Aids to chemistry : specially designed for students preparing for final examinations / by C.E. Armand Semple.

Henry Wood Dodd
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AIDS
TO
CHEMISTRY.

SPECIALLY DESIGNED FOR
STUDENTS PREPARING FOR EXAMINATIONS.

PART I.—INORGANIC:
THE NON-METALLIC ELEMENTS.

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PREFACE.

THE last Edition of these "Aids to Chemistry" was subjected to such careful revision that very few alterations have been rendered necessary in the preparation of this, the Fifth Edition. It has, however, been considered expedient to introduce a few more equations, and to supply some additional explanatory matter.

The original scheme has still been retained, viz. : the explanation of every symbol wherever it occurs.

The present volume is only intended as an introduction to the study of chemistry; and I would draw attention, for a more extended knowledge of the subject, to the excellent works of Fownes, Miller, Attfield, and Roscoe.

ARMAND SEMPLE.

8, TORRINGTON SQUARE,
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THE NON-METALLIC ELEMENTS.

Oxygen.
Hydrogen.
Nitrogen.
Carbon.

Chlorine.
Bromine.
Iodine.
Fluorine.

Sulphur.
Phosphorus.
Arsenicum.
Boron.
Silicon.
Selenium.
Tellurium.

INTRODUCTION.

CHEMISTRY is the science which investigates the nature and properties of all the bodies composing the universe. It demonstrates the actions exerted between the atoms and molecules of bodies, and the forces by which combination takes place.

Chemistry divides all bodies into SIMPLE and COMPOUND. To the simple bodies the name of ELEMENTS is applied; some of these are *gaseous*, two are *liquid*, and the remainder *solid*. The elements are divided into the NON-METALLIC ELEMENTS and the METALS, although it is possible there may be no real distinction between them. That part of chemistry which refers to bodies which are not the products of life, belongs to the province of INORGANIC CHEMISTRY, whereas all those substances which exist in living bodies, or are formed by the agency of living bodies, belong to the province of ORGANIC CHEMISTRY.

Certain characters termed symbols are employed for representing the elementary substances in formulæ and equations. By a symbol not only is the substance specified represented, but also a definite amount of that element, *i.e.*, its *atomic weight* or combining proportion. O represents oxygen, but it also indicates that there are 16 parts of it in the compound; if there are any more parts in it, this fact is denoted by the addition of a little figure termed *the co-efficient*, which is placed immediately under the symbol, thus, O_2, O_3, implying that the 16 is multiplied twice or thrice; and as will be seen hereafter, it is a fundamental law in chemistry that all substances unite in only one proportion, or in multiples of that proportion.

Oxygen unites only in quantities which are represented by the figures 16, 32, 48, 64, &c., or multiples of 16, and nitrogen in the multiples of 14, its atomic weight, viz.: 14, 28, 42, 56, &c.

The density of a gaseous substance, is as a rule identical with its combining weight; thus, the combining weight of oxygen is 16, and its density is 16; the combining weight of nitrogen is 14, and its density is 14, and so of other gases. But an exception to this rule is observed in the case of phosphorus and arsenic, for, as will be hereafter explained, the vapour densities of these two bodies are double their combining weights.

The density of a compound body is obtained by halving the molecular weight; thus, the molecular weight of carbonic oxide, CO, is 28, and its density is therefore 14.

The term *chemical combination* indicates the union of two or more bodies to form a third, differing entirely from the original substances, whereas *mechanical mixture* simply denotes that the substances are merely mixed together; thus, the action of iodine upon metallic mercury to form the green iodide of mercury is an instance of chemical combination; and the mixture of gases in atmospheric air is illustrative of mechanical mixture.

Chemical affinity, or chemical attraction, implies that peculiar force by which a certain element or group of elements will attach itself to another to form a new substance.

Elective affinity is the attraction of one substance for another to the exclusion of a third.

Until the end of the year 1877 the four gases, hydrogen, oxygen, nitrogen, and nitric oxide had never been liquefied; but at this period two experimenters, named Pictet and Chailletet, of Geneva, succeeded, with enormous pressure and intense cold, in reducing these to a liquid form. They also at the same time liquefied atmospheric air.

Every known gaseous body has now been reduced to a liquid.

When it is stated that a gas was liquefied by a pressure of so many atmospheres, it is meant that the number of atmospheres is multiplied by 15. Thus oxygen was liquefied by a pressure of 300 atmospheres, *i.e.*, 300 × 15 (15lbs. being the pressure upon every square inch of the earth's surface), or 4500lbs. Degrees of frost denote so many degrees below the freezing point.

AIDS TO CHEMISTRY.

OXYGEN (oxus, acid, genesis, a generator).

Symbol, O. Combining weight, 16. Density, 16.

Description.—A gas ; colourless, inodorous, invisible, and tasteless. Slightly soluble in water. The great supporter of combustion, and most magnetic of gases. Specific gravity is 1·1056, the specific gravity of air being 1. A dyad element, replacing two monads as in the case of water, $\left.\begin{matrix}H\\H\end{matrix}\right\}O$. Necessary to respiration, decay, germination, and putrefaction. Discovered by Scheele and Priestley, independently, in 1774, and liquefied in 1877 by a pressure of 300 atmospheres and 65 degrees of frost. When oxygen is inhaled in excess, death is produced by over-stimulation.

Sources.—Exists free in the atmosphere, of which it constitutes one-fifth by bulk, and combining with almost all organic bodies and most minerals, forms nearly half by weight of the solid earth. Fluorine is remarkable for forming no compound with this gas. Eight-ninths by weight of water consists of oxygen.

Preparation.—(1.) By heating red mercuric oxide (HgO) ;

$$HgO + \text{heat} = Hg + O.$$

Metallic mercury remains at the bottom of the vessel, and oxygen is given off, and is collected over water.

(2) By heating chlorate of potash ($KClO_3$) ;

$$KClO_3 + \text{heat} = KCl + O_3.$$

Chloride of potassium and oxygen are formed.

(3) By heating manganese dioxide, otherwise called black oxide of manganese (MnO_2).

$$3MnO_2 + \text{heat} = MnO,\ Mn_2O_3 + O_2.$$

The black oxide is decomposed into the red mangano-manganic oxide and oxygen.

(4) By mixing a small quantity of black oxide of manganese with the chlorate of potash, it is found that the oxygen is given off at a much lower temperature from the chlorate, and thus the evolution of the gas is facilitated, while the manganese dioxide does not undergo the slightest change.

(5) By electrolysis from water (H_2O), the oxygen separating at the platinode or positive pole.

(6) By heating strong sulphuric acid (H_2SO_4) with manganese dioxide;

$$MnO_2 + H_2SO_4 = MnSO_4 + H_2O + O.$$

Sulphate of manganese, water, and oxygen are formed.

(7) Oxygen is set free by the action of sunlight upon the carbonic acid (CO_2) contained in the chlorophyll, or green colouring matter of plants. The plant retains the carbon (C) for its growth, the oxygen being set free for the support of the respiration of animals.

Tests.—(1) A *glowing* chip of wood plunged into the gas immediately *bursts into flame.*

(2) Sulphur, which burns with a pale blue flame in air, emits a *bright violet light* in oxygen.

(3) Phosphorus inflamed and placed in this gas exhibits *dazzling brilliancy.*

(4) By tipping a bundle of fine iron wire, or a steel watch-spring, with burning sulphur or glowing amadou (a spongy substance), and placing it in a jar of oxygen, *showers of splendid scintillations* are produced, oxide of iron dropping in the molten state to the bottom of the jar.

OZONE—O_2O—(ozein, to emit an odour).

Description.—An allotropic modification of oxygen; may be termed *condensed* oxygen, since it is found that this substance is one and a-half times as heavy as O, *i.e.*, three volumes of oxygen condense to form two volumes of ozone. It is a gas of a peculiar, strongly oppressive odour which is perceptible during the working of an electrical machine; possesses great bleaching and disinfecting properties, corrodes india-rubber, and is completely soluble in oil of turpentine. Discovered by Schönbein in 1840.

Preparation.—(1) By passing a series of electric sparks through air or through oxygen.

(2) By allowing a stick of phosphorus to hang in a bottle filled with *moist* air.

(3) By the electrolytic decomposition of water, in which small quantities of ozone are produced.

(4) By heating strong sulphuric acid (H_2SO_4) with permanganate of potash ($KMnO_4$) thus—

$$2KMnO_4 + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 3H_2O + 2O + O_2O.$$

Sulphate of potash, sulphate of manganese, water, oxygen, and ozone are produced.

Tests.—(1) Sets iodine (I) free from iodide of potassium (KI), hence paper impregnated with starch and iodide of potassium is turned blue by ozone;

$$6KI + 3H_2O + O_2O = 6I + 6KHO.$$

Iodide of potassium, water, and ozone give free iodine and liquor potassæ.

