add to these without unduly taxing his powers, all the better. He will find use later on for what some might consider his superfluous knowledge. A good knowledge of Latin grammar and a fairly extensive Latin vocabulary are essential; an acquaintance with Latin literature may be classed as non-essential, but decidedly advantageous. Familiarity with the Greek alphabet and prepositions is also almost necessary to every student of any branch of natural science, in order to understand the phraseology of men of science; the grammar and literature of the language are luxuries with which the many must perforce dispense. Professor Allbutt is doubtless right in stating that a classical education should be depended upon "in no pedantic or merely linguistic sense, but as a contemplation of masterpieces," and in the further assertion that "we can meditate on masterpieces without fixing our eyes backwards"; but the classes from which pharmacists are mainly drawn rarely obtain even the briefest glimpse of the masterpieces of classical literature. One modern foreign language should be spoken, written,

and understood with as much facility as may be; there is little to choose between the French and German tongues.

Of English history, literature, and grammar the middle-class boy cannot learn too much; for the Englishman who cannot speak and write English well must always be at a disadvantage, in his private life as much as in his public relations, whatever his occupation. On the way in which a knowledge of English and of "composition" is acquired much depends. It is impossible to mark off as negligible any portion of the great field of English letters. If the student ever hopes to acquire more than the bare minimum of knowledge which is necessary for qualification, he must leave school with a fair knowledge of algebra. In any case, he must be thoroughly accurate in arithmetical calculations. Ability to use logarithms and an acquaintance with the elementary principles of trigonometry, dynamics, and statics are very desirable for practical purposes; while as a stimulus to the reasoning faculty the study of geometry must on no account be neglected. The value of these subjects is rarely realised until the chemist and druggist is preparing for the Major Examination; but without them it is difficult, if not impossible, to make satisfactory progress in the branch of natural philosophy commonly designated as "physics." Differences of opinion exist as to the desirability of any training in natural science before the age at which youths are apprenticed to pharmacy; and, indeed, there is so much else to learn in early youth that for our part we are disposed to recommend that the study of chemistry, botany, and physics should not as a rule be even begun before the age of seventeen. Having thus qualified himself to enter on his pharmaceutical career his next course is to become an apprentice, and with this view he should obtain the advice of some person with pharmaceutical experience, and indenture himself for three years to a pharmacist, then he will have opportunities of learning practical pharmacy and business knowledge, and attending classes. If a master can be found who will regard the apprentice as a pupil rather than as an errand boy or drudge it will be to the apprentice's advantage—incidentally also, the master's. Steady and systematic study should be kept up throughout the apprenticeship, without neglecting opportunities for recreation, which should be regarded as a necessity. During this probationary period the apprentice will have many opportunities of exercising his faculties, and he should at once commence by making mental notes. Although he may not like to have the task of dusting bottles allotted to him he would do well to make the most of his opportunities even here. This drudgery work will familiarise him with the appearance of substances he may rarely be called upon to use in prescriptions, or even in

general pharmacy, but he will thereby be laying up a store of knowledge that he may find useful in unforeseen ways in time to come. He should cultivate the habit of inquisitiveness, but should carefully avoid the habit of tasting and smelling—at all events, during the earlier stage of his career. Stock-taking and window-dressing will also afford him opportunities of gaining useful experience; these along with book-keeping and invoice-checking will be of value in laying the foundations of good business habits.

From the first days of his apprenticeship the ambitious youth should take steps to familiarise himself with the conditions under which the Jacob Bell, Manchester, and Fairchild scholarships are respectively awarded. Study and continuous preparation for any one of these scholarships will be invaluable, and even if he fail to secure a scholarship he will have acquired a store of useful knowledge which will make the passing of the Minor Examination a comparatively simple matter, and will certainly tend towards success throughout his career as a pharmacist. It will also be found advantageous to read carefully the different series of articles published in the "Students' Column," as well as to take part regularly in the *P. J.* practical chemistry competitions. At the completion of his apprenticeship the student will probably realise that he is ready to undergo a course of systematic training, and with this end in view he should, if he can possibly do so, direct his training to the acquisition of a university degree. For this purpose there is perhaps no school better than the historic School of Pharmacy in Bloomsbury Square. At this institution the best tuition in all the subjects necessary to enable him to pass the technical examination is available, and he will have no difficulty on a slight prolongation of his studies in taking his science degree. Above all, the student should, from false notions of economy, guard against merely managing to scramble through the Minor (or qualifying) Examination. He should be in a state of preparation which will enable him, with very little additional effort, to pass the Major Examination.

APPRENTICESHIP.

There are several considerations which should influence parents and guardians, or a youth himself, in the choice of a career, and probably among these the cost involved will be of the first importance. This in pharmacy may vary from £100 or £150 to £1,000. or more according to circumstances, and whether the cost of setting the young man up in business is included. In beginning a career, as in building a house, the foundation is the all-important part, and it is necessary to ascertain what par-

ticular qualifications are required for success in the particular calling chosen, and whether the youth has any special aptitude for the work to be selected. The stuff of which successful chemists are made should contain a large proportion of business aptitude, with rather more than a dash of that scientific, inquiring disposition of which our successful scientists are the embodiment. It is not a sufficient indication of aptitude that the youth should have a liking for the classes in elementary chemistry held at his school. But if a liking for natural science be coupled with some evidence of business instinct, there is certainly some ground for the supposition that in the course of time the youth may develop into a good pharmaceutical chemist—a credit to his people and his craft.

Having decided that the necessary expenses in starting a lad in the pharmaceutical calling are within his means, the parent or guardian will do well to consider carefully the question of apprenticeship. The lad will have just passed his preliminary examination which enables him to be registered as a student-associate of the Pharmaceutical Society, and will be accustomed to a certain amount of study each day. It is important that this habit should not be allowed to lapse. There are four distinct classes of pharmacists to whom he may be apprenticed, and each has a corresponding advantage. But the period required in each case is the same, and is usually three, but sometimes four, years. He may be placed with what is called, for want of a better term, a "high-class" pharmacist. The premium paid will range from £20 to £100, according to the time and individual tuition which is to be given to the apprentice. For the first year the pupil will be instructed in making various preparations, such as those of the British Pharmaceutical Codex, and including the official preparations of the British Pharmacopœia. He will be instructed in the various operations conducted in the pharmacy and taught to recognise the crude drugs which are made into galenicals, and to know from which parts of the globe they come, what active constituents they contain, and how the various processes used are designed to best extract those principles. He will enlarge his Latin vocabulary to include what is known as pharmaceutical Latin, and will learn to translate prescriptions in contracted Latin into his mother tongue, and conversely to write English prescriptions in full Latin equivalents. He will either be personally instructed further in chemistry and botany, or will be allowed to attend classes in these subjects if they are held in the town in which he is serving his apprenticeship.

The second year should find him with a good grounding in practical pharmacy, a fair acquaintance with the Pharmacopœia, and some progress made in the study of materia medica, botany, and chemistry. In addition to keeping up

these studies, in the third year work at the dispensing counter under adequate supervision will be required, and he will be taught the art of elegantly exhibiting the medicines ordered by the physicians. Meanwhile, he will have had the opportunity of learning business methods, the prices at which drugs are bought and sold, and how such book-keeping as is incidental to the business ot pharmacy is carried out.

But the chief value of a good apprenticeship does not lie in the amount of knowledge the apprentice may acquire, although it is important he should learn all he can; it is rather the habits which he forms during this time which influence his future. If he learns to be punctual, observant, neat, and accurate, and to get through a fair amount of hard work regularly each day, he will probably not fail to reproduce these virtues when he is placed in a more responsible position. Hence the necessity of selecting a pharmacist who will not only teach his pupil the rudiments of the sciences which he must learn, but will instruct him in the arrangement and conduct of his business life. The particular advantage which the apprentice has in being trained under a typical "high-class" pharmacist is the sound grounding he gets in practical pharmacy, dispensing, and the more professional side of his calling. If there is any disadvantage at all, it is that occasionally he is not taught all he might be of the commercial side of the work.

In the second type of apprenticeship a pharmacist may be selected who lays greater stress on business training. In this case the youth will require to work harder after his apprenticeship to prepare for his examinations, but having passed them will be quite competent to take charge of a business. The premiums paid in this type of business are not usually as large as in the first type mentioned. They range from £20 to £50, and frequently some or all of the premium is returned as a weekly salary during the second or third years.

In recent years no branch of pharmacy has made more rapid strides than the pharmacy practised in hospitals, and some hospital pharmacists now take apprentices. This experience, whilst being perhaps the best attainable in practical pharmacy, leaves the pupil without much business training, and all the routine of shop work has to be learnt after apprenticeship. Nevertheless, he receives tuition which can be made sufficient for him to pass the Minor Examination at the close of his three years' work.

The fourth class of apprenticeship has been designed to meet the particular need of girls who desire to enter the pharmaceutical profession. About 75 per cent. of women pharmacists are engaged in dispensing at hospitals or for medical men, and a large number of these serve their appren-

ticeship with some experienced woman pharmacist. It will not be deemed invidious if we mention the name of Miss Buchanan, who has so successfully turned out a large number of those who are already qualified.

The Law of Apprenticeship.

Apprentices are usually bound, by indenture or otherwise, for a period of three or four years, the conditions, as regards premium, wages, etc., varying according to circumstances. No person can be bound against his will, and, in the case of a minor, the consent of a parent or guardian is also necessary. A minor can only be bound to serve until he is twenty-one years old. An apprentice must obey his master's lawful commands and give faithful service. The master, on the other hand, covenants to teach his trade or profession to the apprentice, and the latter is entitled to have such opportunities for gaining experience as will enable him to become expert in his master's business. Unless caused by his own misconduct, the temporary illness of an apprentice does not absolve his master from paying his wages, if any, nor can absence through illness be made an excuse for prolonging the apprenticeship beyond the agreed date. Neither can an apprentice be compelled to stay with the executors, after the death of the person to whom he was bound, unless the indenture or agreement contain provision to that effect. The apprentice may, however, claim performance of the contract from the executors, or—as an alternative—the return of a fair proportion of any premium which may have been paid. Similarly, the sale of the business during the apprenticeship does not release the master from his covenant. An apprentice cannot be compelled to stay with his master's successor, nor can he, or his parent or guardian, be compelled to pay for breakages, unless specifically agreed to in the indenture or agreement. An apprenticeship is terminated when the whole time has been served, or—if he refuse to serve longer—when the apprentice attains the age of twenty-one years, or when either apprentice or master dies, though the death of one member of a firm to which the apprentice is bound does not dissolve the contract. In certain circumstances, the parent or guardian may be sued for breach of contract if an apprentice refuse to serve after attaining the age of twenty-one years. An apprenticeship may also be terminated at any time by mutual agreement, or by order of justices, or by the bankruptcy of the master, in which case part of any premium paid may be returned by the trustees, subject to an appeal to the Bankruptcy Court. The stamp duty on an ordinary indenture of apprenticeship is half a crown. Apprenticeship in the strict sense of the word is not insisted upon by the regulations of the Pharmaceutical Society.

Study During Apprenticeship.

While the ultimate goal which the apprentice will seek is the qualifying examination, his immediate aim should be to secure one or other of the scholarships, particulars of which will be found in another column. To do this the student will have to keep fresh his Latin and French (or German) which he has taken in his preliminary examination. In addition to these subjects, he must be prepared to face a three hours' paper dealing with chemistry, pharmacy, and botany in their relation to the British Pharmacopœia. The questions are based upon an elementary knowledge of the principal chemicals, drugs, and processes of the British Pharmacopœia such as a student may reasonably be expected to have acquired during apprenticeship. No questions are now set in English grammar or in arithmetic, the value of the competitor's English being judged from the quality of his written work, considered as a whole; whilst in arithmetic the competitor's knowledge is usually tested by a problem in arithmetical chemistry. What the examiners endeavour to ascertain is the progress the pupil has made in the intelligent study of the British Pharmacopœia, and in what state his knowledge of Latin and a modern foreign language is. Presuming that he has taken these two latter subjects in the London Matriculation Examination, it will only be necessary for him to keep his knowledge of these subjects fresh, and to pay particular attention to the translation of paragraphs relating to pharmacy into Latin or French (or German), and *vice versâ*. Judging from the papers set and oral questions asked, the various pharmaceutical examinations are becoming more and more adapted to test the candidate's knowledge of the arts and sciences in relation to pharmacy, a tendency which is to be highly commended. It is this tendency which makes Humphrey and White's 'Pharmacopedia' such an invaluable book for the pharmacy student. Providing he has taken elementary botany and chemistry in his preliminary examination as soon as he enters on his apprenticeship, he will be able to start work on the 'Pharmacopedia.' In addition to this, he will do well to devote the winter months to continuing his study in chemistry. Classes in this subject are now held in most of the large towns and cities in the kingdom where theoretical and practical instruction may be obtained. In the summer months, when Nature calls with an irresistible voice, the study of botany may most profitably be pursued, again with the help of such classes as are available. During his daily work the pupil should constantly ask himself whether or not he is face to face with some practical application of the sciences which he has been studying in the evening classes, his chief object being to intelligently appreciate the reason for all he does. The preparation of a batch of mercuric nitrate

ointment should recall the chemistry of the oxides of nitrogen, and of mercury, lard, and olive oil. In making some spirit of nitrous ether he will be applying his knowledge of the reactions of copper with nitric acid, and alcohol with nitrous acid. It would be possible to multiply examples almost indefinitely, the application of the principle is so wide in its range.

A student who starts his apprenticeship with a lower preliminary than the Matriculation Examination of London University will, of course, have to start at a somewhat more elementary stage. It is an excellent plan for him to commence by taking a large note-book ruled in four or five parallel vertical columns. In the first column he may copy out all the contracted names which he can find on the bottles and cupboards in the pharmacy, taking one section at a time. In the next column opposite the abbreviated name he should write the full Latin equivalent, and in the third column place the English name of the drug or galenical. The fourth column may be devoted to the source of the drug or chemical. If of vegetable or animal origin, the botanical or zoological source, the natural order and habitat should be stated. In the case of a chemical, the method by which it is obtained may be noted. The last column may be usefully filled with the retail price of the goods. If half an hour or so be spent each day, the young apprentice will before the end of his first year have acquired a very considerable amount of most useful information.

As a final word of advice, we would say, Cultivate the faculty of observation, observe men and things, and seek always to arrive at the correct inference, the logical conclusion, of all you see.

THE STUDY OF CHEMISTRY.

Chemistry is the subject which is generally considered to be the most difficult in the pharmaceutical curriculum, and rightly so, for in no subject is a higher standard exacted in both the Minor and Major Examinations, and of no other science does the pharmaceutical student need to know so much. At the same time chemistry is the subject to which the pharmaceutical student is usually most attracted, and to the study of which he is prepared to devote most of his attention. This science assuredly holds the key to most of the mysteries of the art of pharmacy, and the pharmaceutical student naturally regards it as standing to him in much the same relation as that in which anatomy stands to the student of medicine. If the student should happen to reside in a town where there is a college or institution in which classes in chemistry are held, he is strongly advised to attend those classes, including laboratory work, and each year to learn as

much of the subject as he can in this way, aided by reading and private study.

It must be emphasised most strongly that the private study of chemistry is, at best, only a poor substitute for instruction by a competent teacher. If, unfortunately, the student should find himself out of the reach of classes, he cannot do better than invest in the first two volumes of Emerson Reynolds' 'Experimental Chemistry' (Longmans), and perform for himself most of the experiments with the non-metallic elements which are described in the first volume. Then, if opportunity offers, most of the experimental work with the metals should be carried out, including simple qualitative analysis, from which much chemistry may be learnt if only the student will take pains to find out what chemical changes are occurring in each "test," and will make it a rule to write the simple equations which express these changes. Unless qualitative analysis is learnt in this way, it had better not be learnt at all. There is no special merit in being able to "test" for the metals; it is easy for any schoolboy to learn in the course of a few months or less how to "find" the metals by noting the colours of precipitates.

An excellent book on elementary chemistry for general reference is Newth's 'Text-Book of Inorganic Chemistry,' in which the properties of the elements and their compounds are accurately described in simple and straightforward language. The general principles of chemistry are very difficult for beginners to understand, and can only be learnt very gradually. In the majority of cases it is better to leave the attempt to master chemical theory until the last year of apprenticeship, when the student may begin to read the partly popular, but nevertheless accurate, account of the history of chemical theory in Pattison Muir's 'Heroes of Science, Chemists' (Society for Propagating Christian Knowledge).

Lastly, the student is advised to avoid "cram" books on chemistry which are specially written and advertised for the pharmaceutical student. In many instances the erroneous ideas acquired by the student in his early days cling to him so pertinaciously that he finds it difficult to get rid of them, even after he has been taught the truth. It is important to recollect that the first and foremost thing that the pharmaceutical student has to do is to learn the general facts and principles of chemistry as a science, so that he may be able to understand their applications in pharmacy, and afterwards to apply them himself in solving the problems which daily arise in pharmaceutical practice. This is the only true meaning of pharmaceutical chemistry.

Pharmacy at the present day needs all the help she can get from the science of chemistry, and chemistry can only be properly learnt so as to be useful by study and continuous

work in the properly equipped laboratory of a public institution, under the supervision of a teacher who is thoroughly conversant with the modern developments of the subject. By following the lines indicated here, the student will best prepare himself for this more systematic and directed course of study, without which the education of the pharmacist cannot be complete.

THE STUDY OF BOTANY.

In commencing the study of botany, the student must remember at the outset that he is about to deal with living organisms, and all the details of form and structure which they present must be considered in their bearing upon the mode of life which characterises the vegetable world. Everything that can be seen in a plant with the naked eye, or with the aid of a microscope, has some definite reason to the way it reacts to its environment, and can be explained accordingly. The first requisite for a successful student of botany is a power of careful and exact observation, and details which, to the novice, seem to have no particular purpose, are found on more extended acquaintance to play some part or other in the life of the plant on which they are found. Nor should a student be at all discouraged because the purpose of any particular part is not at once obvious. There are many mysteries about which nothing or next to nothing is yet known, but daily these grow less.

It is obvious from this that a student should not attempt to learn botany from books alone. The living organism itself should be his first object of examination. In the absence of a teacher to explain his difficulties, some book should be used side by side with the plant itself, but he must not fall into the error of thinking that even the most complete acquaintance with the book can supersede actual observation and study of the plant.

In his first studies, such a book as Oliver's 'Lessons in Elementary Botany' (Macmillan) should be the first one used. Here he will find set forth what are the principal features which plants exhibit. Armed with such a companion, he should procure some simple wild plant and learn to identify its parts. Its outward form will first engage his attention, and the peculiarities of its root, its stem, and the appendages which spring therefrom should be carefully compared with the author's descriptions till he is familiar with the several parts. Then other plants should be taken and compared carefully with the first one and with the text-book descriptions. Thus he will form a good idea of the variety which each part of the plant is capable of showing. This variety will gradually lead him up to the idea of classification and natural relationship. The division of plants into groups and the subdivisions of such groups can thus be grasped.

When this study of outward form and relationship has been carried on for a time, and only then, acquaintance should be made with the internal structure of the plant. It will be found that a close relationship between structure and habit of life is very easy to recognise. A water plant, or alga, whose life is spent under the surface of a stream or lake, has a very different amount of rigidity to one which lives on land, such as a herb or a tree. The sub-divisions of its body are different in the two cases, and its general consistency is not at all the same. The internal structure will be found to correspond to such differences—a tree will be hard and woody, difficult to cut or to tear, while a sea-weed will be succulent, and its interior delicate and soft.

Soon a microscope will be advantageously employed, and the minute details of structure can by its assistance be studied. Here another kind of text-book will be wanted, and no better can be placed in the hands of the student than Scott's 'Introduction to Structural Botany' (Black). A very simple plant, the wallflower, is the first one to be taken. It is a very common plant, and easily accessible everywhere. Again, no effort should be made to learn the contents of the book apart from the actual examination of the plant.

These two works having been carefully studied, the student can turn to some more advanced text-book. By this time he will have formed a habit of working on the right lines, and can be trusted to pursue his studies more independently.

The work done so far will enable him then to take up the study of the vital processes which are carried on. The way plants absorb their food, what their food consists of, what changes are the result of such absorption, and so on, will be easily understood, and will at once illustrate and explain much of the detail already familiar to him. He will learn why the plant has assumed the form it has, and what is the meaning of the details of its anatomy.

THE STUDY OF PHARMACOGNOSY.

The intelligent study of materia medica, or pharmacognosy as it is now more properly called, naturally presupposes a more than elementary acquaintance with the morphology and structure of plants. Without such previous knowledge it is difficult for the student to understand even the technical terms commonly used by lecturer and author in describing a drug, and quite impossible for him to have an adequate grasp of the subject he is endeavouring to study. And yet for him to possess such knowledge is the exception rather than the rule; the apprentice is frequently advised to commence his studies by acquiring a knowledge of drugs; he does so by committing to memory the botanical source, natural order, and habitat of each drug, and thus acquires a certain amount of

parrot-like information which, when occasion may require, he repeats in a parrot-like manner, succeeding admirably in converting a fascinating study into tedious repetition.

Should the student not be in a position to avail himself of the services of a teacher of botany, he would do well to take as his guide one of the many elementary text-books, and study morphology and structure on material that he can gather from field or hedgerow, for the commonest trees, shrubs, and herbs will furnish him with abundant examples. Such works as Lindley's 'School Botany,' Oliver's 'Lessons in Elementary Botany,' Scott's 'Structural Botany,' etc., will not only render technical botanical terms intelligible and familiar to him, but will train him to observe, and to observe critically; for this reason the necessity for making the subject essentially a practical one cannot be too strongly insisted on. Nor should he content himself with simply collecting and examining leaves and flowers, as is often the case. Roots, stems, and fruits should, and as his interest grows, would be subjected to scrutiny.

Much information can be gained by allowing stems and roots to dry, and observing the changes that take place. At the same time, with the aid of a text-book the student's knowledge of systematic botany would grow without effort, and he would find himself in a position to study with advantage the crude drugs derived from the vegetable kingdom. In extending his studies in this direction he would do well to classify his drugs organographically, and study the most familiar, say the leaves, first. By this means the mental strain involved in constantly transferring the attention from one to some other totally different organ would be avoided, and the powers of observation further tested. Moreover, he should preface the study of the leaves by studying in his text-book the structure of the leaf in general, and the same with the other organs.

In dealing with the vegetable drugs the aid of a text-book such as Humphrey's 'Materia Medica of Vegetable and Animal Origin' (Kimpton) must be invoked. As the student reads, the drug should be in one hand, his pocket lens in the other, that each statement as it is read may be verified or corrected, but he is advised to refrain from subjecting the drug to microscopical examination until he has acquired a knowledge of botanical anatomy. From Bentley and Trimen's 'Medicinal Plants,' if available, he will gather an idea of the appearance and habit of the mother plant, whilst 'Pharmacographia' offers him in most attractive form concise accounts of its commerce and history. Thus, and thus only, can he learn to know a drug. Let him be warned against contenting himself with "cramming" tables of materia medica that contain little more than

the "name, natural order, and habitat" of the drug, and bear about the same relation to the study of pharmacopedy as a box of dry bones does to the living creature of which they once formed a part.