(2) Converts protosalts of manganese into persalts, and sulphite of lead into sulphate.

HYDROGEN—(hudor, water, genesis, a generator).

Symbol, H. Combining weight, 1. Density, 1.

Description.—A gas; colourless, invisible, tasteless, and inodorous. The lightest body known, being 14·47 times lighter than air. Very slightly soluble in water. The specific gravity, air being taken as the unit, is 0·0693. Discovered by Cavendish in 1766, and liquefied in 1878 by a pressure of 650 atmospheres and 140 degrees of frost. When hydrogen is inspired the voice is rendered puerile.

A monad element, and the standard of atomic weights.

Sources.—Chiefly found in combination; with oxygen in water, of which it forms one-ninth by weight, and in nearly all organic bodies.

Preparation.—(1) From water (H_2O) by metallic potassium (K). Thus—

$$K + H_2O = KHO + H.$$

A solution of potash and hydrogen are formed.

(2) By passing steam over red-hot iron (Fe) in a gun barrel. Thus—

$$4H_2O + 3Fe = Fe_3O_4 + 8H.$$

Ferrous-ferric oxide (Fe_3O_4) remains.

(3) From diluted sulphuric acid (H_2SO_4,H_2O) and zinc (Zn). Thus—

$$H_2SO_4,H_2O + Zn = ZnSO_4 + H_2O + 2H.$$

Sulphate of zinc remaining.

(4) By electrolysis of water, hydrogen separating at the negative pole or zincode.

This gas may be readily collected over water.

Test.—Hydrogen is not a supporter of combustion, but a combustible body. This can be shown by placing a lighted taper in a jar of the gas; the flame of the taper is *extinguished*, but another flame is observed at the mouth of the jar; this is of a very pale blue colour, possesses little luminosity, but intense heat, and is produced by the *combustion* of the hydrogen, the result being a few drops of water.

HYDROGEN WITH OXYGEN forms two compounds:
(1) Hydrogen monoxide, or, water ... H_2O.
(2) Hydrogen dioxide ... ... H_2O_2.

HYDROGEN MONOXIDE (H_2O). WATER.

It is found that when hydrogen burns in air, water is formed by its union with oxygen. In 1781, Cavendish showed that two volumes of hydrogen unite with one volume of oxygen to form water. He made a mixture in this proportion in a jar, and then passed the gases into a strong vessel furnished with a stop-cock from which the air had been pumped out. An electric spark was passed through two platinum wires melted through the glass; an explosion followed, dew was seen to be deposited upon the sides of the vessel, and upon opening the stop-cock under water, this liquid rushed in and completely filled the whole space originally occupied by the mixed gases. The glass was weighed before and after the explosion, and the weight of the glass being known, the weight of the water produced was the same as that of the gases which combined.

The composition of water is determined in two ways:—

(1) By SYNTHESIS
(2) By ANALYSIS.

SYNTHESIS, or the placing together of the ingredients, is performed in the following manner:—a long, accurately graduated, glass tube, called a *Eudiometer* is taken. This is open at one end and closed at the other, and through the top of the closed end are melted two platinum wires. The tube is filled with mercury, and then inverted, open end downwards, over a trough filled with the same metal. Hydrogen is admitted into the tube, and the volume measured (say 100 volumes); oxygen is then allowed to enter (say 75 volumes), and the volume of the two mixed gases is measured. An electric spark is now passed through the gases by means of the platinum wires; a flame passes down through the gas, showing that combination has occurred, and the water produced is deposited as dew upon the inside of the tube; this will only occupy about $\frac{1}{2000}$ part of the bulk of the constituent gases, so its volume may be neglected. Upon opening the bottom of the eudiometer, the mercury in the tube rises, and we find that only 25 volumes of gas remain, which turns out to be pure oxygen. Thus, 100 volumes of hydrogen require exactly 50 volumes of oxygen for their complete combustion. By a modification of this experiment, it can be shown that the volume of gaseous water occupies exactly 100 volumes; or, two volumes of H unite with one volume of O to form two volumes of steam; hence density of steam or weight of one volume is

$$\frac{16 + 2}{2} = 9$$

Analysis, or the splitting up into the constituents, is performed as follows:—A glass vessel is filled with water, acidulated with sulphuric acid, to assist the conduction of electricity; two test tubes, also filled with water, are then inverted into this vessel over two small platinum plates attached to wires passing through a caoutchouc stopper at the bottom of the glass. On connecting the plates with the terminals of a galvanic battery, an evolution of gas from each is observed; that disengaged from the plate in connection with the *platinum end* of the battery is found to be *pure oxygen*, while that from the plate in connection with the *zinc end* is *pure hydrogen.* If the tubes be graduated, the volume of the hydrogen is found to be a very little more than double that of the oxygen, for since O is rather more soluble than H, we do not get quite the exact proportions. Oxygen being sixteen times as heavy as hydrogen, and these gases combining to form water in the proportions, by volume, of one of the former to two of the latter, we thus know that the proportions by weight in which these gases exist in water must be as sixteen to two.

Free O and H combine together, when a light is applied, with such force that a dangerous explosion occurs from the sudden expansion caused by the great heat evolved. If a soda-water bottle be filled one-third full of O, and two-thirds with H, and a flame applied to the mouth, the gases combine with a sudden detonation like the report of a pistol.

The *oxyhydrogen blowpipe* is employed to develop the great heat evolved by the combination of the two gases. These, which should be in the proportions to form water, *i.e.*, two vols. of H to one vol. of O, are contained separately in two caoutchouc bags, and are only brought together at the point where combination is desired, thus avoiding the danger of explosion.

The flame thus produced is only slightly luminous, but is so intensely hot, that the most difficultly fusible metals, such as platinum, may be *easily melted* in it; whilst iron-wire burns in the flame with *beautiful scintillations.* A piece of chalk or lime placed in the flame becomes heated to *bright* whiteness, and emits *intense light.*

In nature we find water in three forms:—

(1) Solid as ice.
(2) Liquid as water.
(3) Gaseous as steam or vapour.

At all temperatures between 0°C and 100°C, water assumes the liquid form; above 100°C it entirely takes the gaseous (under the ordinary atmospheric pressure of 760 mm.). The melting point of ice, being a constant temperature, is taken as the zero of the centigrade scale; water may under certain conditions be cooled below 0°C without solidifying; still, ice can never exist at a temperature above 0°C. In its passage from the solid to the liquid state water becomes reduced in volume, and on freezing, a sudden expansion (from one volume to 1·099) takes place. Observe the splitting of rocks during the winter; the water which has penetrated their cracks and crevices freezes and widens these openings, and by frequent repetitions of the process the rock at last is split into pieces. Hollow balls of cast iron may easily be split in two by filling them with water, closing by a tight-fitting screw, and exposing them to a temperature below 0°C.

In passing from the solid to the liquid state, a given weight of water takes up or *renders latent* just as much heat as would suffice to raise the temperature of the same weight of water through 79°C; the *latent heat of water* is therefore said to be seventy-nine thermal units—a thermal unit implying the *amount of heat required to raise a unit weight of water through* 1°C. When water freezes, the *heat of liquidity* becomes *sensible.* A similar disappearance of heat occurs with all substances on passing from the solid to the liquid form. If we take a hot saturated solution of Glauber's salts (sodium sulphate) and allow it to cool, so long as it remains undisturbed it retains the liquid form, but if agitated, it at once begins to crystallise, and soon becomes a solid mass. If a delicate thermometer be plunged into the salt while solidifying, a sudden rise of temperature will be noticed.

Water, when *heated* from 0°C to 4°C contracts, thus forming a remarkable exception to the general law, that bodies expand with heating and contract on cooling; on *cooling* from 4°C to 0°C, it expands again; above 4°C, it follows the ordinary law.

Thus we say that the *point of maximum density of water is* 4°C ; *i.e.*, a given bulk of water will weigh more at this temperature than at any other. The amount of contraction on heating is but small (one volume of water at 4°C becoming 1 + 0·00012 at 0°C), yet its influence in nature is most important. Were it not for this circumstance our climate would be arctic. In the freezing of large lakes and rivers, the cold winds gradually cool the surface-water which, becoming heavier, sinks, and lighter and warmer water rises to its place. This process goes on until the temperature of the whole mass is reduced to 4°C, and then the surface-water no longer sinks, since it is always lighter than the deeper water at 4°C. Ice is formed only at the top, the mass of water retaining a temperature of 4°C. If water became heavier as it cooled down to the freezing point, a continual circulation would be kept up until the mass was cooled to 0°C, when solidification of the whole would take place. Sea-water rarely, if ever, freezes *en masse*, on account of the great depth of water which prevents the whole being cooled down to the freezing point.

When water is heated to 100°C, it enters into ebullition, *i.e.*, steam is disengaged from the most heated surface. During this process, a large quantity of heat becomes latent, and the *latent heat of steam is said to be* 536 *thermal units.* When water thus passes into the gaseous or vaporous state, heat is absorbed, and so much heat may be thus abstracted from water, that we may cause it to freeze by its own evaporation.

Water, without entering into ebullition, possesses the power of rising in vapour at all temperatures, and this power is called the *elastic force* or *tension* of aqueous vapour.

Again, *water boils when the tension of its vapour is equal to the superincumbent atmospheric pressure.* On the tops of mountains water boils at a temperature below 100°C, because the atmospheric pressure is less than at the sea level.

To obtain *pure* water, we are obliged to *distil* river or spring water ; that is, we boil the water and collect the fluid formed by the condensation of the steam produced. Thus the solid matters are left behind. Rain water is the purest form of water in nature, but even this may contain foreign matters. Sea-water contains about thirty-five parts of solid matter (twenty-eight parts consisting of sodium chloride or common salt) in solution, in 1000 parts of water. Most salts are more or less soluble in water, and crystallise upon the evaporation of the fluid. The solubility of salts is generally greater in hot water than in cold.

Water unites with bodies to form *Hydrates;* thus we have hydrate of lime (CaO, H_2O), hydrate of oxide of copper (CuO, H_2O).

Water of Crystallisation, is the water which is necessary for the preservation of the crystalline form of certain salts, and, upon the driving off of which by heat, the crystals fall to powder. The amount of this water varies in different cases:

Thus we have

Sulphate of iron ...	... $FeSO_4 + 7H_2O$.
Sulphate of copper ...	... $CuSO_4 + 5H_2O$.
Ferrocyanide of potassium	... $K_4FeCy_6 + 3H_2O$.
Borax	... $Na_2B_4O_7 = 10H_2O$.
Alum	... $NH_4Al(SO_4)_2 + 12H_2O$.

If a saline compound absorb water from the atmosphere, it is termed *Deliquescent*, as acetate of potash ($KC_2H_3O_2$); if under the same circumstances it loses water, it is called *Efflorescent*, as in the case of phosphate of soda ($Na_2HPO_4 + 12H_2O$). A salt which undergoes no change upon exposure to air is termed *Permanent*.

HYDROGEN DIOXIDE (H_2O_2). HYDROXYL.

Description and properties.—A liquid of syrupy consistence, and very unstable; does not occur in nature. Possesses powerful oxidising properties, bleaches a solution of litmus, and has a somewhat metallic taste. A drop placed upon the tongue blanches it, and destroys sensation for a time. It has of late years been used as a test for bloodstains, since with freshly-prepared tincture of guaiacum and blood it strikes a blue colour. Discovered by Thénard in 1818.

Preparation.—(1.) From barium dioxide (BaO_2) and hydrochloric acid (HCl)

$$BaO_2 + 2HCl = BaCl_2 + H_2O_2.$$

Barium chloride and hydrogen dioxide are formed.

(2.) By passing carbonic anhydride (CO_2) through barium dioxide (BaO_2) suspended in water—

$$BaO_2 + H_2O + CO_2 = BaCO_3 + H_2O_2.$$

Barium carbonate separates out as a white powder, insoluble in water, and H_2O_2 remains in solution; upon bringing this substance into contact with ozone, common oxygen and water are produced. If silver oxide be brought in contact with H_2O_2, metallic silver is produced, together with water and common oxygen.

NITROGEN (nitron, nitre, genesis, a generator).

Symbol, N. Combining weight, 14. Density, 14.

Description.—A gas; properties, negative; viz.: colourless, tasteless, inodorous, neither supporting combustion nor combustible ; not poisonous ; animals placed in nitrogen die from oxygen starvation, hence the name *Azote* (a, privative, zoe, life), by which it is sometimes designated. Slightly lighter than air. Specific gravity, 0·972, air being 1·0. A triad element replacing three monads,

as in the case of ammonia, $N \left\{ \begin{matrix} H \\ H. \\ H \end{matrix} \right.$ Does not readily combine with other bodies. Discovered by Rutherford in 1772. Liquefied in 1878 by a pressure of 200 atmospheres.

Sources.—Exists free in the atmosphere, of which it constitutes four-fifths by bulk ; occurs in combination in the bodies of animals, in many plants, and in chemical compounds, as nitre (nitrate of potash, KNO_3), whence its name (nitre generator). Also in some mineral waters.

Preparation.—(1.) By burning phosphorus (P) in a bell-jar filled with air, the mouth of which is placed in a vessel full of water ; white fumes at first fill the jar, consisting of phosphorus pentoxide (P_2O_5), and as these subside and dissolve in the water beneath, the nitrogen is left nearly pure.

(2) By passing air over red-hot metallic copper (Cu) ; cupric oxide (CuO) is formed, and nitrogen is set free.

(3) By passing chlorine (Cl) through *excess* of ammonia (NH_3). Thus—

$$6Cl + 2NH_3 = 6HCl + 2N.$$

Hydrochloric acid remains in solution, and nitrogen is given off. If the chlorine be in excess, a most explosive oily compound is formed, called chloride of nitrogen (NCl_3 ?).

(4) By heating the nitrite of ammonium (NH_4NO_2). Thus—

$$NH_4NO_2 + \text{heat} = 2H_2O + 2N.$$

NITROGEN WITH HYDROGEN forms
AMMONIA.

Symbol, NH_3. Molecular weight, 17. Density, 8·5.

Description.—The only (separable) compound of N with H. A gas ; colourless, irrespirable, with the odour of "hartshorn" ; lighter than air, specific gravity 0·59 (air = 1). The volatile alkali ; very soluble in H_2O, which dissolves 700 times its own volume at 0°C. Both liquefiable and solidifiable.

Sources and preparations.—Is produced in decay, and in combustion, where bodies contain N and H, and to some extent in respiration. Chiefly obtained from the decomposition of animal and vegetable matters containing nitrogen and hydrogen, either at the ordinary temperature or by the influence of heat. By heating horns, clipping of hides, or coal, ammonia is given off, hence it is known (in the first mode) as *spirits of hartshorn.* A compound called Sal-ammoniac (NH_4Cl), or chloride of ammonium, was first prepared by the Arabs by heating camels' dung in the deserts of Libya, near the Temple of Jupiter Ammon (whence the name ammonia). The dried excrement of sea-birds (guano) and the urine of animals contain considerable quantities of NH_3.

The great source of ammonia and its compounds at the present time is the ammoniacal liquor of the gas-works. The mode of preparation is the following :—

(*a*) Hydrochloric acid (HCl) is added to the ammoniacal liquor, forming chloride of ammonium (NH_3HCl) ; to this

(*b*) Slaked lime (CaH_2O_2) is added. Thus—

$$2NH_3HCl + CaH_2O_2 = CaCl_2 + 2H_2O + 2NH_3.$$

Ammonia may also be prepared by the action of nitric acid (HNO_3) upon metallic zinc (Zn). Thus—

$$9HNO_3 + 4Zn = 4(Zn2NO_3) + 3H_2O + NH_3.$$

The gas may be collected by displacement, the neck of the receiver being turned downwards, or it may be collected over mercury, but not over water, on account of its extreme solubility.

Tests.—(1) Possesses a strong *alkaline* reaction.

(2) Its solution turns red vegetable colours *blue.*

(3) Gives *white fumes* when placed near any mineral acid, such as nitric (HNO_3), hydrochloric (HCl), or sulphuric (H_2SO_4).

The most striking reactions are

(4) The *deep sapphire blue* colour produced when an *excess* of liquor ammoniæ is added to a solution of a salt of *copper*, and

(5) The *white* precipitate of hydrargyrum ammoniatum (NH_2HgCl) when liquor ammoniæ is added to corrosive sublimate ($HgCl_2$).

COMPOUNDS OF NITROGEN WITH OXYGEN.

Five in number, viz :

(1) *Nitrogen monoxide, nitrous oxide, or laughing gas,* N_2O.
(2) *Nitrogen dioxide, or nitric oxide,* NO or N_2O_2.
(3) *Nitrogen trioxide, or nitrous anhydride,* N_2O_3.
(4) *Nitrogen tetroxide, or hyponitric acid,* NO_2 or N_2O_4.
(5) *Nitrogen pentoxide, or nitric anhydride,* N_2O_5.