Let the student also avoid the error, too commonly committed by both students and teachers, of reducing his studies to the mere discernment of certain characters by which one drug may be distinguished from others that resemble it. The desirability of his being able to so distinguish each and every drug is undeniable, but it is only a fraction of the object of his study, and a fraction with which he will be already acquainted if his examination of each drug has been minutely and conscientiously carried out. He should at all times distinctly remember that his business is not simply to know this or that detail in any one drug, but to be familiar with at least the leading points in the history, life-history, structure, and composition of every drug.

To understand the production and collection of structureless drugs obtained from plants the student must be acquainted with the various glands, ducts, laticiferous vessels, and other tissues in which such substances as oils, oleoresins, gum-resins, etc., are secreted by the plants, as well as the changes which cellulose may undergo in the formation of such substances as gum or resin. Here, necessarily, the microscope must be requisitioned for the study of these structures, and it may be assumed that the student will have made sufficient progress in anatomical botany to enable him to make an intelligent use of the instrument; certainly he will find the study of this second section of pharmacopedy amplify and explain much that he had read and observed in the first. Nor will the study of these drugs be complete without an approximate knowledge of their chemical constituents, their chief reactions, and principal physical characters.

Up to this point the student has been dealing with drugs more or less intact; the further development of the subject will logically consist, first, in the identification of unknown, fragmentary, or powdered drugs, and, secondly, the microchemical detection of their active principles and determination of the tissue or tissues in which they reside, a study which is best pursued at the hand of an experienced histologist.

THE STUDY OF PHARMACY AND DISPENSING.

It is not easy to answer the question, what preparation in practical pharmacy and dispensing may a student profitably make before entering upon his college course? Let it at once be stated that it is hardly possible to set too high a value upon a well-regulated apprenticeship, nay, even that the

immediate gain to be reaped from a further systematic course is in direct proportion to a previous acquaintance with the various details, partly of a business character and partly chemical, which are essential to the right conduct of pharmacy.

Circumstances differ so widely that it would be unwise to lay down definite rules which should equally apply to all, but it has generally been thought undesirable to let a youth acquire his first knowledge of pharmaceutical operations from the class-room and the lecturer, or that his attendance at a public course should be his introduction to the art of deciphering a prescription and following out its instructions. That is to force him to read a book, ignorant even of the alphabet which forms the words.

Let the student carefully consider his own surroundings, and say to himself, I have chosen pharmacy for my vocation, and if I may hope to be successful and not a mere shopman, I must know all about the objects and appliances in the midst of which I am placed, what they are, where they come from, and for what they are used. The most meagre establishment will furnish a selection of drugs, simple apparatus, and preparations such as are commonly met with in pharmacy; let the drugs be so persistently examined that their physical characters may become familiar, and that they may be recognised without the label's aid. Let careful examination of every description of apparatus, if only worthy of the name of druggists' sundries, come next, while preparations may follow in due time. The end of the first year should see the pupil an adept in measuring and weighing and in the mechanical art of powdering drugs and chemicals; he should be able to make an infusion, and a decoction should not be beyond his skill. At this point White and Humphrey's 'Pharmacopedia' will prove a serviceable guide.

Unfortunate must be the position of an apprentice who has not the chance of observing manifold and sundry operations relating to his craft; if he is wise, he will from the commencement of his career devote himself to their practical manipulation, and take pleasure in so doing. Should the task be distasteful, let him conquer his want of interest, for unless he gets to like his occupation he will make but scanty progress. Once let the desire not to be commonplace be kindled, a striving to excel will be created, and he will learn slowly but effectually the whole range of minor pharmaceutical operations, in addition to trade requirements; while books will teach him precautions and adaptations, together with the reasons involved in official processes.

Then it should be said, mind not high things, but begin with simple solutions, with and without heat; make the syrups, omitting complex formulæ, and tinctures by macera-

tion. Let the student try to make them at a later period by percolation, which is excellent practice, requiring much observation, and is a process which can be demonstrated but imperfectly in class. Dexterity in all these galenical branches should be acquired, for the hand quite as much as the head must be trained; manipulation studied, not neglecting cleanliness, which, if next to godliness, is on equal footing with pure pharmacy.

The second year should bring the student a good step further in his career—happy for him if his surroundings offer facilities of progress. At this juncture an elementary knowledge of chemistry becomes essential, ignorance of that science barring further advance, and rendering the making of the simplest form of chemical preparation a thing of haphazard and rule of thumb. The third year may be devoted to the practical application of the above suggestions to dispensing and to the more direct study of the British Pharmacopœia. To begin compounding prescriptions at an earlier period is not a sensible arrangement, and may lead to dangerous consequences and some surprises, while to enter upon official pharmacy without sufficient general knowledge tends to a feeling of despair, and frequently inspires disgust.

Let it, however, be firmly impressed upon the young aspirant to pharmaceutical success, and let it sink into his mind with all the force of a conviction, acted upon and sedulously carried out, that if during his last year of apprenticeship he will, with no sudden spasm of work, but day by day, master the contents of that official text-book, learn its formulæ, and by personal experiment comprehend their meaning, he will place himself in a position of immeasurable advantage. Then he may enter with confidence upon that systematic training and teaching which it is the province of a public course to offer. The 'British Pharmaceutical Codex' gives valuable instruction in the methods and processes involved in compounding medical prescriptions.

One brief note must be added respecting the study of Latin. A pharmacist is required to know the technical form in which a prescription is written; such knowledge should not have to be revived or scraped together at a time when a student should direct his whole attention to purely pharmaceutical matters. Unfortunately, both for the teacher and the taught, instruction in grammar rules and construction cannot as yet be banished from a lecture syllabus. Full explanation of the subject will be found in Ince's 'Latin Grammar of Pharmacy' (Baillière), or Bennett's 'Medical and Pharmaceutical Latin' (Churchill), and the period of apprenticeship is obviously the right time when the pages of such a work should be consulted.

HINTS TO STUDENTS.

Whatever objections may be raised against the examination system, the student will be well advised at the outset to recognise that it is the only means known at present by which a candidate's ability may be measured. That the system has its faults it cannot be denied. There are at least two important facts not allowed for in the examination room. First, nervousness or diffidence; second, slow thinking capacity. Saddled with these disabilities, a really excellent student is at a great disadvantage, and may easily be outstripped by a much less brilliant student who is fortunate enough to possess unlimited confidence in himself. Fortunately, however, these disabilities may to a great extent be overcome by suitable training. But it is well to remember that real deficiency of knowledge can never be covered up by self-possession, and present-day examiners are shrewd enough to distinguish between the two varieties of students. Therefore, if a youth conscientiously makes the best use of his time in study, he will unconsciously overcome much of his diffidence. As for slow thinking, even this, like other faculties, may be developed into quicker action by exercise. In any case, the youth who desires the right to practise as and use the title of pharmacist must face the inevitable and brace himself up accordingly. Preparation for examination has ostensibly only one end in view—namely, the passing of the examination Actually, however, it is a method of arming the student for the battle of life, and the better his stock of knowledge the better he is fitted for the successful conduct of a business which requires knowledge above all things. Since examiners are but human, it may be admitted that such a result as the worse man passing and the better man being rejected may in rare cases be due to imperfections in the examination undergone; but no one who is familiar with the great care taken by the Council of the Pharmaceutical Society in selecting examiners, and by the members of the Boards of Examiners in carrying out the examining process and giving every candidate the best possible chance to do himself justice, can doubt that, in the majority of cases, the cause of a good student failing is his inability to produce his knowledge just when and as required; or, in other words, his neglect of the art of passing examinations.

Practical versus Written Examinations.

It is generally admitted by competent judges that a practical examination is a more satisfactory test of real knowledge and ability than merely writing answers to printed questions; on the other hand, the performance of the delicate processes of chemical analysis and dispensing in unfamiliar surroundings is apt to be attended with some feeling of ner-

vousness, which is a very serious handicap to anyone experiencing it; while the series of *viva voce* examinations at the hands of different examiners no doubt has a similar effect; the commonest symptom of such nervousness is the refusal of the brain to produce information on demand, notwithstanding that it has been duly stored and returns to the memory after the ordeal is over. Who has not experienced the wretched feeling of seeing when too late how much better he could have done! And any "art" that will prevent this is surely worth acquiring! Probably most candidates who are not conscious of feeling nervous are nevertheless aware that they do not answer questions in the examination room as well as they can at other times; these may be said to be affected by nerve tension, if not by nervousness; but there is a third large class who are rarely able to produce the knowledge which they genuinely possess in the form of a clear, intelligible, direct answer to a question, whether in or out of the examination room. If the facts, then, are as we have stated, can it be wondered at that a certain proportion of candidates who really know the work covered by the syllabus are nevertheless rejected?

The Best Remedy.

Now, the cure for the disabilities we have referred to is the same in all cases, and is very simple; it consists simply in repeated and diligent practice in the answering of questions; the questions should, of course, be of somewhat the same nature as those that will be put in the actual test, and it is desirable, wherever possible, that the answers given should be checked and criticised by a teacher or other competent person. But even if these advantages cannot be had, if the student must frame his own questions to himself and criticise his own answers, the frequent holding of such trial examinations should still be resorted to. In this connection we may refer to the written and practical examinations now held at short intervals by *The Pharmaceutical Journal* for students; the gain to the student by entering for these is not in the slightest degree to be measured by his chance of gaining one of the prizes offered; the real advantage lies in the practice obtained in producing information on demand and presenting it in intelligible form, neither exceeding nor falling short of what is asked; also in the enlightenment of the student himself on the subject of what he does and does not know. Speaking from a somewhat extended personal experience of examinations, competitive and otherwise, we can assert emphatically that the most important assistance in obtaining a satisfactory result has always been a habit of persistent practice in answering questions, either those set at previous examinations or others of similar scope. It is well known

that the brain does easily and with little conscious effort what it is accustomed to do; and this smooth working of the mechanism goes far in actually preventing a feeling of nervousness, as well as in preventing the full effects of any such feeling that may be experienced.

Having outlined a method which, if carefully pondered over, will be of infinite value to the student, it will be apropos to call attention to the dangers of cramming. Unscrupulous teachers or educational quacks profess to be in possession of methods which will infallibly carry the student through his examination. The methods, it may be noted, do frequently have the professed result, but at what cost? The student is rushed into his profession on starvation fare, and must inevitably suffer later on. These quacks make it their business to circumvent the examiners. They make a point of studying their methods, getting to know their peculiarities, and preparing the student on these lines. In one case the "teacher" periodically contrived to get a draft of the questions a certain examiner proposed to put to his candidates at their examinations, with the result that his students got through the ordeal with flying colours. This sort of thing is not only humbugging the examiners, but humbugging the student into believing that he is being launched into his profession with a store of knowledge that will meet all his requirements, whereas he actually commences his career crippled, and remains so. It is better by far that he should give more time to his training, even if it cost a good deal more; and in any case he should disabuse his mind of the idea that examinations are the ultimate end of his studies.

PRELIMINARY KNOWLEDGE.

In the very early days of his apprenticeship the student should have an eye on the future, to the extent of preparing the ground for the foundation of his pharmaceutical career by assimilating all he can of the theory and practice of pharmacy, reading appropriate books, such as some of the elementary ones mentioned in the previous articles, and getting all the practice he can lay his hands to in minor operations. Having done so, he must then direct his attention towards his examinations. In order to obtain the qualification of "Chemist and Druggist" in Great Britain it is necessary to be of the full age of twenty-one years, to have passed an approved preliminary examination, to have been for three years practically engaged in the translation and dispensing of prescriptions, and to have passed the Minor Examination of the Pharmaceutical Society, after being duly registered as an "Apprentice or Student." The approved preliminary examination should be passed before commencing the period

of pupilage, and the certificate must include in the subjects for which it is granted English, Latin, a Modern Foreign Language, Arithmetic, Algebra, and Euclid. It should be noted particularly that no certificate can be accepted unless it has been granted for the whole of the six subjects specified, and candidates may save themselves trouble at a later period if they take steps to secure registration as "Apprentices or Students" as early as possible after passing the preliminary examination.

Registration as an Apprentice or Student.

In order to become registered as an "Apprentice or Student" it is necessary to deliver to the Registrar, Mr. Richard Bremridge, 17, Bloomsbury Square, London, W.C., a certificate of having passed an approved preliminary examination.

The following is a List of Certificates which the Registrar is authorised to accept in connection with the Registration of "Apprentices or Students" (subject in all cases to the conditions as to subjects and number of examinations specified) :—

UNIVERSITY OF OXFORD.
Junior or Senior Local Examination.
Higher Local Examinations.
Responsions.

UNIVERSITY OF CAMBRIDGE.
Junior or Senior Local Examination.
Higher Local Examinations.
Previous Examination.

UNIVERSITY OF LONDON.
Matriculation Examination.
Higher School-leaving Certificate.
Junior School Examination.
Matriculation School-leaving Certificate.

UNIVERSITY OF DURHAM.
Junior or Senior Local Examination.
Certificate of Proficiency Examination.

UNIVERSITY OF BIRMINGHAM.
Matriculation Examination.

UNIVERSITIES OF MANCHESTER, LEEDS, LIVERPOOL, AND SHEFFIELD.
Joint Matriculation Examination.

UNIVERSITY OF BRISTOL.
Matriculation Examination.

UNIVERSITIES OF EDINBURGH, ABERDEEN, GLASGOW, AND ST. ANDREWS.
Preliminary Examination in Arts, or Medicine, or Science.

Junior and Senior Local Examinations.

UNIVERSITY OF DUBLIN.
Public Entrance Examinations. (For "High Places.")

ROYAL UNIVERSITY OF IRELAND.
Matriculation Examination.

UNIVERSITY OF WALES.
Matriculation Examination.

SCOTCH EDUCATION DEPARTMENT.
The Intermediate Certificate or Passes in the Higher or Lower Grade of the Leaving Certificate Examination.

INTERMEDIATE EDUCATION BOARD FOR IRELAND.
Senior or Middle Grade Certificate Examination.

CENTRAL WELSH BOARD.
Honours, Senior or Junior Certificate Examination.

OXFORD AND CAMBRIDGE SCHOOLS' EXAMINATION BOARD.
Higher or Lower Certificate Examination.

EDUCATIONAL INSTITUTE OF SCOTLAND.
Medical Preliminary Examination.

COLLEGE OF PRECEPTORS.
First or Second Class Certificate Examination.

Certificates of having passed in the six before-specified subjects at an examination of a legally constituted examining body not included in the above list, and certificates which the Registrar is unable to accept, may be submitted for the consideration of the Council, and each individual case will be considered on its merits.

The certificate submitted must, as already stated, include the whole of the subjects above enumerated, and those subjects must have been passed at not more than two examinations of the same examining body. The registration fee of two guineas must in every case accompany the certificate submitted to Mr. Bremridge, and a person who is registered as an "Apprentice or Student" is eligible to be elected a student-associate of the Pharmaceutical Society on payment of an annual subscription of half-a-guinea, which entitles him or her to receive *The Pharmaceutical Journal* weekly, as issued, to borrow books from the Society's Library, and to compete for various scholarships and prizes.

CERTIFICATES IN PRELIMINARY KNOWLEDGE.

Information concerning the examinations referred to on the preceding page may be obtained on application as follows:—

UNIVERSITY OF OXFORD.—The Registrar, Oxford, or the Secretary, Local Examination Offices, Merton Street, Oxford.

UNIVERSITY OF CAMBRIDGE.—The Registrary, Pitt Press Buildings, Cambridge; or, J. N. Keynes, D.Sc., Syndicate Buildings, Cambridge.

UNIVERSITY OF LONDON.—The Registrar, Imperial Institute, S.W.

UNIVERSITY OF DURHAM.—The Secretary of Examinations, Durham.

UNIVERSITY OF BIRMINGHAM.—The Registrar, Birmingham.

UNIVERSITIES OF MANCHESTER, LEEDS, LIVERPOOL, AND SHEFFIELD.—The respective Registrars.

UNIVERSITY OF BRISTOL.—The Registrar, Bristol.

UNIVERSITY OF EDINBURGH.—Matriculation Office, Edinburgh.

UNIVERITY OF ABERDEEN.—Marischal College, Aberdeen.

UNIVERSITY OF GLASGOW.—Matriculation Office, Glasgow.

UNIVERSITY OF ST. ANDREWS.—The Secretary, St. Andrews, N.B.

UNIVERSITY OF DUBLIN.—The Secretary of the Senate, Dublin.

ROYAL UNIVERSITY OF IRELAND.—The Secretaries, Earlsfort Terrace, Dublin.

UNIVERSITY OF WALES.—The Registrar, Brecon.

SCOTCH EDUCATION DEPARTMENT.—The Secretary, Whitehall, S.W.

INTERMEDIATE EDUCATION BOARD FOR IRELAND.—The Assistant Commissioners, 1, Hume Street, Dublin.

CENTRAL WELSH BOARD.—The Chief Inspector, Cardiff.

EDUCATIONAL INSTITUTE OF SCOTLAND.—A. Mackay, LL.D., 40, Princes Street, Edinburgh.

OXFORD AND CAMBRIDGE SCHOOLS' EXAMINATION BOARD.—P. E. Matheson, M.A., 74, High Street, Oxford; E. J. Gross, M.A., Caius College, Cambridge.

COLLEGE OF PRECEPTORS.—Secretary, 2, Bloomsbury Square, W.C.

MINOR EXAMINATION SYLLABUS.

Persons who pass the Minor Examination are registered as chemists and druggists, and are then eligible for election as members of the Pharmaceutical Society, on payment of an annual subscription of one guinea. The fee for the examination is ten guineas, but a person who has attended and failed to pass may re-enter for examination on payment of a reduced fee of three guineas. The subjects of examination are Botany, Chemistry and Physics, Practical Chemistry, Materia Medica, Pharmacy, Practical Pharmacy and Dispensing, and Prescriptions. The Council of the Pharmaceutical Society recommends that all candidates before presenting themselves for examination should receive a systematic course of instruction occupying a period of not less than six months; and that such period of study should include at least sixty lectures in Chemistry, eighteen hours' work in each week in Practical Chemistry, forty-five lectures and demonstrations in Botany, and twenty-five lectures and demonstrations in Materia Medica.

The Society's Boards of Examiners in London and in Edinburgh meet in January, April, and July, also at the end of September or the beginning of October. Each candidate for the Minor Examination must give notice and pay the fee to the Registrar in London on or before the fifteenth day of March, June, September, or December, and he will receive due notice of the date on which he will be required to present himself for examination. When giving notice for the first time a candidate must have attained the full age of twenty-one years, and must also produce a Registrar's Certificate of Birth, as well as a certified declaration that he has been registered as an "Apprentice or Student," and has for three years been practically engaged in the translation and dispensing of prescriptions. The printed form on which this declaration is to be made can only be obtained from the Registrar, Mr. Richard Bremridge, 17, Bloomsbury Square, London, W.C. Each candidate must also state, at the time of giving notice, whether he desires to be examined in London or Edinburgh. The schedule of the examination requirements is here given in full.

BOTANY.

In this subject, the candidate is required to possess a practical knowledge of the Classification, Morphology, and Physiology of Plants, as follows:—

Classification.

The main divisions of the vegetable kingdom—Thallophyta, Bryophyta, Pteridophyta, Phanerogamia—and their most important characteristics.

The following Sub-classes and Natural Orders of the Angiosperms:—

Thalamifloræ	Spadicifloræ	Leguminosæ
Calycifloræ	Glumifloræ	Umbelliferæ
Corollifloræ	Ranunculaceæ	Compositæ
Monochlamydeæ	Cruciferæ	Solanaceæ
Petaloideæ	Rosaceæ	Liliaceæ

The description of flowering plants in technical language.

List of Plants for Recognition.

The candidate is also required to recognise any of the plants in the following list:—

Aconitum napellus.	Datura stramonium.	Papaver somniferum.
Althæa officinalis.	Digitalis purpurea.	Pinus sylvestris.
Anthemis nobilis.	Fœniculum capillaceum.	Prunus lauro-cerasus.
Aspidium filix-mas.	Hordeum distichon.	Quercus robur.
Atropa belladonna.	Hyoscyamus niger.	Rosa canina.
Avena sativa.	Juniperus communis.	Rosmarinus officinalis.
Brassica alba.	Juniperus sabina.	Ruta graveolens.
Brassica nigra.	Lavandula vera.	Salix alba.
Bryonia dioica.	Matricaria chamomilla	Sambucus nigra.
Cochlearia armoracia.	Mentha piperita.	Solanum dulcamara.
Colchicum autumnale.	Mentha pulegium.	Taraxacum officinale.
Conium maculatum.	Mentha viridis.	Taxus baccata.
Cystisus scoparius.	Menyanthes trifoliata.	Triticum vulgare.
Daphne laureola.	Œnanthe crocata.	Ulmus campestris.
Daphne mezereum.	Papaver rhœas.	Valeriana officinalis.

Morphology, including Anatomy.

The external form of plants:—Thallus, stem, root, leaves, inflorescence, flower, fruit. The distinguishing features and common modifications of these structures.

Principles of branching and different kinds of branch systems.

Phyllotaxis, including vernation.

The different kinds of buds and their arrangement on the stem.

A general acquaintance with the elements of plant anatomy; the vegetable cell, tissues, *e.g.*, merismatic, epidermal, fundamental, and vascular.

The characteristic anatomical features of roots, stems, and leaves of flowering plants and ferns.

The candidate is expected to recognise by means of the microscope, and describe, sections illustrating the above plant structures.

The method of increase in thickness of stems and roots, and the characters of primary and secondary tissues.

The characters of the flowers.

The methods of pollination; self- and cross-fertilisation.

The formation of the seed and germination.

Physiology.

The elementary facts in connection with the physiology of plants, including the nature and source of the food of plants, and the manner in which the raw materials are elaborated.

Chlorophyll, its manner of occurrence in the plant; its functions and the conditions under which it discharges them.

Reserve materials, their nature, mode of deposition, and the manner in which they are utilised by the plant.

The manner in which plants grow, and the conditions necessary for the growth of a plant.

The manner in which plants respond to external stimuli, *e.g.*, light, gravity, etc.

Sexual and asexual reproduction.

CHEMISTRY AND PHYSICS.

In Chemistry and Physics, the candidate is expected to possess an elementary knowledge of the following subjects:—

Physics.

The law of the conservation of energy.
The law of gravitation.
The balance.
Specific gravity.
Atmospheric pressure.
Pressure of aqueous vapour.
The barometer, air-pump, and siphon.
The law of Boyle.
Temperature.
Thermometers.
The law of Charles.
The law of gaseous diffusion.
Victor Meyer's method for determining vapour densities.

Chemical Theory.

The chief characteristics of chemical action.
The distinction of elements and compounds.
The laws of chemical combination by weight and volume.
The hypothesis of Avogadro.
Atomic weight and molecular weight.
Chemical formulæ and nomenclature.
Valency.
The distinction between metals and non-metals.

Non-Metallic Elements.

The general characters of the non-metals.

The chief methods of preparation and the typical reactions of the following non-metallic elements and compounds:—

Hydrogen, oxygen, ozone, water, hydrogen peroxide.

Chlorine, bromine and iodine, and their compounds with hydrogen and oxygen.

Fluorine, hydrofluoric acid.

Nitrogen, ammonia, the oxides of nitrogen, nitrous acid, nitric acid.

Sulphur, hydrogen sulphide, sulphurous and sulphuric anhydrides and acids, thiosulphuric acid.

Phosphorus, phosphine, the oxides and oxyacids of phosphorus, the chlorides of phosphorus.

Silicon, silica, fluoride of silicon, silicofluoric acid.

Boron, boric acid.

The usual impurities in such of the above-named substances as are included in the British Pharmacopœia.

Metallic Elements.

The general characters and classification of the metals.

The general methods of forming oxides and salts.

The sources, the usual methods of extracting, and the chief properties of the under-mentioned metals:—

Potassium	Aluminium	Tin
Sodium	Iron	Copper
Ammonium	Chromium	Bismuth
Lithium	Manganese	Lead
Barium	Nickel	Silver
Strontium	Cobalt	Mercury
Calcium	Arsenium	Gold
Magnesium	Antimony	Platinum
Zinc		

The modes of preparation, properties, adulterations and contaminations of the principal compounds of the above-named metals.

Organic Chemistry.

Carbon and its oxides, cyanogen, hydrocyanic acid, cyanides, ferrocyanides, ferricyanides, oxalic acid.

The chief methods of preparing the following:—

Methane	Acetic aldehyde	Nitro-benzene
Ethane	Acetic acid	Aniline
Ethylene	Ethyl acetate	Benzoic acid
Acetylene	Acetamide	Salicylic acid
Methyl alcohol	Olein	Chloral hydrate
Ethyl alcohol	Glycerol	Chloroform
Formic aldehyde	Benzene	Iodoform
Formic acid	Phenol	Ether

The principal properties, reactions, and mutual relations of the above-named compounds.

A general knowledge of the methods of determining carbon, hydrogen, oxygen and nitrogen in inorganic compounds, and of obtaining molecular formulæ.

The candidate is also expected to solve simple problems relating to the weight and volume, under different conditions of temperature and pressure, of elements and compounds concerned in chemical reactions.

PRACTICAL CHEMISTRY.

In this subject the candidate is required—

To determine the specific gravity of liquids and solids.

To be familiar with the general construction and use of the thermometer and barometer.

To recognise by chemical tests the more important non-metallic elements and compounds, as well as the metals and salts indicated in the foregoing list.

To detect the chief impurities in those elements and compounds that are included in the British Pharmacopœia.

To recognise by their physical properties those elements and compounds which possess well-defined characteristics.

To analyse a mixture containing not more than two metals and two acid radicals.

To identify by chemical tests the following organic compounds:—

Hydrocyanic Acid	Citrates	Quinine
Cyanides	Salicylates	Quinine salts
Ferrocyanides	Starch	Morphine
Ferricyanides	Cane sugar	Morphine salts
Oxalates	Grape sugar	Strychnine
Acetates	Salicin	Strychnine salts
Tartrates		

To detect the impurities in such of the above-named compounds as are included in the British Pharmacopœia.

To perform those volumetric determinations which are described in the British Pharmacopœia.

To understand the principles of volumetric analysis.

To prepare, standardise, and use volumetric solutions.

To be familiar with the construction and use of the balance.

To have a practical knowledge of the Imperial and Metric Systems of Weights and Measures.

To determine quantitatively the following:—

The total alkaloids in cinchona bark and its official preparations; in liquid extract of belladonna and its preparations; and in liquid extract of ipecacuanha.

The strychnine in the extract, liquid extract, and tincture of nux vomica.

The morphine in opium and its extract, liquid extract, and tincture.

The resin in tincture of jalap.

To have a practical acquaintance with the methods of preparing the more important inorganic substances, including the non-metals and their compounds, and such metallic compounds as are included in the British Pharmacopœia, and also the following organic compounds:—

Ether	Amyl nitrite	Hydrocyanic Acid
Chloroform	Ethyl acetate	

To be able to explain to the examiner the operations involved in the preparation of the above-named compounds, and, if called upon, to perform the operations or certain stages of them himself.

MATERIA MEDICA.

In this subject the candidate is required—

To recognise specimens of any crude drugs mentioned in the British Pharmacopœia or in the following list:—

Roots.

Alkanna tinctoria.
Althea officinalis.
Bryonia dioica.
Inula helenium.

Rhizomes, etc.

Acorus calamus.
Agropyron (Triticum) repens.
Helleborus niger.
Iris florentina.
Sanguinaria canadensis.
Veratrum album.
Veratrum viride.

Barks.

Berberis vulgaris.
Canella alba.
Cinchona calisaya.
Cinchona lancifolia.
Cinnamomum cassia.
Coto.
Erythrophlœum guineense.
Nectandra rodiæi.
Pinus larix.
Quercus robur.
Rhamnus frangula.
Ulmus campestris.
Ulmus fulva.

Leaves.

Aconitum napellus.
Nicotiana tabacum.
Piper angustifolium.

Herbs, etc.

Convallaria majalis.
Euphorbia pilulifera.
Grindelia squarrosa et robusta.
Juniperus sabina.
Lactuca virosa.
Marrubium vulgare.
Ruta graveolens.
Solanum dulcamara.

Flowers.

Arnica montana.
Calendula officinalis.
Pyrethrum cinerariæfolium, etc.
Rosa centifolia.

Fruits.

Ægle marmelos.
Cuminum cyminum
Laurus nobilis.
Piper longum.
Punica granatum.
Vanilla planifolia.

Seeds.

Amomum melegueta.
Areca catechu.
Dipteryx odorata.
Hordeum distichon.
Hyoscyamus niger.
Paullinia sorbilis (Guarana)
Pyrus cydonia.
Strychnos amara.
Theobroma cacao.
Trigonella fœnum-græcum.

Hairs or Glands.

Mallotus philippinensis.
Mucuna pruriens.

Juices, etc.

Black catechu.
Cape aloes.
Gutta percha.
Lactucarium.
Manna.
Natal aloes.

Gum-Resins

Euphorbium
Olibanum.

Resins.

Dragons' Blood.
Elemi.
Mastiche.
Sandarac.
Shellac.

Cryptogamic Substances.

Cetraria islandica.
Chondrus crispus.
Fucus vesiculosus.
Lycopodium.

Animal Substances.

Castoreum.
Mylabris cichorii.
Mylabris phalerata.

To know the principal commercial varieties of the various crude drugs.

To be acquainted with their botanical (or zoological), geographical, and commercial sources, the natural orders to which the plants belong, and the modes of collecting and preparing the drugs for the market.

To indicate the morphological nature of such crude drugs as are organised, and the mode of formation of such as are unorganised.

To describe them correctly, and to point out diagnostic characters, either chemical or physical, the latter as far as they can be ascertained by the use of a lens.

To name the chief active constituents of official drugs.

To know the proportion of chief active constituents present in good samples of the more important official drugs.

To possess a practical knowledge of any pharmacopœial tests or processes of assay applied to crude drugs or their official products.

PHARMACY.

In this subject the candidate is required to possess a general knowledge of the following branches:—

Operations Requiring the Use of Heat.

Evaporation, with particular reference to the preparation of extracts and inspissated juices.

Special characters and modes of preparing the various classes of extracts.

Influence of surface, temperature, and pressure upon the rate of evaporation.

Water, steam, and sand baths.

Distillation; the distinctive characters and objects of ordinary, fractional, and destructive distillation.

Official preparations illustrating the various kinds of distillation.

Apparatus employed in distillation; principles on which the retort and receiver, still and worm, and Liebig's condenser, are constructed and used.

Sublimation, its objects and applications in pharmacy.

Official products of sublimation, calcination, and fusion.

Desiccation; temperature best suited for drying particular drugs; loss in drying vegetable drugs.

Forms of drying ovens and the principles on which they are constructed and used.

Disintegration of Solid Substances.

Cutting, bruising, and pulverisation.

Apparatus employed in those operations and the principles indicating which is to be adopted in particular instances.

Methods for controlling the degree of comminution.

Sieves and sifting.

Trituration, levigation, elutriation and granulation, including methods for producing certain chemicals as fine powders, small crystals, scales, etc.

Solution, its nature.

Solvent power of various menstrua.

Influences of (*a*) temperature; (*b*) state of division of the substance to be dissolved; (*c*) time; (*d*) position of the substance in the menstruum.

Lixiviation, infusion, digestion, and decoction.

Maceration, percolation, and displacement; the principles on which the successful performance of those processes depend.

Form and materials for percolators and other vessels employed.

Filtration, its objects and methods.

Filtering media.

Means of expediting filtration.

Dialysis, its application in pharmacy.

Construction and use of the dialyser.

Expression.

Methods of obtaining the juices from plants.

Recovery of the residual liquids from tincture marcs, etc.

Screw, hydraulic and other presses.

The principles involved in the dispensing of medicines.

The best excipients and methods for forming pill masses.

The preparation and nature of emulsions

The most suitable emulsifying agents.

The best means of suspending insoluble substances in liquids.

Galenic Pharmacy.

The candidate is also required to show a general knowledge of the processes, and to understand the principles of the processes by which the official preparations belonging to the following classes are made:—

Collodions	Liniments	Solutions
Confections	Lotions	Spirits
Decoctions	Mixtures	Suppositories
Dilute acids	Ointments	Syrups
Extracts (solid)	Pill masses	Tinctures
Extracts (liquid)	Plasters	Vinegars
Glycerins	Powders (simple)	Waters
Infusions	Powders (compound)	Wines
Juices		

A knowledge is also required of the proportion of active ingredient or crude material in official preparations containing:—

Aconite	Caustic soda	Mercury
Antimony	Colchicum	Nux vomica
Arsenic	Digitalis	Opium
Belladonna	Elaterinum	Phosphorus
Calabar bean	Ergot	Scammony
Cantharides	Iodine	Stramonium
Chloral hydrate	Iodoform	Squill
Chloroform	Ipecacuanha	Alkaloids
Caustic potash	Lead	Alkaloidal salts

Sale of Poisons.

The candidate is further required—

(*a*) To enumerate the poisons contained in the Schedule to the Poisons and Pharmacy Act, 1908 (see page 410).

(*b*) To describe minutely the conditions required upon the sale by retail of poisons, both in Part I. and Part II. of the Schedule; and to write the proper entry required, according to Schedule F of the Pharmacy Act, 1868, for the sale of a poison coming within Part I. of the Schedule.

(*c*) To state the conditions imposed on the sale of scheduled poisons by wholesale and for export, and upon the sale of a scheduled poison when forming an ingredient in a medicine dispensed.

The candidate is also expected to possess a knowledge of the conditions imposed on the sale of Arsenic by the Arsenic Act.

PRACTICAL PHARMACY AND DISPENSING.

In this subject the candidate is required—

To conduct such operations of the British Pharmacopœia, or such parts of them as may be practicable, involved in the processes for preparing the following:—

Collodions	Liniments	Spirits
Confections	Lotions	Suppositories
Decoctions	Mixtures	Syrups
Dilute Acids	Ointments	Tinctures
Extracts, solid	Pill masses	Vinegars
Extracts, liquid	Plasters	Waters
Glycerins	Powders, simple	Wines
Infusions	Powders, compound	
Juices	Solutions	

To weigh, measure, and compound medicines.

To write the directions for medicines in concise language in a neat and distinct hand.

To finish and properly direct each package.

NOTE.—In awarding marks in this subject, the time taken by the candidate in doing the work is taken into account.

PRESCRIPTIONS.

In this subject, the candidate is required—

To read without abbreviation autograph prescriptions.

To translate Latin prescriptions into English.

To understand the grammatical construction of the Latin of prescriptions.

To render a literal as well as an appropriate translation of the directions for use.

To detect errors in prescriptions.

To discover unusual doses.
To have a general knowledge of posology.
To calculate percentages and other quantities occurring in prescriptions.
To render in good Latin ordinary prescriptions written in English.

BOOKS FOR MINOR STUDENTS.

The student preparing for the Minor Examination will find Farmer's 'Practical Introduction to the Study of Botany,' and Watts' 'School Flora' meet all his requirements in that subject. Newth's 'Inorganic Chemistry,' Perkin and Kipping's 'Organic Chemistry,' White and Humphrey's 'Pharmacopedia,' Perkin's 'Qualitative Chemical Analysis,' and Clowes and Coleman's 'Elementary Quantitative Analysis' will be found to cover the ground on the chemical side. Loney's 'Mechanics and Hydrostatics for Beginners' should also be read by Minor students. Humphrey's 'Materia Medica and Pharmacy' is the most recent and complete work on those subjects, and contains useful notes on the pharmacy of official galenicals, as well as the latest information about the chemistry of crude drugs of vegetable and animal origin. Practical pharmacy and dispensing are best studied in White and Humphrey's 'Pharmacopedia,' the 'British Pharmaceutical Codex,' the 'Pharmaceutical Pocket-Book,' and the series of articles on "Practical Pharmacy" published in *The Pharmaceutical Journal* during 1908-9. 'The Pharmacist's Diary and Year-book' gives full information regarding the conditions under which poisons may be sold, but see also pages 410-11.

NEUTRALISATION TABLE.

The figures in the same horizontal line represent equivalent quantities of the acids and alkalies.

Potassium Bicarbonate.	Sodium Bicarbonate.	Citric Acid.	Tartaric Acid.
14	12	***10***	11
20	17	14	***15***
24	***20***	17	18
27	22	19	***20***
29	24	***20***	22
38	32	27	29
42	36	***30***	32

MAJOR EXAMINATION SYLLABUS.

Persons who pass the Major Examination are registered as "Pharmaceutical Chemists," and, as such, are exempt from service on all juries and inquests in England and Wales. The fee for the examination is three guineas, and the fee for re-examination two guineas. The Major Examination will be held on three occasions during 1907—namely, in January, April, and July. Thereafter the examination will be held in April and July only. The examination in the respective subjects—Botany, Chemistry and Physics, Practical Chemistry, and Materia Medica—may be oral, practical, or written, or all three. In the practical portion of the examination, standard works of reference are provided for the use of candidates, at the discretion of the examiner. In preparing for this examination, it is quite as necessary, as in the case of the Minor Examination, if not more necessary, that candidates should, before presenting themselves, receive a systematic course of instruction in the respective subjects, a period of three to six months being devoted to the work, and a large proportion of the time spent in a well-conducted laboratory, such as that in the Pharmaceutical Society's School of Pharmacy, or some other high-class institution, It should be noted that the Council of the Pharmaceutical Society has at present under consideration a proposed readjustment of the Major Syllabus, the effect of which would be that the Major Examination would consist of one obligatory subject, viz., Materia Medica and Pharmaceutics, and two optional subjects—(*a*) Botany and (*b*) Chemistry and Physics—one of which would be selected by the candidate. The obligatory subject would include a certain amount of applied chemistry to meet the case of those who elected to take the biological side of the examination. It is understood that the principle involved in the proposal is regarded favourably, and it is not improbable that powers may be obtained to permit of other subjects, such as Bacteriology, being selected by candidates. Ample notification of the impending change of syllabus will be given in *The Pharmaceutical Journal*, if the suggestions should be adopted. The schedule of the present examination requirements is here given in full.

BOTANY.

In addition to what is required for the Minor Examination, the candidate is expected to show a competent practical knowledge of the classification, morphology and physiology of plants, in addition to ability (a) to make and mount micro-

scopic preparations, illustrating vegetable structure, and (b) to apply micro-chemical tests for certain substances. Thus :—

Classification.

The general principles of classification ; the Natural system. The characteristic features of the following groups :—

CRYPTOGAMIA.

THALLOPHYTA.
- ALGÆ.
- FUNGI (INCLUDING LICHENS)

BRYOPHYTA
- HEPATICÆ
- MUSCI.

PTERIDOPHYTA.
- EQUISETINÆ
- FILICINÆ.
  - Filices.
- LYCOPODINÆ.

PHANEROGAMIA.

GYMNOSPERMÆ
- Coniferæ.

ANGIOSPERMÆ.

Dicotyledones.

Thalamifloræ.
- Papaveraceæ.
- Caryophyllaceæ.
- Violaceæ.
- Malvaceæ.

Discifloræ.
- Geraniaceæ.
- Rutaceæ.

Calycifloræ.
- Saxifragaceæ.

Corollifloræ.
- Dipsaceæ.
- Valerianaceæ.
- Gentianaceæ.
- Scrophulariaceæ
- Boraginaceæ.
- Labiatæ.
- Primulaceæ.

Monochlamydeæ.
- Polygonaceæ.
- Euphorbiaceæ.
- Ulmaceæ.
- Urticaceæ.
- Cupuliferæ
- Salicaceæ.
- Betulaceæ.
- Myricaceæ.

Monocotyledones.

Petaloideæ.
- Orchidaceæ.
- Amaryllidaceæ.
- Iridaceæ.

Glumifloræ.
- Cyperaceæ.
- Graminaceæ

Morphology.

Alternation of generations as illustrated by the life-histories in the several classes of plants.

Relative magnitude and degree of development of the sporophyte and the gametophyte.

The general anatomy of plants, treated more fully than in the Minor Examination.

Physiology.

The general physiology of nutrition and growth.

The relationships and adaptations of plants to their surroundings.

Practical Work.

To make and mount microscopic preparations illustrating vegetable structure.

To apply micro-chemical tests for cellulose and its modifications as they exist in the cell wall, and for the chief products which are formed in plant cells.

CHEMISTRY AND PHYSICS.

In addition to the subjects indicated by the Schedule for the Minor Examination the candidate is expected to possess a knowledge of the most important facts connected with the following:—

General Physics.

Physical constitution of the three states of matter.
Liquefaction of gases, critical point.
The diffusion of gases and liquids, dialysis.
Methods for determining vapour density.
Solution.

Heat.

Dynamical theory of heat.
Heat and temperature.
Sources, development, and propagation of heat.
Radiation, diathermancy, and athermancy.
Separation of heat from light.
Latent heat. Freezing mixtures.
Boiling point. Specific heat.
Distillation. Calorimeters.
Relation of specific heat to atomic weight.
Methods of determining exceedingly high and low temperatures.

Light.

Undulatory theory of light.
Reflection.
Refraction.
Interference of light.
Propagation of light, the photometer.
Mirrors and lenses, the microscope.
Decomposition of white light by a prism.
Spectroscope, spectrum analysis.
Double refraction.
Polarisation, the polariscope.
Influence of light in promoting chemical change.
The principles of the ordinary photographic processes.

Electricity and Magnetism.

Methods of producing magnetism.
Magnetic induction.

Sources of electricity, frictional electricity.
Electroscope.
Electric induction.
Electric machines.
Leyden jar.
Voltaic electricity.
Principal forms of voltaic batteries.
Galvanometer.
Chemical effects of current.
Electrolysis.
Measurement of current, Ohm's law.
Voltameter.
Secondary currents, secondary batteries.
Thermo-electricity, the thermophile.
Production of heat and light from electricity.
Electro-motors.
Dynamo-machines.

Chemical Theory.

History of the atomic theory.
Hypothesis of Avogadro.
Methods by which the standard atomic weights have been determined.
Dissociation.
Specific volume.
Periodic law.

Organic Chemistry.

Classification of carbon compounds.
Rational formulæ.
Isomerism.
Characteristics and constitution of the chief typical organic compounds.
Constitution, sources, methods of preparation, properties, reactions, and mutual relations of the following organic compounds: —

Cyanogen Derivatives.

Urea, cyanuric acid, uric acid.

Hydrocarbons.

The principal members of the paraffin, olefine, acetylene, and benzene series.
Their chief haloid and nitro-derivatives.
Theory of isomerism in paraffin and benzene series.

Paraffin Derivatives.

Distinction of primary, secondary, and tertiary alcohols.
Chief primary manahydric alcohols.
Glycol. Glycerin (glycerol).
Mannite, acetaldehyde, chloral.
Chloral hydrate. Acetone.

Ether.

Principal acids of the acetic series.

Oleic acid.	Glycollic and lactic acids.

Oxalic, succinic, malic, tartaric, racemic, and citric acids.

Ethylamine.	Grape sugar.
Acetamide.	Milk sugar.
Glycocine.	Maltose.
Cane sugar.	Starch and cellulose.

BENZENE DERIVATIVES.

Phenol sulphonic acid.	Benzaldehyde.
Phenol.	Salicylaldehyde.
Resorcin (resorcinol).	Benzoic acid.
Aniline.	Salicylic acid.

Principal properties of the terpenes and camphors, essential oils, resins.

Characteristics of naphthalene and its derivatives.

Processes of alcoholic, acetic, lactic, and ammonic fermentation.

Properties and decomposition products of the principal glucosides, alkaloids, and other substances of definite chemical composition in the British Pharmacopœia.

PRACTICAL CHEMISTRY.

In this subject the candidate is expected to be able—

To analyse mixtures containing three metallic salts.

To determine the nitrogen in organic compounds by the soda lime and Kjeldahl processes.

To determine melting and boiling points.

To perform processes of gas analysis which can be carried out in a nitrometer.

To perform the operations (or certain stages of them) necessary for the preparation of the following:—

Cyanogen	Ethylene dibromide	Nitro-benzene
Artificial urea	Acetaldehyde	Aniline
Ethyl chloride	Formic acid	Benzoic acid
Iodoform	Oxalic acid	Nitrophenols

To recognise by their chemical reactions the most important of the inorganic and organic compounds (including crude drugs and galenical preparations) described in the British Pharmacopœia.

To determine, where necessary, by the pharmacopœial gravimetric or volumetric methods, the strength and purity of those compounds.

To detect and separate the most important alkaloids, alkaloidal salts, and glucosides.

To separate in the pure state morphine from opium and strychnine from nux vomica.

To detect methyl alcohol in tinctures, liniments, and other preparations.

MATERIA MEDICA.

In addition to what is required for the Minor, the candidate is expected to show a practical knowledge of—

The methods of determining the value of important drugs.

The methods of distinguishing commercial varieties of important drugs.

The methods of separating such of the active principles of important drugs as are official in the British Pharmacopœia.

To have a general acquaintance with the active constituents of all important drugs.

To possess a general knowledge of the chemical properties of the official alkaloids, glucosides, resins, and essential and fixed oils.

To make and describe microscopical preparations of any organised vegetable drug official in the British Pharmacopœia.

To point out distinctive histological features in official vegetable drugs.

To discover obvious adulterations present in powdered drugs from comparison with authentic material.

BOOKS FOR MAJOR STUDENTS.