Here we have a striking instance of the *law of chemical combination in multiple proportion.*

In these compounds the O is in the proportion of the numbers 1, 2, 3, 4, 5 to one and the same quantity of N. While 28 parts by weight of N, combined with 16 of O, form 44 parts of nitrogen monoxide, we see that any other compounds of those elements contain some simple multiple of 16 parts by weight of O, either 2 × 16, 3 × 16, 4 × 16, or 5 × 16, and that no compounds exist containing any *intermediate quantity* of O.

N and O do not *readily* combine together, but they may be made to do so under certain circumstances. Suppose a series of electric sparks to be passed through a vessel full of dry air, *red coloured vapours* having a *peculiar acrid smell* are soon noticed; these consist of *tri- and tetr- oxides of nitrogen.* They have the power, like ozone, of liberating iodine from potassium iodide, and can thus be made to colour starch *blue.*

NITROGEN MONOXIDE. NITROUS OXIDE.

Symbol, N_2O. Molecular weight, 44. Density, 22.

Description.—A gas; colourless, inodorous, with a slightly sweetish taste. Respirable for a time, and somewhat soluble in water. Supports combustion nearly as well as oxygen. Specific gravity (air being 1) is 1·527. Has been liquefied by a pressure of 50 atmospheres. Discovered by Priestley in 1785.

Preparation.—(1) By heating ammonium nitrate (NH_4NO_3). Thus—

$$NH_4NO_3 + \text{heat} = 2H_2O + N_2O.$$

(2) By the action of metallic zinc (Zn) upon diluted nitric acid (HNO_3). Thus—

$$10HNO_3 + 4Zn + H_2O = 4Zn2NO_3 + 6H_2O + N_2O.$$

Nitrate of zinc, water, and nitrous oxide are formed.

This gas is best collected over *warm* water, since it is absorbed by cold water. When intended for respiration, it must be passed through a solution of potash, and then through ferrous sulphate.

Tests.—(1) A glowing chip of wood plunged into nitrous oxide is *rekindled,* burning with a brighter flame than in air.

(2) Phosphorus burns in this gas with nearly as bright a light as in oxygen.

(3) The *feeble* flame of sulphur is extinguished, but when *burning strongly* yields a *bright light.*

(4) When *inhaled,* a peculiar *exhilarating effect* is produced, hence the name "laughing gas."

NITROGEN DIOXIDE. NITRIC OXIDE.

Symbol, N_2O_2 or NO. Molecular weight, 30. Density, 15.

Description and Tests.—A gas; colourless, and irrespirable; does not easily support combustion (ignited phosphorus, unless burning brightly, being extinguished on being placed in nitric oxide). In contact with oxygen it immediately forms red fumes, consisting of the higher oxides of nitrogen. Specific gravity (air being 1) is 1·038. Has been liquefied by a pressure of 146 atmospheres and 16 degrees of frost.

* *Preparation.*—(1) By the action of nitric acid (HNO_3) upon copper turnings (Cu). Thus—

$$3Cu + 8HNO_3 = 3(Cu2NO_3) + 4H_2O + N_2O_2.$$

Nitrate of copper, water, and nitric oxide are formed.

(2) By nitric acid upon metallic bismuth (Bi). Thus—

$$2Bi + 8HNO_3 = 2Bi3NO_3 + 4H_2O + N_2O_2.$$

Nitrate of bismuth, water, and nitric oxide are formed.

NITROGEN TRIOXIDE. NITROUS ANHYDRIDE.

Symbol, N_2O_3. Molecular weight, 76. Density, 38.

Description and Tests.—A gas, of *an orange red colour* at ordinary temperatures, but at -18°C a *blue* volatile liquid, emitting a red and irritating vapour. With water (ice-cold) it forms *nitrous acid* (HNO_2). Thus—

$$N_2O_3 + H_2O = H_2N_2O_4 \text{ or } 2HNO_2.$$

(HNO_2 is a very unstable blue liquid, decomposing, when the water is warmed, into nitric acid and nitric oxide. Thus—

$$3HNO_2 = H_2O + N_2O_2 + HNO_3.)$$

Nitrous acid gives rise to salts called *nitrites.* Thus, with ammonia, we have (NH_4NO_2) *nitrite of ammonia.*

Preparation.—(1) By mixing 4 volumes of dry N_2O_2 with 1 volume of O, and cooling the mixture to -18°C.

(2) By the action of nitric acid (HNO_3) and H_2O upon arsenious anhydride (As_2O_3). Thus—

$$As_2O_3 + 2HNO_3 + 2H_2O = 2H_3AsO_4 + N_2O_3.$$

Arsenic acid and nitrogen trioxide are formed.

NITROGEN TETROXIDE. HYPONITRIC ACID.

Symbol, N_2O_4 or NO_2. Molecular weight, 46. Density, 23.

Description and Tests.—A gas; of an *orange-red* colour; liquid under pressure; has a suffocating odour; poisonous (if breathed in only small quantity producing inflammation of the lungs); solidifies at -9°C in long prisms. The chief resultant in air from decomposed nitric acid.

Preparation.—By heating the nitrate of lead ($Pb2NO_3$). Thus—

$$Pb2NO_3 + \text{heat} = PbO + O + N_2O_4.$$

Oxide of lead, oxygen, and nitrogen tetroxide are formed. (By water N_2O_4 is decomposed into nitric acid (HNO_3) and nitric oxide (N_2O_2). Thus—

$$3N_2O_4 + 2H_2O = 4HNO_3 + N_2O_2.)$$

* (3) $6Ag$ (silver) $+ 8HNO_3 = 6AgNO_3 + 4H_2O + N_2O_2$
Nitrate of silver, water, and nitric oxide are formed.

NITROGEN PENTOXIDE. NITRIC ANHYDRIDE.

Symbol, N_2O_5. Molecular weight, 54. Density, 27.

Description and Preparation.—A white crystalline substance; in brilliant right rhombic prisms. Prepared by passing dry chlorine gas (Cl) over nitrate of silver ($AgNO_3$).* Thus—

1st Stage.—$AgNO_3 + 2Cl = AgCl + O + NO_2Cl$.

Chloride of silver, oxygen, and a yellow liquid called nitroxyl chloride are formed.

2nd Stage.—$AgNO_3 + NO_2Cl = AgCl + N_2O_5$.

Nitrate of silver and nitroxyl chloride form chloride of silver and nitrogen pentoxide. This substance (N_2O_5) very easily decomposes, and unites with great energy with H_2O. Thus—

$N_2O_5 + H_2O = H_2N_2O_6$ or $2HNO_3$; forming

NITRIC ACID.

Symbol, HNO_3. Molecular weight, 63.

Description.—A fuming, corrosive, colourless liquid, with strongly acrid properties, and intensely acid taste; usually called Aqua Fortis. Entirely volatilised by heat. Specific gravity 1·517. A monobasic acid.

Sources.—Both kingdoms of nature; generally with potash, soda, lime, and magnesia, as nitrates. These are found in various parts of the world on the surface of the earth, and in some mineral waters, and are frequent constituents of vegetable juices.

Preparation.—(1) By heating sulphuric acid (H_2SO_4) with sodium nitrate ($NaNO_3$). Thus—

$$NaNO_3 + H_2SO_4 = NaHSO_4 + HNO_3.$$

Sodium-hydrogen-sulphate remains in the retort, and nitric acid distils over into a receiver.

(2) By heating sulphuric acid with potassium nitrate (KNO_3). Thus—

$$KNO_3 + H_2SO_4 = KHSO_4 + HNO_3.$$

Potassium-hydrogen-sulphate remains behind.

Tests.—For the *concentrated* acid (HNO_3)—

(1) Stains the skin *yellow*, forming *picric* or *carbazotic acid.*

(2) Nitric acid with dry morphia gives a *yellow* colour, passing into *red;* with brucia an immediate scarlet is produced.

(3) HNO_3 in the presence of hydrochloric acid dissolves *gold leaf.*

(4) Gives off ruddy brown fumes with some metals, as copper, mercury, silver, &c.

(5) Gives *white* fumes with the vapour of ammonia.

---

* Or—$2AgNO_3 + 2Cl = 2AgCl + O + N_2O_5$.
Chloride of silver, oxygen, and nitric anhydride are formed.

(6) Bleaches a solution of indigo.

(7) When poured on red-hot powdered charcoal, brilliant combustion is produced.

For the *diluted* acid, or a *nitrate*—

Upon the addition of a *green* crystal of ferrous sulphate, with a drop or two of strong sulphuric acid, the crystal is turned to a *red-brown* colour, ferric sulphate being formed.

Nitric acid forms salts called nitrates. They are all soluble in H_2O, and deflagrate upon charcoal.

Action of Nitric Acid on the Metals.