The botany of the Major Examination should be studied with the aid of Scott's 'Structural Botany' (2 vols.) and Green's 'Vegetable Physiology,' both of which are necessary. Newth's 'Inorganic Chemistry' may be supplemented by reference to some larger work, such as Roscoe and Schorlemmer's 'Treatise on Chemistry'; and Perkin and Kipping's 'Organic Chemistry,' or Cohen's Theoretical Organic Chemistry,' may be supplemented by reference to Richter's 'Organic Chemistry.' Other useful works of reference are 'Armitage's 'History of Chemistry' and Lothar Meyer's 'Modern Theories of Chemistry.' Woodward's 'Chemical Arithmetic' (Parts 1 and 2) deals with the necessary calculations, while for practical chemistry the best works are Clowes and Coleman's 'Elementary Quantitative Analysis' and Cohen's 'Practical Organic Chemistry for Advanced Students,' which may be supplemented by reference to Sutton's 'Volumetric Analysis.' The physics of the Major should be studied from Draper's 'Heat,' Edser's 'Light,' Silvanus Thompson's 'Elementary Lessons in Electricity and Magnetism,' and Reychler's 'Outlines of Physical Chemistry.' The materia medica of the Major may best be studied in the 'British Pharmaceutical Codex' and Humphrey's 'Materia Medica and Pharmacy,' as those works make a special feature of the chemistry of drugs. As regards the histological examination of drugs and their powders, the student should consult Greenish's 'Microscopical Examination of Foods and Drugs' and Greenish and Collin's 'Anatomical Atlas of Vegetable Powders.'

THE PHARMACEUTICAL STUDENTS' LIBRARY.

If, as is desirable, the pharmaceutical student, at the outset of his career, attends classes in botany, chemistry, and physics, suitable text-books will doubtless be recommended by the teachers of the various classes. Having acquired a fair knowledge of the chief sciences upon which the practice of pharmacy is based, attention should next be directed to the systematic study of the British Pharmacopœia, and, as a guide to the intelligent comprehension of that work, the student should procure a copy of White and Humphrey's 'Pharmacopedia,' which deals in an exhaustive manner with the botany, chemistry, pharmacognosy, and pharmacy of the national medicine book. At the same time attention should be devoted to prescription Latin, Ince's 'Latin Grammar of Pharmacy' or Bennett's 'Medical and Phamaceutical Latin,' being systematically studied as aids to the reading of prescriptions. Other books which will be found useful during apprenticeship are Briggs' 'General Elementary Science,' Newth's 'Inorganic Chemistry,' Farmer's 'Practical Introduction to the Study of Botany,' Scott's 'Introduction to Structural Botany' (Vol. I.), Humphrey's 'Materia Medica and Pharmacy,' and Watts' 'School Flora.' Particulars are here given of the most useful text-books and works of reference for pharmaceutical students:—

Botany.

Bower's 'Practical Botany for Beginners.' (Macmillan, 3s. 6d.)
Ewart's 'New Matriculation Botany.' (Clive, 3s. 6d.)
Farmer's 'Introduction to the Study of Botany.' (Longmans, 2s. 6d.)
Green's 'Vegetable Physiology.' (Churchill, 10s. 6d.)
Scott's 'Introduction to Structural Botany.' (Black, 3s. 6d.)
Strasburger's 'Text-Book of Botany.' (Macmillan, 18s.)
Watts's 'School Flora.' (Longmans, 3s. 6d.)

Chemistry.

Armitage's 'History of Chemistry.' (Longmans, 6s.)
Bernthsen's 'Organic Chemistry.' (Blackie, 7s. 6d.)
Bloxam's 'Chemistry.' (Churchill, 18s. 6d.)
Cohen's 'Practical Organic Chemistry.' (Macmillan, 3s. 6d.)
Cohen's 'Theoretical Organic Chemistry.' (Macmillan, 6s.)
Newth's 'Inorganic Chemistry.' (Longmans, 6s. 6d.)
Perkin and Kipping's 'Organic Chemistry.' (Chambers, 7s. 6d.)
Reychler's 'Outlines of Physical Chemistry.' (Whittaker, 4s. 6d.)
Richter's 'Organic Chemistry.' (Kegan, Paul, 15s.)
Smith's 'General Inorganic Chemistry.' (Bell, 7s. 6d.)
Sutton's 'Volumetric Analysis.' (Churchill, 20s.)
White and Humphrey's 'Pharmacopedia.' (Kimpton, 10s.)
oodward's 'Chemical Arithmetic.' (Simpkin, 5s. 6d.)

Chemistry (Analytical).

Clowes and Coleman's 'Elementary Quantitative Analysis.' (Churchill, 4s. 6d.)

Fresenius's 'Qualitative Chemical Analysis.' (Churchill, 15s.)

Newth's 'Chemical Analysis' (Longmans, 6s. 6d.)

Perkins's 'Qualitative Chemical Analysis.' (Longmans, 3s. 6d.)

Sutton's 'Volumetric Analysis.' (Churchill, 20s.)

Dispensing.

British Pharmaceutical Codex, 1907. (Simpkin, 12s. 6d.)

Kirkby's 'Practical Prescribing and Dispensing.' (Manchester University Press, 4s. 6d.)

'The Chemist's Annual.' (Pharmaceutical Journal, 5s.)

Materia Medica.

Flückiger and Hanbury's 'Pharmacographia.' (Macmillan, 21s.)

Greenish's 'Text-book of Materia Medica.' (Churchill, 15s.)

Humphrey's 'Materia Medica and Pharmacy.' (Kimpton, 6s. 6d.)

Southall's 'Organic Materia Medica.' (Churchill, 7s. 6d.)

Microscopy.

Cross and Cole's 'Practical Microscopy.' (Baillière, 4s.)

Greenish's 'Microscopical Examination of Foods and Drugs.' (Churchill, 10s. 6d.)

Greenish and Collin's 'Anatomical Atlas of Vegetable Powders.' (Churchill, 12s. 6d.)

Scales' 'Elementary Microscopy.' (Baillière, 3s.)

Pharmacy.

British Pharmacopœia, 1898. (Spottiswoode, 10s. 6d.)

British Pharmaceutical Codex, 1907. (Simpkin, 12s. 6d.)

Humphrey's 'Materia Medica and Pharmacy.' (Kimpton. 6s. 6d.)

Lucas's 'Practical Pharmacy.' (Churchill, 12s. 6d.)

White and Humphrey's 'Pharmacopedia.' (Simpkin, 12s. 6d.)

Physics.

Brigg's 'General Elementary Science.' (Clive, 3s. 6d.)

Draper's 'Heat.' (Blackie, 4s. 6d.)

Edser's 'Light.' (Macmillan, 6s.)

Loney's 'Mechanics and Hydrostatics for Beginners.' (Cambridge Press, 3s. 6d.)

Page's 'Elements of Physics.' (Cassell, 3s. 9d.)

Thompson's 'Elementary Lessons in Electricity and Magnetism.' (Macmillan, 4s. 6d.)

Prescription Reading.

Bennett's 'Medical and Prescription Latin.' (Churchill, 6s.)

Ince's 'Latin Grammar of Pharmacy.' (Baillière, 5s.)

PHARMACEUTICAL SCHOLARSHIPS AND PRIZES.

JACOB BELL MEMORIAL SCHOLARSHIPS.

Two Jacob Bell Memorial Scholarships are offered annually, and come into operation at the commencement of the session in October, the scholars being for that session pupils in the Pharmaceutical Society's School of Pharmacy. A scholar is supposed to be commencing his studies, or at least to have made only that progress which may be reasonably looked for during an apprenticeship. The object of the examination is to ascertain that the candidate has such an amount of ability, and affords evidence of having made such use of it in the acquirement of elementary knowledge, as will justify the expectation of his proving a successful student, who may do credit to the appointment, and become a useful and accomplished member of the pharmaceutical body. Each scholarship is of the annual value of twenty-five pounds, and is tenable for one year only; each scholar may, however, at the termination of his year of tenure, apply for free admission to the next ensuing Advanced Course in the Society's School. The payment will be made in two moieties; the first to be paid when the Scholar enters upon his studies in the School, and the second at the expiration of five months. In addition to the endowment, the Council provides for the Bell Scholars free laboratory instruction and admission to the lectures, and books of the value of £5—given by the late Thomas Hyde Hills—are divided equally between them.

Subjects of Examination.

Latin.—Translation of "unseen" passages. Latin into English, English into Latin.

French or German.—Translation of "unseen" passages. French or German into English, English into French or German.

Chemistry, Pharmacy, and Botany.—A three hours' paper dealing with these subjects in their relation to the British Pharmacopœia. The questions will be based upon an elementary knowledge of the principal chemicals, drugs, and processes of the British Pharmacopœia such as a student may reasonably be expected to have acquired during apprenticeship.

No questions will be set in English grammar or in arithmetic. The value of a competitor's English will be judged from the quality of his written work, considered as a whole; whilst in arithmetic the competitor's knowledge will

be tested by problems presented in the course of the technical paper.

CONDITIONS OF THE COMPETITION.—Each competitor must give notice to the Registrar on or before June 1. The notice must be accompanied by

(*a*) A Registrar's Certificate of Birth.

(*b*) Testimonials from present or previous employers or masters as to capability, industry, and general conduct.

(*c*) A declaration that the competitor has passed not less, or has been engaged not less than three years in the pharmacy of a Registered Pharmaceutical Chemist, or Chemist and Druggist.

The form on which this declaration is to be made can only be obtained from the Registrar. At the time of giving notice the competitor must be a Student-Associate of the Society. On the day on which the examination is held the competitor must be not less than twenty or more than twenty-two years of age. No person to whom a Manchester Pharmaceutical Scholarship has been awarded is permitted to compete for a Bell Scholarship. The examination for these scholarships takes place on the third Tuesday in June at London, Edinburgh, and Manchester only. It will be wholly in writing, and will be conducted under such conditions as the Council may deem expedient. The written papers must be distinguished by a motto, and not by the name of the candidate. The examination will be conducted by one or more persons appointed by the Council, and the award made (subject to the approval of the Council) by a Committee, consisting of the President, the Vice-President, and the examiner or examiners.

MANCHESTER PHARMACEUTICAL ASSOCIATION SCHOLARSHIP.

One scholarship is offered annually, and will be presented at the commencement of the session of the Pharmaceutical Society's School in October. The scholar may for that session be a pupil in the Society's School, or in case he may elect, he may be a pupil in any Provincial School of Pharmacy approved by the Council of the Society. The work for this scholarship is the same as that for the Bell Scholarships. The scholarship is of the value of about £25 (the income arising from a sum of £750), which is to be expended for instruction in the Society's School, or in the Provincial School selected by the scholar and approved by the Council of the Society. The subjects of examination are the same as for the Jacob Bell Memorial Scholarships.

CONDITIONS OF THE COMPETITION.—Each competitor must give notice to the Registrar on or before June 1 The notice must be accompanied by

(*a*) A Registrar's Certificate of Birth.

(*b*) Testimonials from present or previous employers or masters as to capability, industry, and general conduct.

(*c*) A declaration that the competitor has passed not less, or has been engaged not less than three years in the pharmacy of a Registered Pharmaceutical Chemist, or Chemist and Druggist, in Lancashire, Cheshire, or the High Peak Parliamentary Division of Derbyshire.

(The form on which this declaration is to be made can only be obtained from the Registrar.) At the time of giving notice the competitor must be a Student-Associate of the Society. On the day on which the examination is held the competitor must be not less than nineteen or more than twenty-one years of age. The examinations are held at the same time and centres as for the Jacob Bell Scholarships, and the award made in the same manner and by the same persons as in the case of those scholarships. No person to whom a Bell Scholarship has been awarded is permitted to compete for the Manchester Pharmaceutical Association Scholarship.

HERBARIUM PRIZE.

A Silver Medal is annually offered by the Council for the best Herbarium, collected in any part of the United Kingdom, the Channel Islands, or the Isle of Man, between the first day of January in one year and the first day of July in the year following; and should there be more than one collection possessing such an amount of merit as to entitle the collector to reward, a second prize, consisting of a Bronze Medal, and also Certificates of Honour, will be given at the discretion of the Council. In the event of none of the collections possessing sufficient merit to justify the Council in awarding Medals or Certificates, none will be given.

CONDITIONS OF THE COMPETITION.—Competitors must be Student-Associates of the Society, and under twenty-one years of age.

The collections must consist of Phanerogamous Plants and Ferns, arranged according to the Natural System adopted in some work on British Botany (such as that of Babington or Hooker), and be accompanied by lists, arranged according to the same method. No collection may contain more than 150 specimens, which must be carefully selected and mounted so as to display the characteristic features of the more prominent and *typical* genera of the chief British Natural Orders.

The name of each plant, its habitat, and the date of collection, must be stated on the paper on which it is mounted. Each collection must be accompanied by a note, containing a declaration signed by the collector, and certified by his employer, or a pharmaceutical chemist to whom the collector is known, to the following effect:—

> The specimens which accompany this note were collected by myself, between the first day of January, 19—, and the first day of July 19—, and were named and arranged without any other assistance than that derived from books.

The merits of the collections will be estimated not so much by the number of plants as by the correctness with which they are named, and by their being typical specimens. The manner in which they are preserved and mounted will also be taken into account. The collections must be forwarded to the Registrar, 17, Bloomsbury Square, so that they may be received by him not later than the first day of July, indorsed "Herbarium for Competition for the Prize." After the opening meeting of the session in October they will be retained one month, under the care of the Curator of the Museums, and then returned to the collectors, if required.

FAIRCHILD SCHOLARSHIP AND PRIZES.

The Fairchild Scholarship was founded by Messrs. Fairchild Bros. and Foster, of New York, and—together with money prizes—is offered to students of pharmacy in the United Kingdom. Applicants must satisfy the regular requirements for admission to the qualifying examination of the Pharmaceutical Society of Great Britain or to that of the Pharmaceutical Society of Ireland, but must not be qualified chemists and druggists. One scholarship, of the value of £50, is awarded annually, and in addition consolation prizes of £5 are awarded to the best candidates, other than the winner of the scholarship, in England, Ireland, Scotland, and Wales respectively. Candidates to whom prizes have been awarded in one year are not eligible for prizes in any subsequent year, but may compete for the scholarship if otherwise eligible. The subjects of the examination are elementary chemistry, elementary materia medica, practical pharmacy and prescription reading, and elementary business knowledge. The successful candidate may select the school at which to study for the qualifying examination. Full particulars may be obtained from Mr. A. E. Holden, Bath House, 59, Holborn Viaduct, London, E.C.

SCHOOL OF PHARMACY PRIZES.

Medals and Prize Certificates are offered for competition by the Council of the Society, and are awarded partly on the results of the class examinations and partly on those of the periodical revision classes in each subject. They can be taken only by subscribers to the Society who have attended at least three-fourths of the course immediately preceding the competition.

BOTANY, CHEMISTRY, PRACTICAL CHEMISTRY, MATERIA MEDICA.

At the end of June a Bronze Medal and two Certificates of Honour are offered for competition in each of these subjects by students who have attended the Elementary Course.

At the end of March a Silver Medal and two Certificates of Honour are offered for competition in each of these subjects by students who have attended the Advanced Course.

PHARMACY.

The Council offers the Martindale Memorial Medal in Silver and two Certificates of Honour for competition to subscribers to the Society who have attended the Course of Pharmacy.

C. J. HEWLETT MEMORIAL EXHIBITION.

This award is made on the recommendation of the Professors to the Student-Associate, other than a Bell Scholar, who distinguishes himself in the School Prizes Competition in June. The amount of the Exhibition is about £15, and the successful student will be required to attend the next ensuing Advanced Course in the Society's School. The first competition takes place in 1910.

POST-GRADUATE PRIZES AND SCHOLARSHIPS.

Pereira Medal and Council Prizes.

Pharmaceutical Chemists who were members of the Society at the time of passing the Major Examination will be entitled to enter for the following prizes at the competition next following the date on which they passed the Major Examination:—

First Prize.—Pereira Medal in silver, and a present of books value £5, given by the late Thomas Hyde Hills in memory of Jacob Bell.

Second Prize.—The Pharmaceutical Society's Medal in silver.

Third Prize.—The Pharmaceutical Society's Medal in bronze.

Subjects of Examination.—Materia Medica, Botany, and Chemistry.

The competition for these prizes takes place in April of every year, after the ordinary meetings in that month of the Boards of Examiners.

The Registrar communicates with each person entitled to compete, requiring not less than three days' notice of his intention to present himself for examination, and no person will be admitted to compete unless he shall have given the required notice.

The examination is a written one, and competitors may be examined in London or in Edinburgh

Redwood Scholarship.

The Redwood Scholarship is offered biennially in April to pharmaceutical chemists who are desirous of obtaining advanced instruction in chemistry and chemical pharmacology, with a view to conducting original investigations in these subjects. The scholar receives the sum of £60, and is provided, free of cost, with a working bench, apparatus, and materials in the Research Laboratory of the Society. He is required to work under the supervision of the Directors and to observe the rules and regulations of the Research Laboratory. The nomination of the scholar is made by the Research Committee after ascertaining the candidate's fitness by means of an examination in chemistry and materia medica, or in such other manner as the Committee may think fit. The nomination of the Research Committee is submitted for the approval of the Council, which elects the scholar. This scholarship, like the others, is open to ladies. An appointment to a Redwood Scholarship will be made in April, 1907.

Burroughs Scholarship.

The Burroughs Scholarship is offered every other year, alternating with the Redwood Scholarship in April to pharmaceutical chemists who are desirous of obtaining advanced instruction in chemistry and pharmacy, with a view to conducting original investigations in these subjects. The scholar receives the sum of £50, and the conditions of the scholarship are the same as those relating to the Redwood Scholarship. The next appointment will be made in 1908.

Salters Research Fellowship in Chemistry.

The Fellowship, of the value of £100, is offered annually by the Salters' Company. It is tenable in the Research Laboratory for one year, but may be renewed under certain conditions, and the holder is expected to devote his whole time to original investigation. Application for the Fellowship should be made in the first instance to the Professor of Chemistry to the Pharmaceutical Society, who submits names of suitable candidates to a Committee of the Council, which may make a recommendation. The appointment must receive the approval of the Court of Assistants of the Salters' Company.

DICTIONARY OF PHOTOGRAPHIC CHEMICALS.

THE following list includes all the chemical reagents used in photography, giving their most important properties, method of preparation where necessary, and the purposes for which they are employed in photographic practice. In the case of substances likely to be well known to chemists and druggists, it has not been thought necessary to give particulars as to their method of preparation or properties.

Acetone.—A condensation product from acetic acid having the formula $CH_3 \cdot CO \cdot CH_3$ (acetic acid being $CH_3 \cdot COOH$). Mixes in all proportions with alcohol and water. Its use instead of alkali in dry plate development has been suggested by Lumiere and Seyewetz. The following is the formula suggested for pyrogallic acid:—

Pyrogallic acid	9 grains.
Water	1 oz.
Sulphite of soda (crystals)	56 grains.
Acetone	12 minims.

Acetone dissolves pyroxylin or celluloid very readily, and can be used with excellent results for the repair of celluloid articles. A solution of celluloid in acetone or amyl acetate forms a useful protective varnish for negatives.

Acid Acetic.—The glacial form, which crystallises at about 34° F., contains 99 per cent. of acid and 1 per cent. of water. It is employed in the dilute form in wet plate developers to "restrain" the reducing power of the ferrous sulphate. It is used also for dissolving ferric hydrate from bromide papers after development with ferrous oxalate. It is sometimes employed in dry plate developers. The commercial "strong" acid is one-third of the strength of the glacial acid. Sulphurous and sulphuric acids are sometimes present as impurities; also hydrochloric acid, which can be detected with silver nitrate. The glacial acid will dissolve pyroxylin or gun-cotton.

Acid Citric is an occasional constituent of developer, where it combines with a portion of the alkali to form a citrate, which acts as a restrainer upon the reduction of the silver.

Acid Gallic has sometimes been used as a developer, but its reducing action is comparatively slow.

Acid Hydrochloric is employed in the platinotype process for dissolving the iron out of the paper. For this purpose it is important that the acid itself should be free from any trace of iron.

Acid Hydrofluoric is used for etching glass and for stripping films from glass plates.

Acid Phosphoric.—Used to acidulate the solution of potassium chloroplatinite for the toning of silver prints.

Acid Pyrogallic (Pyrogallol) is not an acid in the ordinary sense of the term, being a 1 : 2 : 3 tri-phenol. As is the case with ordinary phenol (carbolic acid), however, it forms a compound with alkalies. A simple solution of pyrogallic acid oxidises slowly in the air, but in the presence of an alkali the oxidation proceeds very rapidly, the solution darkening first to a yellowish red, then to a full red, and finally becoming almost black. In spite of the introduction of new developers, such as hydroquinone, metol, amidol, etc., pyrogallic acid is still the most used for developing dry plates. It should be noted that excess of pyrogallic acid, in proportion to the alkali, acts as a restrainer. Pyrogallic acid is obtained by the sublimation of gallic acid. It can also be obtained in a condensed crystalline form.

Acid Sulphuric is used in the dilute state for dissolving iron out of bromide papers after development with ferrous oxalate. The pure acid should always be employed.

Adurol is a monochlor—or monobrom-hydroquinone. Like hydroquinone, it is employed as a developer, but is rather more soluble, keeps better, and gives less contracted negatives or positives than the latter.

Albumen, the chief constituent of white of egg, and prepared from this source or from blood, appears in commerce as dry, transparent granules. It is used in the preparation of albuminised paper, the peculiar gloss of which is due to this preparation.

Alcohol.—Ethylic alcohol and methylated spirit, used largely in photography as a solvent, drying, or hardening agent.

Alizarin.—Alizarin is the colouring matter of madder, now prepared artificially from anthraquinone, which is itself obtained from anthracene—one of the products of the distillation of coal. A lake formed from it is used as a colouring matter in the carbon process. Alizarin blue is employed sometimes as a colour sensitiser for the red rays in making iso-chromatic plates. Its formula is $C_{17}H_9NO_4$, alizarin being $C_{14}H_8O_4$.

Aluminium Chloride, in white crystals, is used in Szczepanik's process for printing in colour.

Alum.—Common alum and chrome alum are employed in photography—the former to prevent a plate frilling, *i.e.*, the gelatin leaving the glass round the edges of the plate. Chrome alum is used as a constituent of dry plate emulsions. The object again is to prevent frilling, and where plates are intended for export a much larger quantity is introduced. It is often

advisable to give gelatino-chloride or printing papers an alum bath in hot weather to prevent the gelatin softening.

Amidol is diamido-phenol—$C_6H_3(NH_2)_2OH$, that is to say, pyrogallic acid with two of the OH's replaced by NH_2, thus—

Pyrogallic Acid.	Di-amido-phenol.
$C_6H_3\begin{cases}OH\\OH\\OH\end{cases}$	$C_6H_3\begin{cases}NH_2\\NH_2\\OH\end{cases}$

It is used for developing dry plates and possesses the peculiarity that it does not require the presence of an alkali. It is a crystalline white powder, which dissolves readily in water, but keeps badly in solution. Bromides do not seem to possess much restraining action with this developer, and sulphite acts as an accelerator. With amidol the image comes up very quickly, and care must be taken to leave the plate in the developer long enough to acquire sufficient density.

Ammonia.—The ordinary solution of the gas is employed sometimes as an alkali in pyrogallic acid developers. At one time it was almost the only alkali employed for this purpose, but its place has been taken by sodium carbonate to a large extent. Ammonia is unsatisfactory in the developer, as it evaporates and its strength is uncertain, results being equally so. Its use is objectionable owing to its irritating action on the eyes and mucous membrane, and its tendency to deposit on everything in the dark room in the form of minute crystals of ammonium bicarbonate. Ammonia is employed for "fuming" sensitised albuminised paper, a process said to increase the brilliancy of the print.

Ammonio Ferrous Sulphate sometimes takes the place of part of the ferrous sulphate in wet plate developers.

Ammonium Bichromate.—Sometimes employed in place of the potassium salt in processes depending on the action of light on gelatin. Its formula is similar to the potash salt, namely $(NH_4)_2Cr_2O_7$, and it is made by neutralising chromic acid with ammonia.

Ammonium Bromide.—At one time largely employed as a restrainer in development, but the potassium salt is now generally used. Ammonium bromide is employed also in preparing the collodion "iodiser" in the wet plate process. This is largely used in plate manufacture and in bromide paper.

Ammonium Carbonate is very occasionally used as an alkali in development.

Ammonium Chloride.—In "salting" albuminised paper, that is to say, in adding the necessary chloride to convert the silver nitrate into chloride, the ammonium salt is used largely-also in preparing "chloride" papers.

Ammonium Fluoride (NH_4F) has formed the base of several compounds used for obtaining an enlarged negative from a small one by causing the gelatin to expand under the action of the fluorine. It is a useful reagent also for etching glass.

Ammonium Iodide.—Like the bromide this is employed sometimes in the iodiser for collodion in the wet plate process.

Ammonium Iron Alum occurs in amethyst crystals, which are stable in air. On this account this substance is a convenient source of definite weight of ferric iron in the preparation of ferric oxalate for the platinum process.

Ammonium Oxalate is recommended in preparing platinotype papers.

Ammonium Persulphate $(NH_4)_2S_2O_8$.—Prepared by electrolysis of a cold saturated solution of ammonium sulphate in dilute sulphuric acid. Crystallises in lozenge-shaped tablets, and is very soluble in water. It is used to improve hard negatives on account of its powerful oxidising properties. It reduces the denser parts in a greater proportion than the shadows. It is also a useful "hypo" eliminator.

Ammonium Sulphide.—Sulphuretted hydrogen and ammonia combine to form NH_4HS, which is colourless. On oxidation this changes to $(NH_4)_2S$, and further oxidation results in compounds containing still more sulphur, and in the production of ammonium thiosulphate. It is employed for blackening the bleached image when the mercury intensification process is used, and in the intensification with lead. It is important that colourless or nearly colourless sulphide should be used. Ammonium sulphide is a dangerous substance to have anywhere in the neighbourhood of sensitive material. This is not commercially obtainable quite colourless.

Ammonium Sulphocyanide or Thiocyanate is a very deliquescent salt, and for this reason is better made up into a 10 per cent. solution when quite fresh. It is employed with chloride of gold in toning gelatino-chloride ("printing-out") papers. It is very soluble in water and in alcohol.

Amyl Acetate is used as a solvent for celluloid, and as the source of illumination in the Hefner-Alteneck standard lamp, adopted as the standard light for speed determinations.

Aniline is employed in the aniline printing process.

Asphaltum or Bitumen, obtained usually from Syria, is the sensitive substance employed in the line engraving or zinco-type process.

Aurantia is a dye obtained by he action of nitric acid on diphenylamine, and is employed for colour sensitising the emulsion for iso-chromatic plates, also for preparing the colour screens for iso-chromatic work.

Aurine is another non-actinic dye.

Azaline is a dye, composed of a mixture of quinoline-red and quinoline-blue (cyanine), and is used in orthochromatic work.

Barium Bromide and Iodide are occasionally used in the making of a collodion iodiser for the wet plate process.

Barium Chloride is used occasionally for "salting" albuminised paper and in making baryta paper.

Barium Nitrate.—Occasionally used with ferrous sulphate in the wet collodion developer to prevent pin-holes.

Barium Sulphate is used in certain printing-out gelatino-chloride emulsions as a backing, and in the emulsion itself to secure a matt effect.

Benzene and Benzine.—The use of these two words often occasions much confusion. By benzene is usually meant C_6H_6, the light oil obtained by distilling coal tar. By benzine, light petroleum spirit. The two substances are entirely distinct in their composition and properties, although both have a very powerful solvent action.

Borax or Sodium Biborate is used on account of its faint alkaline properties in toning baths with chloride of gold.

Cadmium Bromide and Iodide and the double salts with ammonium are largely employed in preparing the "iodiser" for the collodion in the wet plate process.

Calcium Chloride mixed with asbestos, or some other absorptive material, is employed in the tubes used to stock platinotype papers to ensure that the air is kept perfectly dry.

Canada Balsam is the cementing medium for lenses.

Caramel is formed by heating cane sugar to about 400° F. Although theoretically easy to make at home in a saucepan, in reality it requires a great deal of experience to obtain a successful result. Caramel is very soluble in water, and is deliquescent. It is employed either alone or combined with burnt sienna as a coating for the back of the dry plate before exposure to prevent reflection from the back surface and consequenl blurring of the high lights of the negative.

Carbon, in the form of lamp-black, is employed as a pigment the carbon process (see Gelatin).

Castor Oil is a constituent of enamel collodion and certain retouching media.

Catechu, obtained by extracting powdered Bombay catechu with water containing a small amount of alcohol, is employed in toning or intensifying platinum prints. Every trace of iron must be removed from the print before toning, as the catechu-tannic acid would at once form an inky ccmpound with it.

Cellulose is the chemical term for all purified forms of vegetable fibre, etc., such as cotton wool, linen, etc. When nitrated it forms several highly combustible compounds; one of which, di-nitro-cellulose, or pyroxiline, is employed in the form of collodion. Cellulose has many interesting forms and derivatives. The xanthate formed by the action of carbon disulphide upon mercerised cotton wool (*i.e.*, cotton wool treated with caustic soda) re-deposits pure cellulose under certain conditions. The tetra-acetate also is highly interesting, forming a film of remarkable strength, brilliancy and transparency, when deposited from its solution in chlorform.

Cerium Peroxide has been recommended as a reducer for negatives.

Cerium Sulphate.—This has been recommended as a non-staining reducer.

Chloroform.—Employed as a solvent for resins, and also for asphaltum in the zinco-type process.

Chlorophyll the green colouring matter of plants, obtained by macerating parsley or ivy leaves in alcohol, is sometimes used as a colour-sensitiser for iso-chromatic emulsions.

Cœrulein is also a sensitiser for the red.

Collodion has played an important part in the history of photography. It is the medium used as a vehicle in the wet plate process, whilst the collodion emulsion dry plate was the first step towards the gelatin dry plate. Collodio-chloride papers are still employed. Collodion is di-nitro-cellulose dissolved in a mixture of alcohol and ether. For the wet plate process it is important that mineralised methylated alcohol should not be used as a solvent.

Copper Bromide is employed in a method of intensification in which the insoluble cuprous bromide is formed in the film.

Copper Chloride is used in Obernetter's process of making an intaglio plate, by transferring the silver image on to copper. It is very useful in a 5 per cent. solution as a reducer. It first bleaches the negative, which is then redeveloped to the required extent, when it can again be fixed in acid hypo.

Copper Sulphate acts as a restrainer in the ferrous sulphate wet plate developer.

Cyanine, or Quinoline Blue, used in the preparation of azaline.

Cyanin, a complicated blue organic dye used as a colour sensitiser for the red rays in iso-chromatic plates.

Dextrin.—Prepared by heating starch, either alone or with dilute acids. It is very soluble in water, and makes a strong gum, and is useful for mounting purposes.

Di-amido Phenol (see Amidol).

Dianine.—A name given to diamido-resorcin hydrochloride, $C_6H_2(NH_2)_2(OH)_2$, 2HCl. It is used as a developer.

Dianol.—A trade name for di-amido-phenol (amidol).

Diphenal is one of the new developers, its composition being di-amido-oxy-diphenol hydrochloride. It is almost insoluble in cold water, but soluble in hot water and in alcohol. As it will not dissolve in the usual mixture of sodium sulphite and carbonate, it is necessary to use sodium hydrate instead of carbonate.

Eikonogen is sodium amido-β-naphthol-β-sulphonate, and is used as developer. It is not convenient to use, as it dissolves in water with difficulty and when dissolved deteriorates rapidly.

Eosin, a fluorescent dye used in iso-chromatic work as a colour sensitiser for the green and yellow.

Erythrosin.—Another dye used for iso-chromatic work as a sensitiser for the yellow and green.

Ether.—Used as a solvent in the preparation of collodion and in the purification of asphaltum.

Ferric Ammonium Citrate.—Used in the preparation of ferro-prussiate paper. Two forms of this substance are employed, the ordinary brown scale preparation and also a similar preparation, containing a larger proportion of citric acid, and appearing as bright green scales. This green preparation gives a more sensitive paper and purer whites.

Ferric Ammonium Oxalate, prepared by dissolving freshly precipitated ferric hydrate in acid ammonium oxalate, is used in the developer of the platinotype process.

Ferric Chloride is used for etching the zinc plate in process work.

Ferric Oxalate.—Prepared by dissolving ferric hydrate in excess of oxalic acid. This preparation must not be exposed to light for any length of time. It may be obtained in the form of greenish-yellow scales, and is used in the platinotype process.

Ferrous Oxalate is used as a reducing agent in developers for dry plates and bromide papers. Owing to its definite chemical action the ferrous oxalate developer is employed in standardising plates for speed. Instead of using ferrous oxalate a mixture of ferrous sulphate and potassium oxalate is actually employed. In the developer ferrous salt is oxidised to ferric salt. If this be exposed to light it is again reduced to the ferrous state.

Ferrous Sulphate is largely employed in photography as a reducing agent (see Ferrous Oxalate above). The sulphate itself is employed in the wet plate developer, but for dry plates

the oxalate is preferable. Various soluble colloidal forms of metallic silver can be secured by reducing its salts with ferrous sulphate.

Formalin or Formic Aldehyde is the aldehyde formed by the partial oxidation of methyl alcohol, in same way that ethyl aldehyde is the result of partly oxidising ethyl alcohol. Further oxidation leads to the production of acetic acid in the case of the ethyl compound, and of formic acid in the case of the methyl eompound. Formic aldehyde renders gelatin insoluble, and is employed to harden the gelatin in the plate and prevent it frilling in warm weather. It is a powerful antiseptic, and is used to preserve organic mixtures from decomposition.

Gelatin is one of the most important substances used in photography. It is obtained by boiling bones and animal membranes under slight pressure. Soft gelatin will absorb the colour from hard gelatin by diffusion if placed in contact with it. It has the property of absorbing water and swelling in the process, a comparatively small proportion of gelatin being required to make water almost stand upright. One test of good gelatin is that it will absorb in the cold sufficient water to completely dissolve it when warmed above 90° F., the solution setting to a jelly again on cooling. There are two kinds of gelatin—hard and soft—a mixture of the two being employed for emulsion making. Gelatin forms a most convenient vehicle for the sensitive silver salts in dry plates and in printing-out papers. In both cases it is probable that the gelatin itself plays an important part in increasing the sensitiveness of the silver salt. Gelatin is rendered insoluble by exposure to light, and this action is greatly hastened by the presence of a bichromate. The so-called carbon process and several photo-mechanical processes of reproduction depend upon this. Another property is that whilst ordinary gelatin before exposure to light remains "tacky," *i.e.*, has a tendency to absorb water and to repel grease, after exposure it no longer does so. Other reproductive processes depend upon this property. Acetic acid and several other acids dissolve gelatin in the cold, and advantage is taken of the action of acetic acid to form a liquid glue or cement. Tannin combines with gelatin to form an insoluble compound.

Glue is a commercial form of gelatin. Fish glue is largely employed in the photo-mechanical processes.

Glycerin is used in developing platinum prints. The print is first of all coated with glycerin, and the developer, containing more or less glycerin, is applied with a brush. This allows of local development.

Glycin (oxy-phenyl-glycin—$C_6H_4OH{\cdot}NH{\cdot}CH_2{\cdot}COOH$) is one

of the comparatively new developers. It is rather insoluble by itself, but dissolves readily in alkali and sulphite.

Gold Chloride.—The "gold chloride" known to photographers is a double salt of chloride of gold, and sodium or potassium. It is always slightly acid, and it is well to neutralise the solution. The gold salt is employed for toning silver prints, a process of electro-deposition taking place, gold being deposited in place of the silver. It should contain half its weight of metallic gold.

Gum Arabic.—Several processes depend upon the use of this substance—notably the gum-bichromate process, in which paper coated with bichromatised pigmented gum is exposed beneath a negative. Washing—largely assisted by the judgment of the operator—removes the portions not rendered insoluble by light.

Gun-cotton (see Pyroxylin).

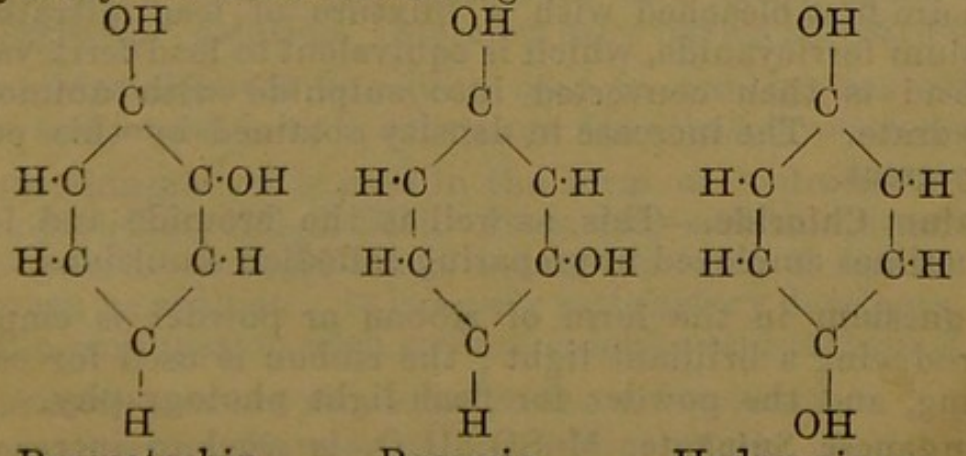
Hydramine.—A substance consisting of one molecule of hydroquinone and one of paraphenylene diamine. It occurs in white scales. Only slightly soluble in water, but more so in alkalies. It is used as a developer.

Hydrazine (N_2H_4) and

Hydroxylamine ($NH_2 \cdot OH$) have been suggested as developers.

Hydrogen Peroxide is occasionally employed to get rid of the last traces of thiosulphate ("hypo") in prints after fixing. It possesses strong bleaching properties, and is sometimes used for that purpose.

Hydroquinone is one of the three diphenols—pyrocatechin and resorcin being the other two. All are used or can be used as developers, hydroquinone being employed very extensively. The following diagram shows the relative composition of the three bodies, the difference consisting in the arrangement of the hydroxyls in the benzene ring:—



Pyrocatechin. Resorcin. Hydroquinone.

In connection with this, it is interesting to note that pyr y
or pyrogallic acid is the 1 : 2 : 3 triphenol, that i is

catechin, with the third H replaced by OH. Hydroquin gives a rather dense negative, and for this reason is frequen employed with metol, which gives detail rather than density

"Hypo" (see Sodium Thiosulphate).

Hypochlorites.—All hypochlorites, such as solution bleaching powder or eau de javelle, reduce the density of silver image by oxidising and dissolving the metal.

Imogen Sulphite is probably a mixture of other alre known developers.

Iron, Ammonio-Citrate of (see below).

Iron Salts play an important part in several photograp processes. Ferric salts are reduced to ferrous salts by the act of light, and although the reduced image is barely visible to naked eye, it can immediately be rendered so by the addition potassium ferricyanide, which causes the reduced image turn blue. If ferrocyanide be added a negative print is obtai instead of a positive. In practice the printing paper is coated fi with a mixture of ammonio-citrate of iron and potassium fe cyanide, so that the paper contains its own developer, o washing being required to remove the unacted upon s Various modifications of this process are practised. Anot important application of iron salts is in the platinum proc A mixture of potassium chloroplatinite and ferric oxalate employed on the paper. The light first reduces the ferric s which in turn reduces the platinum.

Isinglass.—A variety of gelatin, the purest form be prepared from the swimming bladder of the sturgeon. It occasionally used instead of gelatin.

Lead Acetate is used in toning baths, and occasionally a 'hypo" eliminator.

Lead Nitrate is used as an intensifier for weak negativ which are first bleached with a mixture of lead nitrate a potassium ferricyanide, which is equivalent to lead ferricyani The lead is then converted into sulphide with ammoni sulphydrate. The increase in density obtained by this proc is very great.

Lithium Chloride.—This, as well as the bromide and iodi is sometimes employed in preparing collodion emulsions.

Magnesium in the form of ribbon or powder is employ for producing a brilliant light; the ribbon is used for cont printing, and the powder for flash-light photography.

Manganese Sulphate, $MnSO_4 5H_2O$, is used to increase t sitiveness of carbon tissue; it is also used in the ozoty cess.

rcuric Chloride is used for intensification, the pl

being first bleached with the perchloride, and then blackened with dilute ammonia or redeveloped with ferrous oxalate.

Mercuric Iodide is sometimes used as an intensifier for negatives in conjunction with sodium sulphite.

Meta-Phenylene-Diamine is used in conjunction with potassium chloroplatinite for obtaining black tones on gelatino-chloride prints.

Methyl Orange.—A non-actinic organic dye, sometimes used in making fabrics or papers intended to cut off actinic rays.

Metol (Methyl-para-amido-meta-cresol—$C_3H_4 \cdot CH_3 \cdot NHCH_3 \cdot O$) is one of the best of the developers which have partly taken the place of pyrogallic acid. It is very good for snap-shot work, as it brings up detail in the shadows unusually well. Owing to the rapidity with which the detail comes up in developing there is a danger of not leaving the plate in long enough to secure sufficient density. For this reason a mixture of metol and hydroquinone is better than metol by itself. The developer is used in conjunction with alkaline carbonate and sulphite.

Naphthol Green and Naphthol Yellow are used in preparing screens used in colour photography.

Ortol is the sulphate of methyl-ortho-amido-phenol mixed with hydroquinone. It is employed as a developer in conjunction with sodium sulphite and carbonate.

Palladium.—This metal can be employed in place of platinum, the sodio-chloride of palladium being the actual salt used. The result on the printing paper is very similar to platinum; but as palladium is very much more expensive than the last-named metal, and there is no particular advantage gained by the substitution, it is rarely used.

Palladium Salts are sometimes used for giving a sepia tone to platinum prints, the palladium salt being added to the "sensitising" solution. Mercury salts have a similar effect.

Paraformaldehyde has been used in combination with sulphite and bromide as a substitute for alkali in developers.

Paramido-phenol is used in the form of hydrochloride as a developer ($C_6H_4 \cdot NH_2Cl \cdot OH$). It is very soluble in water and slightly in alcohol and ether, and in the form of hydrochloride is known as rodinal. It is a very satisfactory developer, and is used in conjunction with sodium sulphite and carbonate.

Paranol, a trade name for para-amido-phenol.

Paraphenylenediamine is the hydrochloride of the para, or 1 : 4 phenyl-diamine, $C_6H_4(NH_2 \cdot HCl)_2$. This developer is very soluble in water and slightly so in alcohol. Sodium hydrate is employed in the developer instead of the carbonate.

Pentane.—A paraffin hydrocarbon used as the source of illumination in the standard pentane lamp; this is frequently used as a standard light in speed determinations.

Petroleum Ether, otherwise known as benzoline, or benzine, is used as a solvent for resins, grease, etc.

Pinakol.—A name given to a preparation of the sodium salt of amidoacetic acid, $NH_2 \cdot CH_2 \cdot COONa$; it is used in pyro developers.

Platinum, in the form of the double chloride with potassium, is employed for toning prints, and, in the well-known platinotype process. Platinous chloride is nearly insoluble in water, but the double salt, or potassium chloroplatinite, is very soluble, and this is the form generally used. The platinum salt itself is practically unaffected by light, and an iron salt is the sensitive constituent of the coating on the paper. On being developed in a bath of potassium oxalate the iron reduces the platinum; so that a platinum image instead of an iron one is obtained.

Potassio Mercuric Iodide, prepared by dissolving mercuric iodide in potassium iodide and crystallising the product. It is in the form of yellowish-green crystals, and is used as an intensifier.

Potassium Bichromate possesses great importance in conjunction with gelatin. Bichromatised gelatin becomes insoluble and undergoes certain other changes on exposure to light, which is made use of in several ways, as in the carbon process, photogravure and half-tone engraving, collotype, etc. Ammonium bichromate is sometimes employed instead of the potassium salt. (See gelatin.) Bichromate of potash, with sulphuric acid, which is equivalent to chromic acid, forms an excellent reagent for thoroughly cleaning glass or porcelain plates, etc., which are required to be coated with an emulsion, or for other purposes where great cleanliness of the surface is required.

Potassium Bromide.—All haloid salts hinder the decomposition of silver bromide in presence of a reducing agent. Consequently, either potassium or ammonium bromide is added to the developer to restrain its reducing power, and allow the deposition of the silver to proceed selectively instead of as a general "fog" all over the plate. It is always advisable to have a small amount of bromide present—say, 1 grain to the ounce of developer. In cases of over-exposure further additions can be made. In making emulsions a mixture of silver nitrate and potassium bromide or iodide is employed, so as to obtain the salt in a very finely divided state.

Potassium Carbonate is occasionally given in formulæ for developers instead of the sodium salt. The only advantage it possesses over the latter is that it is more soluble. It is,

however, more expensive than the sodium carbonate, and its propensity for absorbing moisture is inconvenient.

Potassium Chlorate.—Used in the platinum process as a constituent of the sensitising solution.

Potassium Chloroplatinite is the double salt of platinous and potassium chlorides, its formula being K_2PtCl_4 (see Platinum). When used for the toning of silver prints, the solution must be acid.

Potassium Citrate is used as a restrainer in developers.

Potassium Cyanide dissolves silver bromide, chloride, or iodide, which has not been acted upon by light, forming a double cyanide with the silver. It is employed consequently for fixing wet plates, and in conjunction with an oxidising agent for reducing the density of negatives or prints.

Potassium Ferric Oxalate, in greenish crystals; it is used as a reducer.

Potassium Ferricyanide gives the well-known Prussian blue colour with a ferrous salt, and it is employed for this purpose in making the blue prints which are so much used for reproducing plans and mechanical drawings (see Iron). It is also used in the sulphide toning process for developed prints.

Potassium Ferrocyanide gives the reverse effect to the last salt, iron prints developed with it coming out as a reproduction of the negative, the whites of the negative being white and the dark blue (see Iron).

Potassium Iodide is used in making emulsions with silver nitrate (which see).

Potassium Metabisulphite has the formula $K_2S_2O_5$, or $K_2SO_3 \cdot SO_2$, and is prepared by passing sulphurous anhydride (SO_2) into potassium carbonate until it is saturated. The meta-bisulphite is then precipitated with alcohol. This salt has a similar action to ordinary sulphite in preserving pyrogallic acid from oxidation and preventing the staining of the gelatin film. It has the drawback, however, that on oxidation free sulphuric acid is produced, requiring an extra amount of alkali to neutralise it.