Gold, platinum, and aluminum are unattacked by nitric acid, HNO_3. Tin (stannum, Sn) is oxidised to meta-stannic acid ($H_2Sn_5O_{11} + 4H_2O$), antimony (stibium, Sb) to antimonic acid ($HSbO_3$), both insoluble in H_2O. Copper (Cu) is converted into soluble cupric nitrate ($Cu2NO_3$), mercury (Hg) into mercurous nitrate ($HgNO_3$) or mercuric nitrate, ($Hg2NO_3$), silver (Ag) into argentic nitrate ($AgNO_3$), zinc (Zn) into zinc nitrate ($Zn2NO_3$).

THE ATMOSPHERE

Is the gaseous envelope of the earth, and forms the ocean of air at the bottom of which we live. The average composition of air may be said to be the following :—

100 volumes of air contain—

Oxygen	20·6	volumes.
Nitrogen	77·9	,,
Carbonic anhydride	0·04	,,
Aqueous vapour (about)	1·46	,,
Ammonia	traces.	
Ozone		
Nitric acid		
Marsh gas		
Sulphurous anhydride		
Sulphuretted hydrogen (in towns)		
	100 00	

As most of the last-named ingredients are present in small and variable proportion, they are generally separated first in an analysis of air.

By oxygen, animal life is supported ; the nitrogen serves to dilute the oxygen ; carbonic anhydride and ammonia nourish plants ; water favours the absorption of these, and ozone purifies the air.

Of *carbonic acid*, there are present from 4 to 6 volumes in

10·000 of air. The proportion of ozone is various, but is greater in the country than in town. To detect the carbonic acid, we expose a vessel containing lime-water to the open air. The lime-water soon becomes turbid, from the formation of insoluble carbonate of lime.

The amount of aqueous vapour is dependent for the most part upon temperature, and varies with latitude, season, and region, &c.

The quantity of ammonia in the form of carbonate and nitrate is small, being about 1 part in 1,000,000 of air: its presence can only be shown by acting upon large quantities of air.

Oxygen may be proved to exist in the air, by combustible bodies being converted into oxides when made to burn in it, Thus, by burning hydrogen (H) we have water (H_2O) formed.

The existence of nitrogen is demonstrated by the result of combustion in confined portions of air, as has been shown previously in the section on preparing this gas.

The pressure of the atmosphere is observed when we remove the air from beneath the hand by an air pump; we then find that the hand is pressed down with a force equal to 15lbs. on every square inch. From this it is evident that the human body must consequently support *several tons*, but under ordinary circumstances this pressure is not perceptible, since it is exerted *equally* in every direction.

To measure the pressure of the air we make use of

THE BAROMETER.

This consists in the simplest form of a *straight glass tube*, about 800 millimetres (33 inches) in length, open at one end, and closed at the other. It is filled with mercury, and placed open end downwards in a vessel containing the same metal. The mercury then sinks in the tube to a point about 760 millimetres (32 inches) from the surface of the mercury in the vessel. In this position it is sustained by the force exerted by the air. As this pressure increases, the height of the mercurial column becomes greater; as it diminishes, so does the column fall. In order to compare the bulk of two gases, they must always be compared under like conditions of pressure and temperature; it is, therefore, agreed to compare all the volumes of gases at the *standard pressure of* 760 *millimetres of mercury, and at the standard temperature of* 0°C. It is difficult to say where the air exactly ceases, but it seems that the limit is about 45 miles from the level of the sea. Of course, the atmosphere having weight and elasticity, its lower layers must be more compressed than those above them; but if the whole atmosphere were throughout of the same density, it would only reach to a height a little more than 5 miles above the sea level.

As to the *chemical constitution of the atmosphere*, it must be borne in mind that the air is *not a chemical compound*, but a *mechanical mixture* of its constituents. This conclusion is arrived at on the following grounds :

(1) If O and N are brought together in the proportions in which they are found in air, *no elevation of temperature, and no alteration in bulk* takes place (as is the case when gases combine chemically), and still the mixture acts exactly like air.

(2) The relative quantities of the two gases are *not those of their combining weights, nor of any simple multiples of these weights.*

(3) Although in general the proportions of the two gases are constant, instances not unfrequently occur in which *this ratio differs* from the ordinary one.

(4) When air is shaken up with water, some of it is dissolved, but can be easily expelled by boiling ; upon analysis the expelled air is found to consist of oxygen and nitrogen in the relative proportions of 1 to 1·87. It would have been quite impossible to decompose the air by simply shaking it up with water if it had been a chemical compound ; *the compound would have dissolved as a whole*, and, upon analysis, the air expelled by boiling would have consisted of oxygen and nitrogen as 1 to 4, the proportions of the original air.

The air is therefore only a mixture, since a larger amount of O is dissolved than corresponds to that contained in the atmosphere, a fact due to the greater solubility in water of oxygen over nitrogen.

The best method of determining the amounts by volume of O and N contained in the air is by the *Eudiometer* (*eudia*, clear weather ; *metron*, a measure ; a measure of the clearness or purity of the air, viz., what quantity of oxygen it contains). The same arrangement is used as in the eudiometric synthesis of water. Into the tube, previously filled with mercury, air is introduced in sufficient quantity to fill it about one-sixth full. We can accurately ascertain the volume of this air by reading off the number of millimetre divisions on the tube to which the mercury rises.

A quantity of pure hydrogen, more than sufficient to combine with all the oxygen present, is now added, and the volume of this gas determined. An electric spark is then passed through the mixture, and after the explosion *the volume* is determined as before. This is found to be less than before explosion, water having been formed by the union of the whole of the oxygen with part of the hydrogen. We already know that 2 volumes of H unite with exactly 1 volume of O to form H_2O (water); then one-third of the diminution in volume represents the O that has disappeared, and therefore the volume of O contained in the air taken. Now suppose the quantity of air amounted to 100 volumes, and after the addition of the hydrogen the volume of the mixture was 150 volumes. After explosion we find 87 volumes remain, therefore 63 volumes have disappeared. Then the volume of O contained in 100 volumes of air is

$$\frac{63}{3} = 21.$$

The most careful analyses of air collected in various parts of the globe have shown that the relative quantities of O and N remain the same, or nearly the same, from whatever region obtained. Whether from the depths of mines, from 20,000 feet above the surface of the earth, from the Arctic seas, or from the tropics, the air contains from 20·9 to 21 volumes of oxygen per cent.

The composition of air by volume, and the relative densities of the constituent gases (N = 14 ; O = 16) being known, its composition by weight can be calculated. Thus, in 100 grams of air, we find that 76·84 grams of N are mixed with 23·16 grams of O, and the mean of a large number of experiments shows that 100 parts by weight of air contain 77 parts by weight of N and 23 of O.

CARBON (carbo, coal).

Symbol, C. Combining weight, 12. Density, 12.

Description.—A solid element. A tetrad replacing 4 atoms of monad hydrogen, as shown in the composition of marsh gas $C\left\{\begin{matrix}H\\H\\H\\H\end{matrix}\right.$ and existing in 3 "allotropic" modifications, viz.:—

(1) The diamond.
(2) Graphite, plumbago, or, black-lead.
(3) Charcoal, lamp-black, or, amorphous carbon.

THE DIAMOND.

The purest form of carbon, and the hardest gem known:

can be entirely converted into carbonic dioxide (CO_2) by combustion in O. By intense heat, in absence of air, it is reduced to a coke-like substance. The specific gravity varies from 3·3 to 3·5. It crystallizes in cubes and octahedra, and is insoluble in all media, and infusible. Is largely used for glass-cutting, and is cut into various forms by its own dust. The mode in which the diamond has been formed is unknown.

GRAPHITE, OR PLUMBAGO.

A black metallic-looking substance, hence the name black-lead; leaves a greasy stain when drawn upon paper. Crystallises in 6-sided plates, bearing no relation to the form of the diamond. Sp. gr. 2·18 to 2·38. It is much used for the manufacture of pencils.

CHARCOAL, OR AMORPHOUS CARBON.

Is the light-giving principle of flame. The purest form of charcoal-carbon is lamp-black. It also occurs as wood-charcoal, coal, coke, and animal-charcoal. Much lighter than the other forms. Sp. gr. varies from 1·6 to 2·0. A piece of charcoal floats upon water in consequence of its porosity, but if finely powdered it instantly sinks. It is a great absorbent of gases and colouring matters, and is used as a disinfectant in hospitals, &c. *Carbo ligni, wood-charcoal,* is obtained from wood charred by exposure to a red heat, without access of air.

CARBON WITH OXYGEN

forms two compounds, viz.:

(1) Carbon monoxide, or carbonic oxide ......CO.
(2) Carbon dioxide, or carbonic anhydride...CO_2.

CARBON MONOXIDE.

Symbol, CO. Molecular weight, 28. Density, 14.