Potassium Oxalate is used as a constituent of the ferrous oxalate developer, a mixture of ferrous sulphate and potassium oxalate being equivalent to employing ferrous oxalate itself. It is used also in the platinum process in a similar way.

Potassium Percarbonate, $K_2C_2O_6$, is prepared by the electrolysis of a saturated solution of the carbonate at a temperature of —10° to —15° C. It occurs as a bluish-white powder which rapidly decomposes in the presence of water, giving off hydrogen peroxide, and hence is a useful "hypo" eliminator.

Potassium Persulphate, $K_2S_2O_8$, prepared by a process similar to the one used for the ammonium salt. It is used for the same purposes but possesses the disadvantage of being only slightly soluble in water.

Potassium Phosphate is sometimes added to the potassium oxalate solution for the development of platinum papers.

Primuline is an organic dye of the diazo type, and possesses the property of dyeing cotton without the assistance of a mordant. The material is dipped in a solution of primuline and dried; then sensitised with a mixture of sodium nitrite and oxalic acid, and dried again; exposed in the printing frame, and then developed in various re-agents, which give different-coloured results.

Pyrocatechin is the ortho or 1 : 2 di-oxy-benzene, the other two occupying the positions 1 : 3 and 1 : 4, being resorcin and hydroquinine. It is employed as a developer in conjunction with sodium sulphite and carbonate. It it readily soluble in water and alcohol (see Hydroquinone).

Pyrogallol (see Pyrogallic Acid and Hydroquinone).

Pyroxylin, or gun cotton, is the di-nitro cellulose produced by the nitrating action of a mixture of nitric and sulphuric acids on cotton wool. It dissolves in a mixture of alcohol and ether, and is then known as collodion. This is employed as a vehicle for the sensitive silver salt in the wet-plate process, in collodion-emulsions, and in collodio-chloride papers.

Quinoline Red.—A constituent of azaline, a colour preparation used in orthochromatic work.

Resorcin is the meta or 1:3 di-oxy-benzene. It has been used as a developer, but its amido compound—di-amido-resorcin—is more frequently employed. It is very soluble in water and alcohol (see Hydroquinone).

Rodinol (see Paramido-Phenol).

Rose Bengal.—An organic dye employed in ortho-chromatic work as a sensitiser for the yellow and yellow-green rays.

Schlippe's Salt (see Sodium Sulph-Antimoniate).

Silver, which is a beautifully white metal as ordinarily known, exists also in a peculiar colloid state, in which it is soluble in water. There are several forms of this colloid silver, but space will not allow of their description here. Silver haloid salts (chloride, bromide, and iodide) are peculiarly sensitive to light, and it is upon this fact that nearly the whole of photographic work is based. In making sensitive emulsions the particular salt—chloride, bromide, or iodide, is not used, but a mixture of silver nitrate with a soluble haloid, such as common salt, ammonium chloride, potassium bromide, cad-

mium bromide, potassium iodide, etc., is employed, according to the nature of the emulsion required. A double reaction occurs, the silver haloid salt being formed, and the sodium or potassium nitrate, together with any excess of the soluble haloid, is removed by careful washing.

Silver Albumenate.—Silver forms a very insoluble compound with albumen, and this fact has to be taken into account in sensitising albuminised paper.

Silver Bromide is a yellow salt formed by double decomposition between silver nitrate and a soluble bromide. (See Silver.) It is insoluble in water, alcohol, and in acids, but soluble in ammonia to a slight extent, and in alkaline thiosulphates (hyposulphites), cyanides and thiocyanates (sulphocyanides). A subbromide is supposed to be formed by the action of light on the bromide. At all events, the light-struck salt is much more readily reduced to the metallic state than the ordinary bromide.

Silver Carbonate is a yellowish salt formed by treating silver nitrate with an alkaline carbonate. Like the bromide, it is darkened by exposure to light. It has occasionally been used in making emulsions. It is insoluble in water and alcohol, but soluble in the ordinary solvents of the haloid salts of silver.

Silver Chloride is a white salt, insoluble in water and alcohol, but soluble in alkaline thiosulphates, etc., similarly to the bromide. It is changed first to purple and then to black by light. It is used for making gelatino-chloride and collodio-chloride papers, lantern-slide emulsions, and is present in sensitised albumenised paper.

Silver Citrate is formed by double decomposition with a soluble citrate, and is employed as one of the constituents of gelatino-chloride emulsions.

Silver Iodide is obtained by double decomposition with a soluble iodide, and is used in wet plates and in dry-plate emulsions. Silver iodide gives a harder and less detailed negative than the bromide, which is inclined to give flat results if used alone. Mixtures of bromide and iodide are usually employed. Silver iodide is yellow and insoluble in water and alcohol, and almost so in ammonia, but dissolves in other solvents similarly to the bromide.

Silver Nitrate.—It is important that silver nitrate used for photographic purposes should be free from any excess of nitric acid. It forms a double soluble salt with ammonia, and is slightly soluble in alcohol. In water it is very soluble, but it is necessary to use distilled water, as any haloid present will form a precipitate at once (see Silver and the other Silver Salts above).

Sodium Acetate is used in toning baths with gold chloride.

Sodium Bicarbonate is used as an alkali in some gold toning baths.

Sodium Carbonate.—Ordinary washing soda is somewhat uncertain in strength, as it may contain a certain proportion of sulphate. For this reason the pure dry carbonate is much preferable to washing soda for use as an alkali in dry plate developers, for which sodium carbonate is now almost entirely used. There is a mono-hydrated form, but it is not often met with commercially. By igniting the bicarbonate, pure normal carbonate is secured.

Sodium Chloride is used for salting albuminised paper and in many other ways for forming silver chloride by interaction with the nitrate.

Sodium Formate, $H{\cdot}COONa$, prepared by neutralising formic acid with sodium bicarbonate, is a white deliquescent solid. It is used in various toning baths, and for intensifying platinum prints.

Sodium Hydrate is sometimes used in dry-plate developers instead of the carbonate.

Sodium Hyposulphite.—True sodium hyposulphite is Na_2SO_2, but the thiosulphate (which see) is usually designated "hyposulphite" by photographers.

Sodium Phosphate, $Na_2HPO_4 12H_2O$, is used in toning baths, and gives purple tones.

Sodium Silicate, Na_2SiO_3, water-glass, is employed in the collotype process mixed with albumen.

Sodium Sulph-antimoniate has the formula $Na_3SbS_4 9H_2O$ and is very soluble in water. It is employed sometimes for toning bromide prints, to which it gives a reddish tint.

Sodium Sulphide, $Na_2S, 9H_2O$, is used in dilute solution for the toning of developed prints after they have been acted upon by potassium ferricyanide. It is very deliquescent and should be made into solution of known percentage strength when fresh.

Sodium Sulphite.—Confusion sometimes arises in developing formulæ between the dry sulphite and the crystals which contain seven molecules of water ($Na_2SO_3 7H_2O$). It is prepared by passing sulphurous anhydride (SO_2) into solution of sodium carbonate. Sodium sulphite is employed as a preservative for pyrogallic acid and other organic developers, and to prevent staining of the gelatin. Its use as a fixing agent, instead of "hypo," has been suggested, but its powers in this direction are very small.

Sodium Tartrate is used for intensifying platinum prints, and is also a constituent of many toning baths.

Sodium Thiosulphate is obtained commercially from the tank waste of the alkali works, and has the formula $Na_2S_2O_3 5H_2O$. It can be formed by heating sodium sulphite with excess of sulphur. Sodium thiosulphate possesses the property of dissolving silver haloid salts, and is employed almost entirely for "fixing" negatives and prints by removing the silver salt which remains unreduced. It forms first of all a very sparingly soluble double salt, $AgNaS_2O_3$, and then a much more soluble salt, $Ag_2Na_4(S_2O_3)_3$. Consequently it is important to have a large excess of "hypo" in the fixing bath. On decomposition with an acid the thiosulphate is resolved into free sulphur and sulphurous acid, both of which have an injurious effect on the print or negative; so that an acid, or an acid salt like alum, should never be introduced into the fixing bath.

Sodium Tungstate is used in gold toning baths. It is a compound of soda and tungstic acid, and is soluble in water, but insoluble in alcohol.

Strontium Chloride is soluble in water and alcohol, and on this account is occasionally used instead of other chlorides, most of which are nearly insoluble in alcohol.

Thiocarbamide or thiourea, CH_4N_2S, has a tendency to produce reversal if introduced into the developer. It is valuable for removing green fog and pyro stains from negatives. It has also been recommended as a constituent of gold toning for gelatino-chloride prints.

Thiosinamine is allyl-thio-urea, $CS{\cdot}NH_2{\cdot}NH{\cdot}C_3H_5$. It has a very similar action to thiocarbamide.

Tri-amido-phenol is the hydrochloride of the 2:4:6 tri-amido-phenol, $C_6H_4(NH_2{\cdot}HCl)_3OH$. It is very soluble in water, but almost insoluble in alcohol. When employed as a developer it is used in conjunction with neutral sodium sulphite.

Uranium Nitrate is employed for toning bromide prints, intensifying weak negatives, and in the uranium printing process, where the uranium salt is reduced directly by the action of light. It gives a rich red image. The reduced uranium compound is very opaque to actinic rays, so that in intensifying negatives care must be taken not to carry the process too far.

Vanadium Chloride in green crystals when recently prepared, but usually in the form of a bluish paste, is used to give a green tone to bromides.

Zinc Bromide and Zinc Iodide are used occasionally in the "iodiser" in wet-plate work.

Zinc Chloride has a very strong solvent action on pap cotton wool, or other forms of cellulose.

THE PREPARATION OF PLANT SECTIONS.

The following notes on the preparation of plant sections for histological examination have been specially compiled for the information of pharmaceutical students, and of such practising pharmacists as are interested in the study of the minute structure of plants. In studying the histology of plants it is usually necessary to subject the tissues of fresh specimens to special treatment before proceeding to actual work, and the method of this preliminary preparation will vary according to the manner in which it is proposed to study the specimens. When it is simply the general histology of the plant that is to be studied, the kinds, shapes, and relative positions of the different tissues, it is sufficient to *harden* these so that they may be sufficiently firm to admit of thin sections being cut satisfactorily. If, however, it is desired to investigate the cell contents *in situ*, and particularly the structure of the protoplasm and nucleus, the histological elements must be *fixed*—*i.e.*, rapidly killed—so that the different elements may retain unchanged the forms they had whilst alive as well as their relative positions. The more skilfully this is effected the better the results and the greater the dependence that can be placed upon them.

Fixing and Hardening Tissues.

Simple hardening of vegetable tissues is best effected by means of 90 per cent. alcohol, and sections may afterwards be cut without further preparation of the mass. For all ordinary purposes strong non-mineralised methylated spirit (old form) will serve, but for special cases the pure spirit is better. Objects may be preserved in these media for an indefinite time, undergoing no change, apart from the extraction of chlorophyll, resin, and other substances soluble in spirit, except the acquirement of a certain degree of brittleness. This may be remedied, and excessive hardness in fresh specimens also removed, by placing the object, some hours before cutting, in a mixture of equal parts of glycerin and strong alcohol. The latter, on exposure, gradually evaporates, leaving the glycerin to saturate and toughen the tissues. Another method is to soften in a mixture of water and glycerin in equal proportions as long as may be desirable.

Alcohol, Picric Acid, and Chromic Acid.

Fixing, which is, of course, accompanied by hardening, may be performed by means of absloute alcohol, or an aqueous solution of picric acid (saturated) or chromic acid (0·1—0·5 per cent.). The after-treatment, when absolute

alcohol is used for fixing, will depend upon the length of time the immersion continues, and this in turn will be regulated by the nature of the specimen. Very soft specimens must remain until hardened sufficiently to bear the knife, others may be cut straightway, and only when any are left very long will it be necessary to toughen by means of glycerin, as in the former of the two methods already described. When the acids are used there should be thorough permeation by the reagent. This may take from a few minutes to several hours, and must be ascertained by actual experiment. On removal, the tissues must be washed thoroughly to remove all traces of the acids. In the case of picric acid, washing with 70 per cent. alcohol (or methylated spirit diluted with one-fourth its bulk of water) is to be preferred. Chromic acid should be removed by washing with water. Specimens prepared by either method may afterwards be preserved in 90 per cent. alcohol, or strong non-mineralised methylated spirit, until required for use. In all fixing and hardening processes objects should be immersed in about twenty times their bulk of the selected fluid, and this should be agitated from time to time to ensure thorough penetration.

Embedding and Section Cutting.

After masses of vegetable tissue are properly hardened by one or other of the methods already mentioned, it may be necessary, particularly if the objects are very small, to subject them to further preparation before sections can be cut satisfactorily. This process, known as embedding, is also made use of when a series of sections is desired.

Section Cutting by Hand.

In dealing with most objects, however, when only one or two sections are required, it suffices to cut them by hand, as thus described by Professor Hillhouse:—"The object to be cut should be held pretty firmly between the thumb and index finger of the left hand, the index finger being held as nearly as possible horizontally, and slightly bent, the thumb likewise very slightly bent, and with the joint depressed below the level of the finger, in order to secure its safety should the razor slip. In holding the object to be cut, the side of the tip of the index finger should be rather higher than that of the tip of the thumb. The razor being then grasped firmly, but not stiffly, the blade held quite flat and horizontal, the edge towards the body; the index finger of the left hand will serve as a table, on which the blade will lie and thus be greatly steadied. The section should be cut by a single forward and *lateral* movement of the blade." Keep the razor blade wet with the fluid in which the object has been immersed, to prevent the sections adhering to it, take care that the object itself is kept moist, and by means of a camel-hair

brush remove sections from the blade as soon as cut into a watch-glass or saucer containing the same fluid. Unless the object be kept moist with the liquid from which it has been taken, air will enter the tissue and cause some trouble in its removal from the sections, especially if they be longitudinal ones.

Transverse, Radial, and Tangential Sections.

When studying the microscopical structure of drugs, sections should be taken from dried specimens for comparison with those from material softened by immersion in water, or water and glycerin. The importance of this will be seen when powdered drugs are under examination, and in this connection it may be stated that sections of drugs should be cut in various directions—transverse, radial, oblique, and at different tangents, though for the complete study of roots, stems, and leaves it is usually sufficient to cut transverse, radial, and tangential sections. A *transverse* section is obtained by cutting across at right angles to its length, and a *radial* or *radial longitudinal* section by cutting through the middle of the specimen in the direction of its length, while a *tangential* or *tangential longitudinal* section is cut in the same direction as a radial section, but through some other than the middle point. Barks and seeds must of necessity be studied in a number of successive tangential sections if their structure is to be fully elucidated.

Embedding in Pith or Carrot.

Embedding in its simplest form consists in placing the object in a slit in a piece of dried elder pith or a very soft cork. The pith or cork is best completely divided into two halves, the tissue placed between, and the whole bound together with thread. It may then be held in the hand and cut as if it were a piece of stem. A slightly hollow-ground razor will be found most useful for free-hand cutting, and a razor with the blade ground flat on one side for work with the microtome. The blades should be kept very sharp, and it is advisable to strop them after every few cuts. Dip them into water or alcohol and wipe dry before proceeding with the examination of the newly-cut sections. When a microtome is used, a cylinder of carrot, of such diameter that it exactly fits the well, is cut with a cork-borer. This cylinder is then divided lengthways and the piece of tissue fitted between the two halves, after which the mass is placed in the well and sections taken through both carrot and tissue. This is the speediest method to adopt in dealing with leaves, barks, and stems, when they are to be cut transversely.

Cacao Butter, Paraffin, and Celloidin.

There are several embedding media, which may be employed if sections are wanted in other directions or if small seeds, etc.,

are to be cut. Amongst these are cacao butter, hard paraffin, and mixtures in varying proportions of hard and soft paraffin or white wax and soft paraffin. On melting any of these and pouring into the well of the microtome, the object may be fixed in any desired position and cut when the medium has solidified again. To avoid loss of time in cooling large quantities of the waxy media, it is customary to cast blocks of these beforehand in which cavities may be made sufficiently large to take the objects to be cut. A very small proportion of the melted medium then serves to fill the cavities, and the minimum of time is occupied in the process. The solubility of cacao butter in alcohol causes it to have a special value in certain cases where there might otherwise be difficulty in removing it and, if it be allowed to harden thoroughly before cutting, it forms as useful and simple embedding medium as can be found. Delicate or porous tissues, such as the parts of fresh plants requiring special treatment in fixing and hardening, must be *saturated* with melted paraffin, a solution of celloidin in absolute alcohol and ether, or a mixture of glycerin and gelatin, before they can be cut with safety. They must also be dehydrated before treatment with the first two. Reference may be made to Lee's 'Microtomist's Vade Mecum,' Squire's 'Methods and Formulæ,' or Cross and Cole's 'Practical Microscopy,' for details of the various processes. Sections, as cut, should be transferred from the razor to a saucer containing dilute (50 per cent.) alcohol, and allowed to remain in that liquid until required for examination or further treatment.

Staining Vegetable Tissues.

It is found in practice that sections prepared for microscopical examination become much more intelligible, even to experienced workers, if they are suitably stained. By this is meant a process of differentiation of the tissue systems, based upon the employment of various dyestuffs. In many instances, too, the recognition of certain cell-contents is rendered more certain. Squire divides such colouring agents into nuclear, plasmatic, and specific stains. The first-named are of value in proportion as they exhibit a selective affinity for the substance of nuclei, whilst leaving the ground substance comparatively uncoloured. Such stains are, of course, only needed in dealing with fresh tissues, and there is little doubt that hæmatoxylin is the best for the purpose. There are many different formulas for its preparation, but it is both difficult and tedious to prepare satisfactorily by most of them.

Hæmatoxylin Stain.

The following formula for ammoniated hæmatoxylin (Squire) is free from the objections mentioned :—Hæmatoxy-

lin, 2 grammes, and ammonium carbonate, 4 decigrams, are placed in a large stoppered bottle with 60 per cent. alcohol, 40 mils, and the mixture is shaken at intervals for three days, the stopper being left out between the shakings. The solution is then exposed to the air in an open dish and allowed to evaporate to dryness, after which the crystalline residue is dissolved in the following mixture:—Absolute alcohol, 100 mils; glycerin, 100 mils; distilled water, 100 mils; ammonia alum, 2 grammes; and glacial acetic acid, 10 mils. The solution is ready to be diluted for use straightway, and does not deteriorate by keeping. Sections, when stained with it, are of a violet colour, but this may readily be changed to blue by washing in a dilute aqueous solution of sodium bicarbonate (1 in 1,000). As soon as the colour is satisfactory the sections, if not mounted immediately, should be transferred to 70 per cent. alcohol and protected from the light; for, if kept in water and exposed to light, the colour will fade. Over-staining may be remedied by the addition of one-tenth to one-half per cent. of strong hydrochloric acid to the alcohol, and subsequent washing with the sodium bicarbonate solution already mentioned.

Carmine Stain.

Carmine answers the same purpose as hæmatoxylin, and may be used as an alternative, but does not leave nuclei so sharply defined. A useful preparation of it is Grenacher's alcoholic borax-carmine, made by dissolving borax, 4 grammes, in distilled water, 100 mils, adding carmine, 3 grammes, and heating gently; 100 mils of 70 per cent. alcohol is then added, and the solution filtered if necessary before use. The sections, after staining, are transferred to 70 per cent alcohol, containing half to one per cent. of hydrochloric acid (sp. gr. 1·16).

Plasmatic and Specific Stains.

Plasmatic stains colour the tissue uniformly and are used to colour the ground for the sake of contrast, when nuclear and specific stains have been previously used. Alcohol must be removed from the sections by placing them for a minute in distilled water, after which they may be transferred to the plasmatic stain. To follow hæmatoxylin, this may be water-soluble eosine (1 gramme in 40 mils of 90 per cent. alcohol, and 160 mils of distilled water), erythrosine (same strength as eosine), or orange (2 grammes in 20 mils of 90 per cent. alcohol, and 80 mils of distilled water). After using carmine, picric acid (1 gramme in 100 mils of 70 per cent. alcohol) affords a suitable contrast. In each instance, afterwards wash with 90 per cent. alcohol. Specific stains, as their name implies, are used to distinguish certain elements only from the mass of tissue. Carmine, hæmatoxylin, and

most of the aniline dyes stain unaltered cellulose, whilst lignified tissue may be stained permanently with methyl green (25 centigrammes in 20 mils of 90 per cent. alcohol, and 80 mils of distilled water).

Double Staining.

The following is Squire's process for double staining stem and root sections containing cellulose and lignified tissue:—First rinse in distilled water, then place in methyl green solution for three or four minutes; again rinse in water, wash in 90 per cent. alcohol for five or ten minutes, place in Grenacher's alcoholic borax-carmine for fifteen or twenty minutes, rinse quickly in distilled water, and pass through 90 per cent. alcohol, after which dehydrate, clear, and mount in balsam. Chlor-zinc-iodine (Schulze's solution, prepared by evaporating 100 mils of the B.P. solution of zinc chloride to 70 mils, dissolving it in 10 grammes of potassium iodide, adding 1 decigramme of iodine, and shaking frequently until saturated) colours cellulose blue, and lignin yellow or yellowish-brown, the latter being also coloured red with phloroglucin (1 gramme in 20 mils of 90 per cent. alcohol and 30 mils of distilled water), followed by strong hydrochloric acid, and yellow with aniline chloride (2 grammes in 65 mils of 90 per cent. alcohol, 35 mils of distilled water, and 2 mils of strong hydrochloric acid). Hoffmann's blue and eosine are specially useful for distinguishing sieve areas. Particulars of other specific stains and their uses may be found in Poulsen's 'Botanical Micro-Chemistry' and Zimmermann's 'Botanical Microtechnique.'

Stains for Permanent Preparations.

For permanent preparations of fresh vegetable tissues hæmatoxylin will be found the most useful single stain, since by controlling its action it is quite possible to differentiate all the constituents with it, each one displaying a distinct shade of blue, marking it off clearly from the rest. The best results in double staining or in dealing with dark-coloured drug sections, etc., can only be obtained by first bleaching with solution of chlorinated soda, and then carefully removing all traces of the bleaching agent by washing several times in distilled water and finally with water containing 15 decimils of strong nitric acid to each litre) before applying the stains. In this case of course all cell-contents are of necessity destroyed, and removed during the process of washing.

Clearing and Mounting Sections.

When sections have been properly stained and it is desired to preserve selected specimens as permanent preparations, they must be mounted in some medium which will interfer

as little as possible with the structure of the tissues and the colours that have been imparted to them. At the same time, by being careful to make use of the most appropriate mounting medium in each particular instance, much aid may be rendered in studying the sections by the increased translucency afforded by this means. Preparations of glycerin or of resinous substances will be found in practice to meet all requirements, and it is often advisable to mount specimens of the same object in both.

Glycerin as a Mounting Agent.