Description.—A gas, not occurring naturally, but artificially produced. Colourless, with slightly oppressive odour. Very poisonous. Does not support combustion, but *burns with a light blue flame,* forming carbonic anhydride (CO_2). Sp. gr. (air = 1) is 0·969. Very slightly soluble in H_2O. Discovered by Priestley in 1787. CO forms with chlorine a compound called *phosgene* gas.

Preparation.—(1) By passing carbonic anhydride (CO_2) over red-hot charcoal (C). Thus—

$$CO_2 + C = 2CO.$$

(2) By heating oxalic acid ($H_2C_2O_4$) with sulphuric acid (H_2SO_4). Thus—

$$H_2C_2O_4 + H_2SO_4 = H_2SO_4, H_2O + CO_2 + CO.$$

The sulphuric acid abstracts the elements of water (H_2O); the carbonic anhydride and carbon monoxide are evolved as gases, and are collected in a long cylindrical tube; upon shaking up lime water (CaH_2O_2) in the tube, carbonate of lime ($CaCO_3$) is formed, and carbon monoxide left.

(3) By heating zinc (Zn) and chalk ($CaCO_3$) to redness in a gun-barrel. Thus—

$$Zn + CaCO_3 = ZnO + CaO + CO,$$

Oxide of zinc, lime, and carbon monoxide are formed.

(4) By heating carbonic anhydride (CO_2) and hydrogen. Thus—

$$CO_2 + 2H = H_2O + CO.$$

(5) By heating ferrocyanide of potassium ($K_4FeC_6N_6, 3H_2O$) with sulphuric acid (H_2SO_4) and water (H_2O). Thus—

$$K_4FeC_6N_6, 3H_2O + 3H_2O + 6H_2SO_4 = 2K_2SO_4 + FeSO_4 + 3(NH_4)_2 SO_4 + 6CO,$$

Sulphate of potash, sulphate of iron, sulphate of ammonia, and carbon monoxide are formed.

CARBON DIOXIDE. CARBONIC ANHYDRIDE.

Symbol, CO_2. Molecular weight, 44. Density, 22.

Description.—A gas; colourless, inodorous, with a slightly acid taste. Tolerably soluble in water; neither combustible nor supporting combustion. Liquid under pressure, and then solid by spontaneous evaporation, forming snow-white flakes. Constitutes the "choke-damp" and "after-damp" of mines; specific gravity 1·529. Discovered by Black in 1756.

Sources.—Occurs free in the air, and in the waters of many mineral springs. Is evolved from the craters of active volcanoes. Is given off in the processes of fermentation, respiration, combustion, decay, putrefaction, and germination. When a room contains 0·10 per cent. of CO_2 it is unfit for continued respiration. Combined with lime and magnesia, carbon dioxide occurs plentifully in nature.

Its salts are called carbonates, and except the alkaline carbonates are mostly insoluble.

CO_2 gives a white precipitate with lime-water.

Preparation.—(1) By heating calcium carbonate ($CaCO_3$) to redness. Thus—

$$CaCO_3 + \text{red heat} = CaO + CO_2.$$

Lime and carbon dioxide are formed.

(2) By pouring hydrochloric acid (HCl) upon chalk, marble or other form of carbonate of lime, ($CaCO_3$.) Thus—

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2,$$

Chloride of calcium, water, and carbonic anhydride are formed.

(3) Charcoal burns in oxygen to CO_2.

Carbonic anhydride (CO_2) + H_2O = Carbonic acid (H_2CO_3.)

COMPOUNDS OF CARBON WITH HYDROGEN.

These are very numerous, and exist in gaseous, liquid, and solid forms. For the present we shall only deal with three of the simplest, leaving the remainder for consideration under Organic Chemistry.

(1) Methyl Hydride, Methane, Light Carburetted Hydrogen, or Marsh Gas, CH_4.

(2) Acetylene, C_2H_2.

(3) Ethylene, Heavy Carburetted Hydrogen, or Olefiant Gas, C_2H_4.

METHYL HYDRIDE. MARSH-GAS.

Symbol, CH_4. Molecular weight, 16. Density, 8.

Description and Sources.—A gas; colourless, inodorous, and tasteless. Known as "*Firedamp*" in coal mines. Produced in *stagnant pools* by the decomposition of dead leaves (hence its name, marsh-gas). A constituent of coal gas, and evolved in volcanic districts.

Preparation.—It cannot be prepared by the direct union of its elements, but is produced in the following modes:

(1) By heating acetate of sodium ($NaC_2H_3O_2$) with caustic soda (NaHO). Thus—

$$NaC_2H_3O_2 + NaHO = Na_2CO_3 + CH_4,$$

Carbonate of soda and marsh-gas are formed.

(2) By passing a mixture of carbon disulphide vapour (CS_2) and sulphuretted hydrogen (H_2S) over red-hot copper (Cu). Thus—

$$8Cu + CS_2 + 2H_2S = 4Cu_2S + CH_4.$$

Cuprous sulphide and marsh-gas result.

This gas burns with *a blueish-yellow non-luminous flame*, forming carbon dioxide and water. When mixed with *ten times its volume of air, or twice its volume of O*, it explodes suddenly and violently upon ignition.

ACETYLENE.

Symbol, C_2H_2. Molecular weight, 26. Density, 13.

Is formed by the direct union of carbon and hydrogen, at a very high temperature. It is a colourless gas, burning with a bright luminous flame, and having a peculiar disagreeable odour which may be noticed when a candle burns with a smoky flame. It combines with certain metals, as copper and silver, and these compounds very easily decompose with explosion. C_2H_2 unites directly with hydrogen to form

ETHYLENE.

Symbol, C_2H_4. Molecular weight, 28. Density, 14.

Description and Sources.—A gas; colourless, with a sweetish taste; has been condensed by high pressure and a temperature of -110°C to a colourless liquid. It is an important constituent of coal-gas, and burns with a *smoky luminous* flame, forming carbon dioxide and water. Detonates powerfully when mixed *with three times its bulk* of oxygen and fired. It is called olefiant gas, because it combines directly with its own volume of chlorine gas (Cl), to form an oily liquid, $C_2H_4Cl_2$, termed Dutch liquid, or ethylenic dichloride. Discovered by some Dutch chemists in 1796.

Preparation.—(1) By the destructive distillation of coal. (2) By heating alcohol (C_2H_6O) with sulphuric acid (H_2SO_4) at a temperature above 154°C,* thus—

$$C_2H_6O + H_2SO_4 = H_2SO_4,H_2O + C_2H_4.$$

The sulphuric acid abstracts the elements of water, and C_2H_4 is evolved as a gas.

COAL GAS.

In order to prepare this gas, the coal is heated in a closed retort.

The results of this heating are—

(1) *Volatile bodies* formed and expelled.

(2) A residue of impure carbon left as *coke.*

The volatile products are tar, ammonia, water, and gas. The tar yields substances from which the *aniline colours* are produced.

The ammonia is the chief source of the *ammoniacal salts.*

The gas consists of (1) *luminous* and (2) *non-luminous substances.*

The *luminous* gases are olefiant gas (C_2H_4) and other hydrocarbons having an analogous composition, as C_3H_6, C_4H_8, C_5H_{10}, &c.

The *non-luminous* gases are hydrogen (H), carbonic oxide (CO) and marsh-gas (CH_4).

The *impurities* are carbon dioxide (CO_2), sulphuretted hydrogen (H_2S), and the vapour of carbon disulphide (CS_2).

THE STRUCTURE OF FLAME.

Flame is gas highly ignited. The hottest flames do not necessarily give off much light. Luminosity depends upon the presence of solid matter which becomes heated to whiteness. In a burning candle the flame presents three separate parts, viz.:

---

* Between 127°C and 154°C, ether is produced.

(1) The *dark* central zone of *unburnt* gas around the wick;
(2) The *luminous* zone of *incomplete* combustion;
(3) The *non-luminous* zone of *complete* combustion.

The blow-pipe flame can be divided into two parts:

(1) The *oxidizing* or *outer* flame, with excess of oxygen, and
(2) The *reducing* or *inner* flame, with excess of carbon.

THE DAVY LAMP.

A certain temperature is required to inflame every mixture of gases; until this temperature is attained, the mixture will not take fire. A flame may be cooled sufficiently to put it out by placing a coil of cold copper wire over it, but if the coil be previously heated, the flame continues to burn. If a piece of wire gauze containing about 700 meshes to the square inch be held close over a jet of gas, and the gas lighted above, we may remove the gauze several inches above the jet, and the inflammable gas does not take fire *below*, the flame burning only *above* the gauze. The heat is so quickly conducted away by the wires, that the temperature of the gas at the lower side of the gauze is not raised sufficiently high to produce ignition. Upon this principle Sir Humphry Davy constructed his safety lamp. Thus—

An oil lamp is enclosed in a wire gauze covering; air can pass through the meshes of the gauze, and the products of combustion of the oil can escape, but still no flame can proceed from the inside to the outside of the gauze; if the lamp be placed in a most inflammable mixture of air and firedamp, immediate ignition *externally* is not possible, although the mixture takes fire and burns *inside* the gauze. Of course, after a time, when the gauze becomes over-heated, the surrounding firedamp may attain the temperature requisite for its ignition.

CARBON WITH NITROGEN forms

CYANOGEN (kuanos, blue, genesis, a generator).

Symbol, CN (sometimes Cy). Molecular weight, 26.

Description.—A gas; colourless and poisonous, with an odour of peach blossoms. Specific gravity 1·806. Does not support combustion, but *burns with a rose-coloured flame*, forming carbon dioxide and free nitrogen. Combines with metals to form cyanides. Belongs to a class of bodies called *compound radicals*, and is monobasic, replacing one atom of monad hydrogen, as shown in the composition of prussic acid, H/CN. Has been condensed to a colourless liquid.

Preparation.—By heating a metallic cyanide, such as mercuric cyanide (HgC_2N_2 or $HgCy_2$); metallic mercury and a black substance (paracyanogen) are left, and cyanogen gas is given off. It is best collected over mercury, since water dissolves 4 times its bulk of the gas.

Carbon and nitrogen do not unite together, but by passing N over a white-hot mixture of charcoal (C) and carbonate of potash (K_2CO_3) we obtain cyanide of potassium (KCN). Thus—

$$K_2CO_3 + 2N + 4C = 3CO + 2KCN.$$

From this KCN can be prepared a number of bodies, all containing CN, and possessing peculiar properties. The name cyanogen is given to this group on account of its forming with iron some blue compounds.

A compound of cyanogen with iron and potassium called *Ferrocyanide of Potassium* ($K_4FeCy_6, 3H_2O$) or *Yellow* Prussiate of Potash is prepared by heating together horns and hoofs and clippings of hides in an iron pot with carbonate of potash. By passing chlorine gas through $K_4FeCy_6, 3H_2O$, we obtain *Ferricyanide of Potassium* (K_3FeCy_6) or *Red* Prussiate of Potash. Thus—

$$K_4FeCy_6, 3H_2O + Cl = KCl + 3H_2O + K_3FeCy_6.$$

Chloride of potassium, water, and ferricyanide of potassium result.

This latter salt gives no special precipitate with *persalts* of iron, but yields a *dark blue precipitate* with the *protosalts* of that metal.

CYANOGEN WITH HYDROGEN
forms
HYDROCYANIC OR PRUSSIC ACID.

Symbol, HCN or HCy. Molecular weight, 27.

Description.—In the anhydrous or undiluted state this substance is a colourless, limpid, volatile liquid. Specific gravity, 0·7058 at 5°C, boiling at 26°C. Feebly acid, with odour of peach blossoms or bitter-almond oil. Dreadfully poisonous, inhalation even in small quantities producing giddiness and headache. It occurs in small quantities in some kernels and leaves of the orders Amygdaleæ and Pomeæ. Discovered by Scheele in 1782.

Preparation.—(*a*) In a *hydrated* form.

(1) By acting upon cyanide of potassium (KCN) with diluted sulphuric acid (H_2SO_4, H_2O). Thus—

$$2KCN + H_2SO_4 + H_2O = K_2SO_4 + H_2O + 2HCN,$$

Sulphate of potash, water, and prussic acid are formed.

(2) By boiling sulphuric acid (H_2SO_4) with ferrocyanide of potassium ($K_4FeCy_6, 3H_2O$). Thus—

$$2K_4FeCy_6, 3H_2O + 3H_2SO_4 = K_2Fe_2Cy_6 + 3K_2SO_4 + 6H_2O + 6HCy,$$

Everitt's yellow salt, sulphate of potash, water and prussic acid are formed.

(*b*) In an *anhydrous* form.

(3) By passing sulphuretted hydrogen gas (H_2S) over dry mercuric cyanide (HgC_2N_2). Thus—

$$HgC_2N_2 + H_2S = HgS + 2HCN,$$

Mercuric sulphide and prussic acid result.

Tests.—

(1) Its odour and volatility.

(2) The formation of the *white cyanide of silver* upon the addition of a solution of nitrate of silver ($AgNO_3$). Thus—

$$AgNO_3 + HCy = HNO_3 + AgCy,$$

Nitric acid and cyanide of silver are formed.

The cyanide of silver has the following characters:

(*a*) It is soluble in *boiling strong nitric acid.*

(*b*) When heated it gives off *cyanogen gas* which, upon the application of a light, burns with a *rose-coloured* flame.

(3) The formation of *Prussian blue* $\left\{ Fe_4(FeCy_6)_3 + 18H_2O \right\}$ by the following method:

Liquor Potassæ (KHO) is added to the prussic acid (HCy) forming cyanide of potassium (KCy); then a proto- and per-salt of iron are added; this operation is followed by the formation of a proto- and per- cyanide of iron; but Prussian blue *cannot exist* in the presence of the alkali *potash*, so a mineral acid (sulphuric acid is the best) is employed to neutralize the alkali. Upon the addition of this acid, the Prussian blue is immediately developed. Thus—

$$\left\{\begin{array}{c}\text{Prussic acid}\\ 18HCy\end{array}\right. + \left\{\begin{array}{c}\text{Liq. potassæ}\\ 18KHO\end{array}\right. + \left\{\begin{array}{c}\text{Ferrous sulphate}\\ 5FeSO_4.\end{array}\right.$$
$$+ \left\{\begin{array}{c}\text{Ferric Sulphate}\\ Fe_2(SO_4)_3\end{array}\right. + \left\{\begin{array}{c}\text{Sulphuric acid}\\ H_2SO_4\end{array}\right. = \left\{\begin{array}{c}\text{Sulphate of potash}\\ 9K_2SO_4\end{array}\right.$$
$$+ \left\{\begin{array}{c}\text{Hydrogen}\\ 2H\end{array}\right. + \left\{\begin{array}{c}\text{Ferrocyanide of Ferric iron or Prussian blue}\\ Fe_4\,(FeCy_6)_3,\ 18H_2O.\end{array}\right.$$

(4) The formation of the *blood-red sulpho-cyanide of iron* ($Fe_2(SCy)_6$) as follows:

Some prussic acid is heated upon a watch-glass to a syrupy consistence with a drop or two of sulphide of ammonium (NH_4HS). Thus—

(*a*) $HCy + NH_4HS = 2H + NH_4SCy$:

Hydrogen and sulphocyanide of ammonium (white) result.

(*b*) Perchloride of iron (Fe_2Cl_6) is added to NH_4SCy. Thus—

$$6NH_4SCy + Fe_2Cl_6 = 6NH_4Cl + Fe_2(SCy)_6.$$

Chloride of ammonium and sulphocyanide of iron (red) are formed.

The *Acidum Hydrocyanicum Dilutum* of the British Pharmacopœia consists of hydrocyanic acid dissolved in water and constitutes 2 per cent. by weight of the solution.

Scheele's prussic acid contains 4 per cent. of the anhydrous acid.

The anhydrous acid is very volatile, and speedily decomposes into a carbonaceous mass. The diluted acid can be much longer preserved if a trace of a mineral acid be present.

The strength of any solution of prussic acid may be detected by adding a solution of nitrate of silver to 100 grains of the solution as long as a precipitate falls. Collect this, dry and weigh it, and divide its weight by 5; the answer will be the per-centage. Thus, if 10 grains fall, then there is 2 per cent. present.

THE HALOGENS.

Under this heading we describe four elements, viz.:—*Chlorine, Bromine, Iodine, and Fluorine.* They have received this name from the fact of their forming salts *analogous in their composition* to common salt, or chloride of sodium (NaCl).

CHLORINE (chloros, green).

Symbol, Cl. Atomic weight, 35·5. Density, 35·5. Sp. gr. 1·33

Description and Sources.—A gas; never native; of a *greenish yellow colour* with a peculiar *disagreeable odour*, which in small quantities resembles that of seaweed; in large quantities a powerful irritant, causing inflammation of the mucous membrane, and even producing a fatal result when inhaled. Can be condensed to a heavy yellow liquid, but has never been solidified. Found combined with metals as chlorides. *Dry* chlorine will *not bleach*, but *when water is added does so powerfully.* Only bleaches *vegetable colours,* mineral colours being unaffected. Is not combustible, but supports combustion. An aqueous solution of chlorine will dissolve gold leaf. Discovered by Scheele in 1774. Liquefied by a pressure of 4 atmospheres.