Glycerin alone is very awkward to manipulate for permanent preparations, though for temporary examination of vegetable tissues, when somewhat diluted (two fluid parts to one of distilled water), it is a very satisfactory medium. If, however, it be desired to gain the fullest advantage from the use of glycerin, it must be used in a more concentrated form, either alone or with as little water as experience shows to be desirable with the particular class of objects in hand at any time. Each section, after being washed in distilled water to remove any alcohol, should be soaked in glycerin. A ring of Miller's caoutchouc cement is then made in the middle of a clean slide and allowed to dry. Next, place the section in position within the ring, cover it with a drop of glycerin, give another coating to the cement ring, and having gently breathed upon a clean cover-glass, invert it on the object in such a manner as to avoid introducing air-bubbles. The cover will soon be firmly held by the cement, and any superfluous glycerin may afterwards be washed off the slide by a gentle stream of water from a wash-bottle. Finally, carefully brush round the cover another ring of the cement, and, when this is properly set, the process may be repeated with any finishing varnish that may be desired. If the object is to be mounted in glycerin jelly, as much water as possible should be drained away after placing the section in position on the slide, and the jelly, just sufficient of which has been melted, should be dropped on the section, and a cover, previously breathed upon as before, placed over it. The slide is afterwards to be set aside until the jelly becomes firm, when the cover may be ringed with Bell's cement. Other convenient preparations of glycerin, which set at the edges of the cover and thus fix it to the slide, contain gum arabic as an ingredient. Hoyer's medium contains, in addition, (*a*) chloral hydrate or (*b*) potassium acetate, according as it is to be used with sections stained (*a*) with carmine or hæmatoxylin, or (*b*) with aniline colours.

Canada Balsam as a Mounting Agent.

Of resinous media, canada turpentine, or "balsam," is at once the type and the best to use. The raw material is not

very suitable, however, since it contains a large proportion of volatile oil, which presents it setting satisfactorily. It is, therefore, desirable to heat the turpentine gently on a water-bath until it is of such consistence that it becomes brittle when cold. By then dissolving in benzol, chloroform, xylol, or rectified oil of turpentine, in the proportion of about 100 grammes to 50 mils of solvent, it is rendered fit for use. If the menstruum be required to evaporate slowly, xylol, chloroform, or oil of turpentine should be employed; but for general purposes the benzol solution will be found preferable. Before these solutions can be applied to the sections, the latter must be dehydrated by means of methylated or absolute alcohol. When the former is employed, the sections must afterwards be "cleared" by immersion in oil of bergamot or oil of cloves before mounting. After dehydration by absolute alcohol, however, oil of cedar or xylol will act more satisfactorily. Oil of cloves is very generally used, but it is apt to dissolve out aniline colours and render objects very brittle if they are left in it very long.

Mounting Sections on Cover-glasses.

As a rule, it is best to leave sections in the clearing liquid just long enough to effect the desired purpose (entire removal of alcohol, indicated by the sections appearing perfectly translucent), then remove and mount straightway, by placing upon clean cover-glasses, covering with a drop of the benzene-balsam and immediately inverting upon a clean slide which has been slightly warmed to remove the film of surface moisture always present upon glass exposed to ordinary temperatures. If any air-bubbles appear, gentle warming and careful manipulation of the cover-glass with a mounted needle will generally remove them. Balsam-mounted objects require no ring of cement to retain the covers in position, but the application of a layer of caoutchouc cement is sometimes advantageous, while one or two coats of Bell's cement will prevent the cedar-wood oil used with immersion objectives from dissolving out the balsam at the edge of the covers. Further details of processes and full particulars regarding the various solutions, cements, etc., will be found in Lee's 'Microtomist's Vade Mecum' and Squire's 'Methods and Formulæ,' to both of which works references have already been made.

PHYSICAL CONSTANTS.

Miscellaneous Factors.

$\pi = 3{\cdot}14159.$

Area of triangle = Half area of rectangle on same base and of same vertical height.

Circumference of circle $= 2\pi \times$ radius.

Area of circle $= \pi \times$ square of radius.

Area of surface of sphere $= 4\pi \times$ square of radius.

Volume of sphere $= \frac{4}{3}\pi \times$ cube of radius.

Area of surface of cylinder $= 2\pi \times$ radius $\times$ (height + radius).

Volume of cylinder $= \pi \times$ height $\times$ square of radius.

$$\text{Volume of cone} = \frac{\pi \times \text{height} \times \text{square of radius of base}}{3}$$

$$\left.\begin{matrix}\text{Volume of} \\ \text{pyramid}\end{matrix}\right\} = \frac{\text{Volume of cube on same base and of same height}}{3}$$

One cubic foot of water weighs 1,000 oz. = 62·5 lb.

One cubic inch of water weighs 253·2 grains.

One gallon = 0·16 cubic foot 276·48 cubic inches.

One ton of water measures 224 gallons = 35·9 cubic feet.

Rainfall of 1 inch = 101·3 tons per acre.

Acceleration due to gravitation ("g") in Great Britain at sea level = 32·2 feet per second.

Length of pendulum beating seconds = 38·9 inches.

One poundal (unit of force) gives in one second a velocity of 1 foot per second to a mass of 1 lb.

One dyne (unit of force) gives in one second a velocity of 1 centimetre per second to a mass of 1 gramme.

One calorie (unit of heat) raises temperature of 1 gramme of water 1° C.

One horse-power = 550 foot-pounds per second.

Mechanical equivalent of heat: heat required to raise 1 lb. of water 1° F. = 778 foot-pounds; heat required to raise 1 gramme of water 1° C. = 424 gramme-metres.

One watt (electrical unit of power) = one ampere at E. M. F. of one volt.

$$= \frac{1 \times \text{Horse-power}}{746}$$

Relation of Hydrometer Degrees and Specific Gravity.

To convert degrees of Twaddell's hydrometer to specific gravity, multiply by 0·005, and add 1·000 to the result. To convert degree of Baumé's hydrometer to specific gravity; if

the liquid is heavier than water $\frac{144{\cdot}3}{144{\cdot}3 - B^\circ}$ = specific gravity.

To convert degrees of Balling's hydrometer to specific gravity;

if the liquid is lighter than water $\frac{200}{200 + B^\circ}$ = specific gravity,

if the liquid is heavier than water $\frac{200}{200 - B^\circ}$ = specific gravity.

Pressure of Aqueous Vapour in Millimetres of Mercury.

Temp.	Press.	Temp.	Press.
0° C.	4·6	20° C.	17·4
5°	6·5	22°	19·7
8°	8·0	24°	22·2
10°	9·2	26°	25·1
12°	10·5	28°	28·1
14°	11·9	30°	31·5
16°	13·5	32°	35·4
18°	15·4	34°	39·6

SCALE OF DOSES

At various ages compared with doses for adults.

Age.	Proportionate Doses.		
Adult	1 grain	1 fl. ounce	1 fl. drm,
Twelve years	½ grain	4 fl. drms.	30 minims
Four years	¼ grain	2 fl. drms.	15 minims.
Two years.....	⅛ grain	1 fl. drm.	7 minims.
One year.....	1/16 grain	¼ fl. drm.	3 minims.

POISONS AND ANTIDOTES.

The following notes on treatment in cases of poisoning are based on those by Mr. Edmund White, B.Sc. (Lond.), F.I.C., in the 'Pharmacopœia of St. Thomas's Hospital':—

GENERAL PRINCIPLES.

1. **Remove by lavage or emesis** any poison which remains in the stomach, or chemically neutralise it.

   For lavage, use a soft stomach-tube and warm water containing the appropriate chemical antidote, if such be available, in solution or suspension.

   For emetics, see list below.

   (**Caution!** Avoid lavage and emesis in poisoning by corrosive substances.)

2. **Administer the physiological antidote**, if one be known. See list below.

3. **Hasten elimination of the poison**.—Intravenous infusion of normal saline solution in poisoning with alkaloids. Aperients. (**Caution!** Avoid castor oil in phosphorus poisoning.)

4. **Treat other symptoms** as they arise:

   Collapse.—Hot bottles. **Caution!** Beware of burning an unconscious patient. Hot blankets. Strong coffee by mouth or rectum. Elevate foot of bed.

   Syncope.—Recumbency. Subcutaneous injections of ether or strychnine. Arom. sp. of ammonia in water, by the mouth. Faradism. Mustard papers to precordial region.

   Respiratory Failure.—Artificial respiration. Cold affusion. Tracheotomy, if there is laryngeal obstruction. Oxygen inhalation.

   Pain, if severe.—Morphine hypodermically.

5. **When poison has been eliminated**, as far as possible, give demulcents (see following list).

LIST OF ANTIDOTES.

The following articles are the most useful antidotes in cases of poisoning. The quantities given are for adults and for a single dose, which must be repeated, within the limits of safe dosage, according to the severity of the symptoms and the quantity of poison ingested.

EMETICS.

1. **Apomorphine Hydrochloride**, $\frac{1}{10}$ gr. for hypodermic injection.
2. **Powd. Ipecac.** (*not* Pulv. Ipecac. *Co.*), 30 gr. in water.
3. **Liquid Extract of Ipecac.**, 20 minims in water.

EMETICS *(continued)*.

4. **Mustard,** one tablespoonful in 8 oz. water.
5. **Common Salt,** one tablespoonful in warm water.
6. **Zinc Sulphate,** 30 grains in 8 oz. warm water.

If there is delay in obtaining emetics tickling the fauces may be resorted to.

DEMULCENTS.

7. **Milk.**
8. **Olive Oil,**
9. **Thick Gruel** (fine oatmeal, 1 oz., mixed and boiled with 10 oz. of water).
10. **White of Egg.**

STIMULANTS.

11. **Brandy,** ½ oz. in 2 oz. water.
12. **Strychnine Hydrochloride,** $\frac{1}{60}$ gr. for hypodermic injection.
13. **Ether,** 30-60 minims, for hypodermic injection.
14. **Arom. Spt. of Ammonia,** 60 minims in water.
15. **Smelling bottle,** for ammonia inhalation.
16. **Coffee,** 2 oz. to be boiled with ½ pint water.
17. **Mustard Papers,** to be moistened with tepid water.

CHEMICAL ANTIDOTES.

18. **Chalk, Whiting,** or **Wall Plaster,** ½ oz. stirred up in water.
19. **Sodium** or **Potassium Bicarbonate,** 120 gr. in water (only used for acids in absence of magnesia and chalk, on account of the rapid evolution of gas).
20. **Magnesia,** ½ oz. stirred up in water.
21. **Saccharated Solution of Lime,** 1-2 fl. drm. in water.
22. **Citric** or **Tartaric Acid,** 20 gr. in water.
23. **Vinegar** or **Lemon Juice,** 1 oz. diluted with water.
24. **Magnesium** or **Sodium Sulphate,** ½ oz. in 8 oz. of water.
25. **Hydrated Ferric Oxide,** produced when required by adding to ½ oz. Sol. of Ferric Chloride in 8 oz. of water, ¼ oz. Magnesia or 2 fl. drm. Sol. of Ammonia (*not* Liq. Ammon. Fort.).
26. **Copper Sulphate,** 2½ grains in 2 or 3 oz. of water.
27. **French Turpentine** or **Sanitas,** 30 minims in 1 oz. of water, repeated about four times in the first hour.
28. **Potassium Permanganate,** 5 grains in ½ pint of water.
29. **Tannic Acid,** 20 grains in water; or strong (overdrawn) Tea.

PHYSIOLOGICAL ANTIDOTES.

30. **Amyl Nitrite** Capsules, 3 minims, for inhalation.
31. **Atropine Sulphate,** $\frac{1}{60}$ grain for hypodermic injection.

PHYSIOLOGICAL ANTIDOTES *(continued).*

32. **Chloral Hydrate,** 40 grains in 3 oz. of water, by rectum or mouth.
33. **Chloroform,** for inhalation.
34. **Digitalis Tincture,** 20 minims for hypodermic injection.
35. **Morphine Tartrate,** $\frac{1}{3}$ grain for hypodermic injection.
36. **Pilocarpine Nitrate,** $\frac{1}{4}$ grain for hypodermic injection.
37. **Potassium Bromide,** 30-60 grains in water, by the mouth.

NORMAL SALINE Solution.

38. **Common Salt,** 83$\frac{1}{3}$ gr. in one pint of sterilised water at body temperature.

TREATMENT IN SPECIAL CASES.

The various poisons are arranged in groups, alphabetically, under the name of the active principle or typical member of each group. Apply in all cases the general principles of treatment, modified or supplemented as described under each group. The numbers refer to the numerical arrrangement of the substances in the list of antidotes.

ACIDS, MINERAL. Hydrochloric. Nitric. Sulphuric. Spirit of Salt. Muriatic. Aqua Fortis. Acetic. Butter of Antimony. Soldering Fluid. Battery Fluids.	**Caution ! Lavage** or **Emesis** inadmissible. **Chemical Antidotes,** 20, 18, 19, 21. **Demulcents,** 7, 10, 9.
ACID, OXALIC. Salt of Sorrel. Salt of Lemon.	**Caution : Lavage** or **Emesis** only if case is treated soon after ingestion of poison, and then cautiously. **Chemical Antidotes,** 18, 21 ; *not* 19 or 20.
ACID, CARBOLIC. Creosote. Disinfecting Fluids.	**Lavage,** with care. Wash out with 24. **Demulcents,** 8, 7. **Stimulants,** freely. **Intravenous** or **rectal injection of saline solution.**

ACID, HYDROCYANIC. Cyanides. Bitter Almond Oil.	**General Principles,** particularly treatment for respiratory failure. **Stimulants,** 13, 14, 15, 11.
ACONITE. Monkshood. Aconitine.	**General Principles,** especially treatment for respiratory failure. **Stimulants,** 12, 11. **Saline infusion.**
ALCOHOL.	**General Principles,** especially Cold Affusion, Faradism, and Artificial Respiration.
ALKALIES. Potash. Soda. Ammonia. Hartshorn. Weed-killer.	**Caution! Lavage** or **Emesis** inadmissible. **Chemical Antidotes,** 22, 23. **Demulcents,** 8, 7, 10. **Stimulants.**
ANTIMONY SALTS. Tartar Emetic. Butter of Antimony.	**General Principles,** especially stimulants and treatment for collapse. Caution! Avoid Lavage after Butter of Antimony (see Acids). Emesis generally occurs from action of poison — give copious draughts of warm water. **Chemical Antidote,** 29. **Demulcents,** 7, 10.
ARSENIC COMPOUNDS. White Arsenic. Weed Killers. Some Vermin Killers. Sheep Dips. Some Fly Papers.	**General Principles,** unless in poisoning by strongly alkaline weed-killers, when Lavage must be applied cautiously or not at all. **Chemical Antidote,** 25. **Demulcents.**
ATROPINE. Nightshade. Belladonna. Stramonium Hyoscyamus.	**General Principles,** especially treatment for respiratory failure. **Chemical Antidote,** 29. **Physiological Antidote,** 36.
BARIUM SALTS.	**General Principles.** **Chemical Antidote,** 24.
CAMPHOR. Camphorated Oil. (Lin. Camph. B.P.)	**General Principles.**

CANTHARIDES.	**General Principles.** Caution! Proceed carefully if mouth or œsophagus be blistered. **Demulcents.**
CHLOROFORM.	**General Principles,** especially fresh air, stimulation, and artificial respiration. **Physiological Antidote,** 30.
COCAINE.	**General Principles,** with stimulants, 14, 15, 12. **Physiological Antidote,** 30.
COPPER. Blue Vitriol. Verdigris.	**General Principles.** **Chemical Antidote,** 19 (or Potassium Ferrocyanide, 10 gr. in 2 oz. of water). **Demulcent,** 7, copiously.
DIGITALIS. (Foxglove.)	**General Principles.** **Chemical Antidote,** 29.
GASES. Carbon Monoxide. Carbon Dioxide. Coal Gas. Sewer Gas. Acetylene. Chlorine. Nitrous Fumes.	**General Principles,** particularly artificial respiration and oxygen inhalation.
HYPNOTICS. Chloral Hydrate. Chloralamide. Sulphonal. Paraldehyde.	**General Principles.** **Stimulants,** particularly 12.
IODINE.	**General Principles.** **Chemical Antidote,** 21. **Demulcents,** copiously.
IRRITANTS, VEGETABLE. Unidentified Plants. Violent Purgatives. Nicotine. Tobacco. Savin. Squill.	**General Principles.** **Demulcent,** 7, freely by stomach tube.

LEAD SALTS.	**General Principles.** **Chemical Antidote,** 24.
MERCURY SALTS. White Precipitate. Red Precipitate.	**General Principles.** **Demulcents,** 10 and 7, freely
MINERAL OILS. Benzoline. Paraffin. Petroleum.	**General Principles.** **Demulcents,** 8 freely, followed by free **lavage** with milk.
MORPHINE. Opium. Codeine. Syrup of Poppy. Soothing Syrups. Chlorodyne. Laudanum. Paregoric.	**General Principles.** **Chemical Antidote,** 28, freely washing out after use. **Physiological Antidote,** 31. **Stimulants** freely, but do not overdo rousing, forced movements and exposure.
PHOSPHORUS. Rat Pastes.	**General Principles.** **Chemical Antidotes,** 26, 27. **Demulcents.** Caution! Avoid oil.
PTOMAINES. Stale Food. Canned Food.	**General Principles,** especially treatment for collapse. **Chemical Antidote,** 29.
SILVER SALTS.	**General Principles.** **Chemical Antidote,** 5.
STRYCHNINE. Vermin Killer.	**General Principles. Chloroform** by inhalation, **Emesis** by Apomorphine, or **Lavage** as soon as patient is under influence of Chloroform. **Chemical Antidote,** 29. **Physiological Antidote,** 37, or 32.
TURPENTINE. Polishing Fluids or Pastes.	**General Principles; Lavage with** milk.
ZINC SALTS. White Vitriol. Burnett's Fluid. Soldering Fluid.	**Caution! Lavage** and **Emesis** inadmissible except in poisoning with neutral zinc salts. **Chemical Antidote,** 19. **Demulcents,** 7, copiously.

ROYAL PHOTOGRAPHIC SOCIETY'S STANDARDS.*

The series of standards adopted by the Society in 1881, and modified in 1891, have been carefully reconsidered by a committee of experts appointed by the Council. Their recommendations, which are embodied below, have been adopted by the Council of the Society.

Lens Diaphragms.

(1) That intensity ratio be defined as dependent upon the *effective aperture* (and not upon the diameter of the diaphragm) in relation to the focal length of the lens.

(2) That effective aperture be determined in the following manner:—The lens shall be focussed for parallel rays. An opaque screen shall be placed in the principal focal plane, the plate being provided in its centre (in the axis of the lens) with a pinhole. An illuminant shall be placed immediately behind the pin-hole, and the diameter of the beam of light emerging from the front surface of the lens shall be the measure of the effective aperture.

NOTE.—It will be found, except when the diaphragm is situated in front of the lens, that the diameter of the diaphragm itself is seldom identical with the effective aperture.

(3) That every diaphragm be marked with its true intensity ratio, as above defined, in the following order of sequence:—

*f*1·4 .. *f*/2 *f*/2·8 .. *f*/4 *f*/5·6 .. *f*/8 *f*/11·3 .. *f*/16 *f*/22·6
f/32 *f*/45·2 .. *f*/64, etc.

each diaphragm requiring double the exposure required by the preceding diaphragm.

Should the greatest effective aperture of a lens not conform exactly to one of the intensities set forth above, this aperture should be marked in accordance with the definition of effective aperture, but all succeeding smaller apertures should be marked in uniformity with the intensities recommended in the above sequence.

Lens Mounts and Fittings.

(1) That the equivalent focal length of a lens be engraved upon its mount.

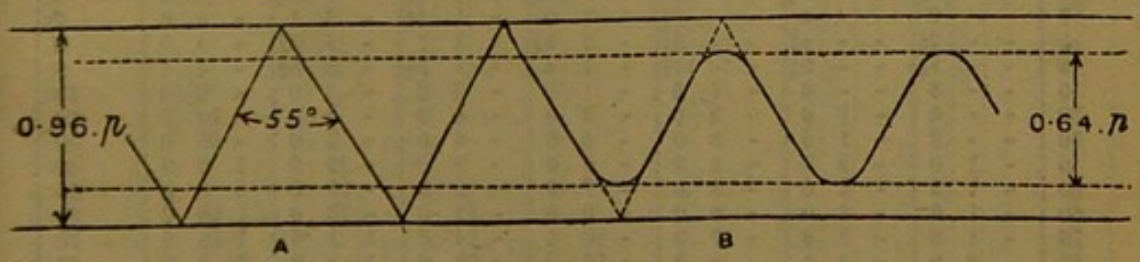
* From *The Photographic Dealers' Annual.*

(2) That the following series of screws for photographic lens flange fittings be adopted, it being understood that, in order to secure free interchangeability, every male screw should be made at least as small as these sizes and every female screw at least as large :—

Diameter in Inches.	No. of Threads per inch.	Core Diameters in inches.
1	24	0·9466
1·25	24	1·1966
1·5	24	1·4466
1·75	24	1·6966
2	24	1·9466
2·25	24	2·1966
2·5	24	2·4466
3	24	2·9466
3·5	12	3·3933
4	12	3·8933
5	12	4·8933
And upwards advancing by inches.	12	

* For screws less than one inch in diameter, the Royal Microscopical Society's standard screw should be adopted.

The form of thread is that known as Whitworth's Angular Thread, and is designed as follows:—



Two parallel lines, at a distance apart equal to 0·96 of the screw pitch, are intersected by lines inclined to each other at 55°, as shown in the figure at A. One-sixth of the vertical height of the triangular spaces so obtained is rounded off both at the top and bottom, leaving the form of the screw thread as at B. The depth of this thread is 0·64 of the screw pitch. It should be understood that this is the theoretical form of the Whitworth thread, but that for the purpose of securing real interchangeability it is generally found necessary to use chasers or other threading tools which have additional

prominence upon their points which come first into operation and are subject to most wear. For this purpose an addition may be made to the amount of one-tenth ($\frac{1}{10}$) of the theoretical depth of thread or to any less amount that may be sufficient.

(3) That every flange and adapter have a mark upon its front to indicate the position of the diaphragm slot or index of any lens when screwed home. The mark on any adapter should coincide with the mark upon any flange into which it is screwed. This mark should be placed at the point at which the thread becomes complete at the shoulder of the flange or adapter

Camera Screws.

That all screws fitted to cameras either for attachment to the stand, for fixing rising fronts, or other movable parts, be either $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, or $\frac{3}{8}$ of an inch in external diameter, and in pitch of thread and other details in accordance with the generally recognised Whitworth standards for these sizes.

USEFUL TABLES FOR PHARMACISTS.

COMMISSION TABLE.

Amount.	At ¼ per cent.	At ½ per cent.	At ¾ per cent.	At ⅞ per cent.	At 1 per cent.	At 1½ per cent.	At 2½ per cent.	Amount.
£	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£
1	- - 0¼	- - 0½	- - 1	- - 1¾	- - 2½	- - 3¾	- - 6	1
2	- - 0½	- - 1	- - 2¼	- - 3½	- - 4½	- - 7	- 1 0	2
3	- - 0¾	- - 1½	- - 3¾	- - 5¼	- - 7	- - 10½	- 1 6	3
4	- - 1	- - 2¼	- - 4½	- - 7	- - 9¼	- 1 2½	- 2 0	4
5	- - 1¼	- - 3	- - 6	- - 9	- 1 0	- 1 6	- 2 6	5
6	- - 1½	- - 3¾	- - 7½	- - 10½	- 1 2½	- 1 9¾	- 3 0	6
7	- - 2	- - 4	- - 8¼	- 1 0¼	- 1 4½	- 2 1	- 3 6	7
8	- - 2¼	- - 4½	- - 9¼	- 1 2¼	- 1 7	- 2 4½	- 4 0	8
9	- - 2¼	- - 5¼	- - 10½	- 1 4	- 1 9¼	- 2 8¼	- 4 6	9
10	- - 3	- - 6	- 1 0	- 1 6	- 2 0	- 3 0	- 5 0	10
20	- - 6	- 1 0	- 2 0	- 3 0	- 4 0	- 6 0	- 10 0	20
30	- - 9	- 1 6	- 3 0	- 4 6	- 6 0	- 9 0	- 15 0	30
40	- 1 0	- 2 0	- 4 0	- 6 0	- 8 0	- 12 0	1 0 0	40
50	- 1 3	- 2 6	- 5 0	- 7 6	- 10 0	- 15 0	1 5 0	50
60	- 1 6	- 3 0	- 6 0	- 9 0	- 12 0	- 18 0	1 10 0	60
70	- 1 9	- 3 6	- 7 0	- 10 6	- 14 0	1 1 0	1 15 0	70
80	- 2 0	- 4 0	- 8 0	- 12 0	- 16 0	1 4 0	2 0 0	80
90	- 2 3	- 4 6	- 9 0	- 13 6	- 18 0	1 7 0	2 5 0	90
100	- 2 6	- 5 0	- 10 0	- 15 0	1 0 0	1 10 0	2 10 0	100
200	- 5 0	- 10 0	1 0 0	1 10 0	2 0 0	3 0 0	5 0 0	200
300	- 7 6	- 15 0	1 10 0	2 5 0	3 0 0	4 10 0	7 10 0	300
400	- 10 0	1 0 0	2 0 0	3 0 0	4 0 0	6 0 0	10 0 0	400
500	- 12 6	1 5 0	2 10 0	3 15 0	5 0 0	7 10 0	12 10 0	500
600	- 15 0	1 10 0	3 0 0	4 10 0	6 0 0	9 0 0	15 0 0	600
700	- 17 6	1 15 0	3 10 0	5 5 0	7 0 0	10 10 0	17 10 0	700
800	1 0 0	2 0 0	4 0 0	6 0 0	8 0 0	12 0 0	20 0 0	800
900	1 2 6	2 5 0	4 10 0	6 15 0	9 0 0	13 10 0	22 10 0	900
1,000	1 5 0	2 10 0	5 0 0	7 10 0	10 0 0	15 0 0	25 0 0	1,000
2,000	2 10 0	5 0 0	10 0 0	15 0 0	20 0 0	30 0 0	50 0 0	2,000
3,000	3 15 0	7 10 0	15 0 0	22 10 0	30 0 0	45 0 0	75 0 0	3,000
4,000	5 0 0	10 0 0	20 0 0	30 0 0	40 0 0	60 0 0	100 0 0	4,000
5,000	6 5 0	12 10 0	25 0 0	37 10 0	50 0 0	75 0 0	125 0 0	5,000
10,000	12 10 0	25 0 0	50 0 0	75 0 0	100 0 0	150 0 0	250 0 0	10,000

TABLE OF INCOME OR WAGES.

Per Year.	Per Month (Cal.).	Per Week.	Per Day.	Per Year.	Per Month (Cal.).	Per Week.	Per Day
£ s.	£ s. d.	£ s. d.	£ s. d.	£ s.	£ s. d.	£ s. d.	£ s. d.
- 10	- - 10	- - 2½	- - 0½	13 0	1 1 8	- 5 0	- - 8½
1 0	- 1 8	- - 4⅓	- - 0¾	13 13	1 2 9	- 5 3	- - 9
1 10	- 2 6	- - 7	- - 1	14 0	1 3 4	- 5 4½	- - 9¼
2 0	- 3 4	- - 9½	- - 1¼	14 14	1 4 6	- 5 7¼	- - 9¾
2 2	- 3 6	- - 9¾	- - 1⅓	15 0	1 5 0	- 5 9½	- - 9¾
2 10	- 4 2	- - 11½	- - 1½	15 15	1 6 3	- 6 0¾	- - 10¼
3 0	- 5 0	- 1 1½	- - 2	16 0	1 6 8	- 6 1½	- - 10⅓
3 3	- 5 3	- 1 2⅓	- - 2	16 16	1 8 0	- 6 5½	- - 11
3 10	- 5 10	- 1 4½	- - 2¼	17 0	1 8 4	- 6 6⅝	- - 11¼
4 0	- 6 8	- 1 6⅓	- - 2¾	17 17	1 9 9	- 6 10¼	- - 11¾
4 4	- 7 0	- 1 7⅝	- - 2¾	18 0	1 10 0	- 6 11	- - 11¾
4 10	- 7 6	- 1 8¼	- - 3	18 18	1 11 6	- 7 3½	- 1 0½
5 0	- 8 4	- 1 11	- - 3¼	19 0	1 11 8	- 7 3¾	- 1 0½
5 5	- 8 9	- 2 0½	- - 3¼	20 0	1 13 4	- 7 8⅓	- 1 1¼
5 10	- 9 2	- 2 1⅓	- - 3½	30 0	2 10 0	- 11 6½	- 1 7¾
6 0	- 10 0	- 2 3⅓	- - 4	40 0	3 6 8	- 15 4⅓	- 2 2¼
6 6	- 10 6	- 2 5	- - 4¼	50 0	4 3 4	- 19 2¾	- 2 9
6 10	- 10 10	- 2 6	- - 4½	60 0	5 0 0	1 3 1	- 3 3½
7 0	- 11 8	- 2 8½	- - 4⅔	70 0	5 16 8	1 6 11	- 3 10
7 7	- 12 3	- 2 10	- - 4¾	80 0	6 13 4	1 10 9½	- 4 4⅓
7 10	- 12 6	- 2 10½	- - 5	90 0	7 10 0	1 14 7¾	- 4 11¼
8 0	- 13 4	- 3 1	- - 5¼	100 0	8 6 8	1 18 5⅝	- 5 5¾
8 8	- 14 0	- 3 2¾	- - 5⅓	200 0	16 13 4	3 16 11	- 10 11⅓
8 10	- 14 2	- 3 3⅓	- - 5⅓	300 0	25 0 0	5 15 4⅓	- 16 5¼
9 0	- 15 0	- 3 5⅓	- - 6	400 0	33 6 8	7 13 10¼	1 1 11
9 9	- 15 9	- 3 7⅝	- - 6¼	500 0	41 13 4	9 12 3⅓	1 7 4⅓
10 0	- 16 8	- 3 10½	- - 6⅓	600 0	50 0 0	11 10 9⅓	1 12 10⅓
10 10	- 17 6	- 4 0¼	- - 7	700 0	58 6 8	13 9 2¾	1 18 4⅓
11 0	- 18 4	- 4 3⅓	- - 7¼	800 0	66 13 4	15 7 8⅓	2 3 10
11 11	- 19 3	- 4 5⅓	- - 7⅓	900 0	75 0 0	17 6 1⅔	2 9 3⅓
12 0	1 0 0	- 4 7⅓	- - 8	1000 0	83 6 8	19 4 7⅓	2 14 9⅓
12 12	1 1 0	- 4 10¼	- - 8¼				

TABLE OF DISCOUNTS.

Amnt.	At 1½ per cent.	At 2 per cent.	At 2½ per cent.	At 3 per cent.	At 3½ per cent.	At 4 per cent.	At 4½ per cent.	At 5 per cent.
£	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1	- - 3½	- - 4⅔	- - 6	- - 7¼	- - 8½	- - 9½	- - 10¾	- 1 0
2	- - 7	- - 9½	- 1 0	- 1 2½	- 1 4⅔	- 1 7	- 1 9½	- 2 0
3	- - 10½	- 1 2½	- 1 6	- 1 9½	- 2 1	- 2 4⅔	- 2 8¼	- 3 0
4	- 1 2½	- 1 7	- 2 0	- 2 4⅔	- 2 9½	- 3 2½	- 3 7	- 4 0
5	- 1 6	- 2 0	- 2 6	- 3 0	- 3 6	- 4 0	- 4 6	- 5 0
6	- 1 9½	- 2 4⅔	- 3 0	- 3 7	- 4 2½	- 4 9½	- 5 4⅔	- 6 0
7	- 2 1	- 2 9½	- 3 6	- 4 2½	- 4 10¾	- 5 7	- 6 3½	- 7 0
8	- 2 4⅔	- 3 2½	- 4 0	- 4 9½	- 5 7	- 6 4⅔	- 7 2½	- 8 0
9	- 2 8¼	- 3 7	- 4 6	- 5 4⅔	- 6 3½	- 7 2½	- 8 1	- 9 0
10	- 3 0	- 4 0	- 5 0	- 6 0	- 7 0	- 8 0	- 9 0	- 10 0
20	- 6 0	- 8 0	- 10 0	- 12 0	- 14 0	- 16 0	- 18 0	1 0 0
30	- 9 0	- 12 0	- 15 0	- 18 0	1 1 0	1 4 0	1 7 0	1 10 0
40	- 12 0	- 16 0	1 0 0	1 4 0	1 8 0	1 12 0	1 16 0	2 0 0
50	- 15 0	1 0 0	1 5 0	1 10 0	1 15 0	2 0 0	2 5 0	2 10 0
60	- 18 0	1 4 0	1 10 0	1 16 0	2 2 0	2 8 0	2 14 0	3 0 0
70	1 1 0	1 8 0	1 15 0	2 2 0	2 9 0	2 16 0	3 3 0	3 10 0
80	1 4 0	1 12 0	2 0 0	2 8 0	2 16 0	3 4 0	3 12 0	4 0 0
90	1 7 0	1 16 0	2 5 0	2 14 0	3 3 0	3 12 0	4 1 0	4 10 0
100	1 10 0	2 0 0	2 10 0	3 0 0	3 10 0	4 0 0	4 10 0	5 0 0

PERCENTAGE TABLE.

Per cent.	In the £.	Per cent.	In the £.	Per cent.	In the £.
	s. d.		s. d.		s. d.
7	1 6	15	3 0	22½	4 6
10	2 0	17½	3 6	25	5 0
12½	2 6	20	4 0		

10 per cent., followed by 5 per cent. off the remaining sum, amounts to 2*s.* 10½*d.* in the £, to 14*s.* 6*d.* in £5, and to £1 9*s* in £10.

INFORMATION FOR NURSES AND DISPENSERS.

From the 'Pharmacopœia of St. Thomas's Hospital.'

INVALIDS' DIETARY.

FEVER DIET.

1. Milk, 4 pints per day, with Beef Tea, Barley Water, etc.
2. The same as 1, with addition of Bread, Butter, and Milk Pudding.

FISH DIET.

Breakfast.—Tea or Cocoa with Sugar and Milk; Bread and Butter.
Lunch.—Bread and Milk.
Dinner.—Fish, Vegetables, Pudding, and Milk.
Tea.—Tea or Cocoa with Sugar and Milk; Bread and Butter.
Supper.—Milk, Bread and Butter.

FULL DIET.

Breakfast.—Tea or Cocoa with Sugar and Milk; Bread and Butter.
Lunch.—Bread and Milk.
Dinner.—Meat (see Note 3), Vegetables; Milk, Batter, or Suet Pudding.
Tea.—Tea or Cocoa with Sugar and Milk; Bread and Butter.
Supper.—Milk, Bread and Butter.

FANCY DIET.

Same as Full Diet, with either Fish, Fowl, or Meat for Dinner as desired by Patient; and other extras as required.

Note 1.—In all diets, except Fever Diets, Bread is supplied *ad libitum*, and 1 oz. of Butter is allowed per patient.

Note 2.—Milk Puddings are made with Bread, Rice, Tapioca, Corn Flour, Vermicelli, or some such material.

Note 3.—Beef and Mutton are given in rotation. The Mutton is alternately roast and boiled. Cold Meat on Sundays.

Note 4.—Extras. Articles of diet, other than those mentioned above, such as Beef Juice, Soups, Fruit, Jellies, etc., are supplied when ordered on diet sheet.

Note 5.—Children. For children the above diets are modified according to age.

Note 6.—Wines, Spirits, and other stimulants, and Aërated Waters, are supplied when specially ordered, such orders being renewed at least bi-weekly.

INFANT FEEDING.

Table showing the intervals of feeding and quantities of suitably modified milk required by an infant from the age of one week to six months.

Age.	Intervals of Feeding.	Number in Twenty-four Hours.	Average Amount of Each Feed.	Amount in Twenty-four Hours.
One week.....	2 hrs.	10	1 oz.	10 oz.
One month	2½ hrs.	8	1½—2 oz.	12—16 oz.
Two months	2½ hrs.	8	3—4 oz.	24—32 oz.
Three and four months..	3 hrs.	7	4—5 oz.	28—35 oz.
Five and six months	3 hrs.	6	6—7 oz.	36—42 oz.

The child should not be fed between 11 p.m. and 5 a.m. as a rule.

PREPARATION OF BEEF TEA.

Finely chop, mince, or pound 1 lb. of lean beef with 1 teaspoonful of salt; add 1 pint of cold water, thoroughly mix and set aside for ten minutes. Place the mixture in a pot surrounded by water in a saucepan and gradually raise the temperature of the water to boiling point, stirring and squeezing the meat and liquor in the pot. When the odour of raw meat is no longer perceptible and the liquor has become brown, vigorously stir the mixture and quickly decant the liquor with the suspended flocks of coagulated proteid, retaining the tough lumps of meat-fibre by means of a fork or coarse strainer. The fat may be separated by allowing the beef tea to cool and skimming the surface. When serving, the bulk should be well stirred so as to evenly distribute the nutritious flocks.

PREPARATION OF BEEF JUICE.

Thinly slice lean beef and place in a meat-press. Apply pressure gradually and collect the expressed juice, waiting until it ceases to flow and increasing the pressure when necessary. This juice will contain about 8 per cent. of coagulable proteid. If a meat-press is not available, the meat may be minced, sprinkled with salt, and an equal weight of cold water added. After standing a few minutes the liquor may be strongly expressed by the hands through stout muslin or cream cloth previously wrung out in cold water. The juice thus obtained is not so strong as that yielded by the first method. The residue from either process may be employed in making gravy or soup; or may be added to the bulk used in making beef tea, as it still contains much nutriment extractable by further treatment with water. Beef juice must be freshly prepared.

SCHEDULE OF POISONS.

The following poisons may not be sold by retail in Great Britain, after April 1, 1909, except by persons who are duly registered under the Pharmacy Acts:—

PART I.

Aconite, Aconitine, and their preparations.

Alkaloids.—All poisonous vegetable alkaloids not specifically named in this schedule and their salts, and all poisonous derivatives of vegetable alkaloids.

*Arsenic, and its medicinal preparations.

Atropine and its salta, and their preparations.

Belladonna, and all preparations and admixtures [except belladonna plaisters] containing 0·1 or more per cent. of belladonna alkaloids.

Cantharides, and its poisonous derivatives.

Coca, any preparation or admixture of, containing 1 or more per cent. of coca alkaloids.

Corrosive Sublimate.

Cyanide of Potassium, and all poisonous cyanides and their preparations.

Emetic Tartar, and all preparations or admixtures containing 1 or more per cent. of emetic tartar.

Ergot of Rye, and preparations of ergots.

Nux Vomica, and all preparations or admixture containing 0·2 or more per cent. of strychnine.

Opium, and all preparations or admixtures containing 1 or more per cent. of morphine.

Picrotoxin.

Prussic Acid, and all preparations or admixtures containing 0·1 or more per cent. of prussic acid.

Savin, and its oil, and all preparations or admixtures containing savin or its oil.

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* NOTE.—The Arsenic Act makes it an offence to sell arsenic or poisonous preparations thereof unless mixed with soot or indigo, or sold in quantities of not less than ten pounds for special purposes. The person to whom the arsenic, or preparation thereof, is sold, must be of mature age, his occupation (as well as name and address) must be entered in the Poison Book, and his introducer (if any) shall also enter his name and address in the Poison Book.

PART II.

* All preparations or admixtures which are not included in Part I. of this schedule, and contain a poison within the meaning of the Pharmacy Acts, except preparations or admixtures the exclusion of which from this schedule is indicated by the words therein relating to carbolic acid, chloroform, and coca, and except such substances as come within the provisions of Section 5 of this Act.

Almonds, Essential Oil of (unless deprived of prussic acid).

Antimonial Wine.

Cantharides, tincture and all vesicating liquid preparations or admixtures of.

Carbolic Acid, and liquid preparations of carbolic acid and its homologues containing more than 3 per cent. of those substances, except preparations for use as sheep wash, or for any other purpose in connection with agriculture or horticulture, contained in a closed vessel distinctly labelled with the word "poisonous," the name and address of the seller, and a notice the special purposes for which the preparations are intended.

Chloral Hydrate.

Chloroform, and all preparations or admixtures containing more than 20 per cent. of chloroform.

Coca, any preparations or admixtures of, containing more than 0·1 per cent. but less than 1 per cent. of coca alkaloids.

Digitalis.

Mercuric Iodide.

Mercuric Sulphocyanide.

Oxalic Acid.

Poppies, all preparations of, excepting red poppy petals and syrup of red poppies (*Papaver rhœas*).

Precipitate, Red (and all oxides of mercury).

Precipitate, White.

Strophanthus.

Sulphonal.

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* NOTE.—This paragraph includes preparations or admixtures of all vegetable drugs containing poisonous alkaloids, *e.g.*, Calabar Bean, Colchicum, Conium, Gelsemium, Hyoscyamus, Lobelia, Stavesacre, Stramonium, etc.

Conditions of Sale.

The Pharmacy Act, 1868, makes it illegal to sell any poison either by wholesale or retail unless the box, bottle, vessel, wrapper, or cover in which such poison is contained be distinctly labelled (1) with the name of the article, (2) with the word "Poison," (3) with the name and address of the seller. It is also illegal to sell any article in Part I. of the Poisons Schedule to any person unknown to the seller, unless introduced by a person known to both parties. Further, it is illegal to sell any article in Part I. without entering, or causing to be entered, in the Poison Book before sale (1) the date of sale, (2) name and address of purchaser, (3) name and quantity of article, and (4) purposes for which it is wanted. The entries must be attested by the signature of the purchaser and of his introducer, if any.

Poison Regulations.

In addition to the foregoing conditions of sale, the following regulations for the keeping, dispensing and selling of poisons have been prescribed by the Pharmaceutical Society, with the consent of the Privy Council, in pursuance of Sections 1 and 15 of the Pharmacy Act, 1868.

1. That in the keeping of poisons, each bottle, vessel, box, or package, containing a poison be labelled with the name of the article, and also with some distinctive mark indicating that it contains poison.

2. Also that in the keeping of poisons, each poison be kept on one or other of the following systems, viz.:—

(*a*) In a bottle or vessel tied over, capped, locked, or otherwise secured in a manner different from that in which bottles or vessels containing ordinary articles are secured in the same warehouse, shop, or dispensary; or

(*b*) In a bottle or vessel rendered distinguishable by touch from the bottles or vessels in which ordinary articles are kept in the same warehouse, shop, or dispensary; or

(*c*) In a bottle, vessel, box, or package kept in a room or cupboard set apart for dangerous articles.

3. That in the dispensing and selling of poisons all liniments, embrocations, lotions, and liquid disinfectants containing poison be sent out in bottles rendered distinguishable by touch from ordinary medicine bottles, and that there also be affixed to each such bottle (in addition to the name of the article, and to any particular instructions for its use) a label giving notice that the contents of the bottle are not to be taken internally.

Other Poisonous Substances.

It is illegal to sell Hydrochloric, Nitric, and Sulphuric Acids, and Soluble Salts of Oxalic Acid, unless the box, bottle, vessel, wrapper, or cover in which the substance is contained is distinctly labelled with the name of the substance and the word "Poisonous," and with the name and address of the seller of the substance. In addition, the Pharmaceutical Society strongly recommends all Pharmacists to adopt special precautions when dealing with the following articles, with a view to the prevention of cases of accidental poisoning:—Acetanilide, Amyl Nitrite, Antipyrine (Phenazone), Butyl-Chloral Hydrate, Cannabis Indica and its preparations, Elaterium, Phenacetin, and Vermin Killers containing free Phosphorus. The sale of such dangerous articles as Adrenine, Lead Plaster and Salts, Phosphorus and preparations containing it in the free state, Poisonous Glucosides and preparations containing such, Potassium Bichromate, Strong Solution of Ammonia, Synthetic Cocaine - Substitutes, Hypnotics (including Veronal), Zinc Salts, also demands special precauti

BATH'S PROFIT ASSESSMENT TABLES.

Percentages of Profit.

The following examples show how the important questions of profits and percentages upon cost and sales can be effectually dealt with. The cost and profit figures may be taken as either pounds, shillings, pence or farthings.

1. To find the percentage of profit on cost—
   Say the cost is 8 and the profit 4.
   $4 \times 100 = 400 \div 8 = 50$ per cent.

2. To find the percentage of profit on sales—
   Taking the same figures for cost and profit.
   $4 \times 100 = 400 \div 12\ (4 + 8) = 33$ per cent.

3. To find what amount to add to cost to realise a certain rate per cent. upon the cost—
   Say the cost is 6 and the rate required 25 per cent.
   $6 \times 25 = 150 \div 100 = 1{\cdot}5$
   which may be £1 10s., 1s. 6d., or 1½d.

4. To find what amount to add to cost to produce a certain rate per cent. upon sales—
   Say the cost is 6 and the rate 25.
   $6 \times 25 = 150 \div 75\ (100 - 25) = 2$.

Percentages on Cost and Sales.

One-half ..	.. 50	per cent,	on cost,	and 33·33	per cent.	on sales
„ third	.. 33⅓	„	„	25	„	„
„ fourth	.. 25	„	„	20	„	„
„ fifth ..	.. 20	„	„	16·6	„	„
„ sixth..	.. 16⅔	„	„	14·28	„	„
„ seventh	.. 14·28	„	„	12·5	„	„
„ eighth	.. 12·5	„	„	11·11	„	„
„ ninth	.. 11·11	„	„	10	„	„
„ tenth	.. 10	„	„	9·09	„	„
„ eleventh	.. 9 09	„	„	8·33	„	„
„ twelfth	.. 8·33	„	„	7·69	„	„
„ thirteenth	7·69	„	„	7·14	„	„
„ fourteenth	7·14	„	„	6 66	„	„
„ fifteenth ..	6·66	„	„	6·25	„	„
„ sixteenth..	6·25	„	„	5·88	„	„
„ seventeenth	5·88	„	„	5·55	„	„
„ eighteenth	5·55	„	„	5·26	„	„
„ nineteenth	5·26	„	„	5	„	„
„ twentieth..	5	„	„	4·76	„	„

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