Preparation.—(1) By heating the dioxide of manganese (MnO_2) with hydrochloric acid (HCl). Thus—

$$MnO_2 + 4HCl = MnCl_2 + 2H_2O + 2Cl,$$

Manganese chloride, water, and chlorine result.

(2) By heating sulphuric acid (H_2SO_4) with dioxide of manganese (MnO_2) and chloride of sodium (NaCl). Thus—

$$2NaCl + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + 2Cl.$$

Sulphate of soda, sulphate of manganese, water and chlorine are formed.

This gas cannot be collected over cold water or mercury, since the former dissolves 2·37 volumes of Cl at 15°C, and with the latter mercuric chloride is formed. It may be collected by displacement, being nearly 2·5 times as heavy as air, but is conveniently prepared over *warm* water.

Tests.—(1) Its *greenish-yellow* colour, and its odour.

(2) A lighted candle placed in Cl *continues to burn*, but with a very *smoky* flame; the hydrogen of the wax enters into combination with the Cl forming hydrochloric acid (HCl), whilst its carbon is given off from the wax as soot.

(3) Phosphorus burns *spontaneously* in chlorine.

(4) Certain metals, as arsenic, antimony, copper and gold, *in a fine state of division or attenuation*, and paper dipped in oil of turpentine, take fire *spontaneously* when thrown into chlorine.

CHLORINE WITH HYDROGEN
forms
HYDROCHLORIC ACID. HYDRIC CHLORIDE.

Symbol, HCl. Combining weight, 36·5. Density, 18·25.

Description.—A gas; colourless, poisonous, and pungent, neither combustible nor supporting combustion. Has very acid properties and is very soluble in water, one volume of which at 15°C dissolves 454 volumes of the gas. Discovered by Priestley in 1772. Liquefied by a pressure of 40 atmospheres.

Preparation.—(1) By the union of H and Cl, in equal volumes, in the sunlight or by heat. Thus—

$$H + Cl = HCl.$$

(2) By heating sulphuric acid (H_2SO_4) upon chloride of sodium (NaCl). Thus—

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl.$$

Sodium sulphate and hydrochloric acid are formed.

Tests.—For the strong or *concentrated* acid (a solution of the gas in water).

(1) *Whitens* the skin, forming chloride of albumen.

(2) *Dissolves gold leaf* in the presence of nitric acid (HNO_3).

(3) Gives off *chlorine gas* when added to dioxide of manganese.

(4) Gives *white fumes* with the vapour of ammonia.

For the *diluted* acid or a *soluble chloride.*

Nitrate of silver ($AgNO_3$) gives a *white* precipitate of the chloride of silver ($AgCl$). This precipitate is recognised by the following characters—

(*a*) It is soluble in liquor ammoniæ, and reprecipitated by nitric acid.

(*b*) It blackens by exposure to light.

(*c*) When heated, it melts to a mass called horn silver.

Hydrochloric acid, when added to nitric acid, forms—

Aqua Regia.—This mixture dissolves the noble metals, namely gold and platinum, the solvent action being dependent upon the chlorine, which is set free by the oxidising agency of the nitric acid upon the hydrogen of the HCl, soluble chlorides being formed. The nitric acid is reduced to nitrogen dioxide (N_2O_2); and nitrous oxychloride ($NOCl$), and nitric oxychloride ($NOCl_2$), are liberated as yellowish gases.

COMPOUNDS OF CHLORINE WITH OXYGEN.

Chlorine and oxygen do not unite directly, but indirectly they form the following compounds, viz. :—

Cl_2O, chlorine monoxide, yielding $HClO$ hypochlorous acid. Thus—

$$Cl_2O + H_2O = 2HClO.$$

Cl_2O_3, chlorine trioxide, yielding $HClO_2$, chlorous acid. Thus—

$$Cl_2O_3 + H_2O = 2HClO_2.$$

Cl_2O_4, chlorine tetroxide.

$HClO_3$, chloric acid.

$HClO_4$, perchloric acid.

No acid corresponding to chlorine tetroxide, or any oxides corresponding to chloric and perchloric acids, have as yet been prepared.

CHLORINE MONOXIDE.

Symbol, Cl_2O. Molecular weight, 87. Density, 43·5.

Description.—A gas, condensible to a red explosive liquid, very soluble in water, forming a yellow solution which bleaches vegetable colours more entirely than chlorine.

Preparation.—From mercuric oxide (HgO) and chlorine (Cl). Thus—

$$2HgO + 4Cl = Hg_2Cl_2O + Cl_2O.$$

Mercuric oxychloride, and chlorine monoxide, are formed.

BLEACHING POWDER

Is a mixture of chloride of calcium ($CaCl_2$), and hypochlorite of calcium ($CaCl_2O_2$). It is prepared by passing chlorine gas (Cl) into slaked lime (CaH_2O_2). Thus—

$$2CaH_2O_2 + 4Cl = 2H_2O + CaCl_2 + CaCl_2O_2.$$

The chlorine for this preparation is now obtained on a large scale by passing hydrochloric acid gas and air over heated sulphate of copper ($CuSO_4$). The H of the HCl, and the O of the air form water, setting free the chlorine. The sulphate of copper undergoes no change whatever.

HYPOCHLOROUS ACID.

Symbol, $HClO$.

A colourless liquid with a peculiar smell and strong bleaching properties.

Preparation.—From carbonate of lime ($CaCO_3$), water (H_2O), and chlorine (Cl). Thus—

$$CaCO_3 + H_2O + 4Cl = CO_2 + CaCl_2 + 2HClO.$$

Carbonic anhydride, chloride of calcium, and hypochlorous acid are formed.

CHLORINE TRIOXIDE.

Symbol, Cl_2O_3.

A gas of a deep yellowish-green colour. Formed by the action of nitric acid (HNO_3) upon arsenious anhydride (As_2O_3), chlorate of potash ($KClO_3$) and water (H_2O). Thus—

$$2KClO_3 + As_2O_3 + 2HNO_3 + 2H_2O = 2H_3AsO_4 + 2KNO_3 + Cl_2O_3.$$

Arsenic acid, nitrate of potash, and chlorine trioxide result.

CHLOROUS ACID.

Symbol, $HClO_2$.

Is prepared by condensing Cl_2O_3 gas in water; it is a greenish-yellow liquid, which bleaches and oxidises.

CHLORINE TETROXIDE.

Symbol, Cl_2O_4.

A deep yellow gas, and at -20°C a red liquid.

Preparation.—By the action of sulphuric acid (H_2SO_4) upon chlorate of potash ($KClO_3$). Thus—

$$6KClO_3 + 3H_2SO_4 = 3K_2SO_4 + 2HClO_4 + 2H_2O + 2Cl_2O_4,$$

Sulphate of potash, perchloric acid, water, and chlorine tetroxide result, the gas being collected by displacement.

This gas is very liable to decompose with violent explosions, and is soluble in water, yielding mixtures of chlorite and chlorate.

CHLORIC ACID.

Symbol, $HClO_3$.

A syrupy, strongly acid liquid, and a powerful oxidising agent. When dropped upon paper it takes fire, giving up its oxygen; forms salts called chlorates, all of which are soluble in water.

Preparation.—From barium chlorate ($Ba2ClO_3$) and sulphuric acid (H_2SO_4). Thus—

$$Ba2ClO_3 + H_2SO_4 = BaSO_4 + 2HClO_3.$$

Sulphate of baryta and chloric acid result.

PERCHLORIC ACID.

Symbol, $HClO_4$. Molecular weight, 100·5.

Description.—An oil-like liquid, forming with water a crystalline hydrate. One of the most powerful oxidising agents known; if dropped on wood or paper it instantly causes ignition, and when thrown on charcoal it decomposes with detonation. It is the most stable of all the acids derived from chlorine.

Preparation.—By distilling chlorate of potash ($KClO_3$) with sulphuric acid (H_2SO_4) in a retort. Thus—

$$4KClO_3 + 2H_2SO_4 = 2K_2SO_4 + H_2O + 3O + 2Cl + 2HClO_4.$$

Sulphate of potash, water, oxygen, chlorine and perchloric acid are formed.

The following, then, is the unbroken series of the acids of chlorine, increasing step by step by one atom of O:—

HCl, hydrochloric acid.
$HClO$, hypochlorous acid.
$HClO_2$, chlorous acid.
$HClO_3$, chloric acid.
$HClO_4$, perchloric acid.

COMPOUND OF CHLORINE WITH NITROGEN.

This is formed only indirectly, and its composition has not as yet been precisely ascertained. It is obtained by passing *excess* of chlorine gas through a solution of ammonia. It is an oily liquid of specific gravity, 1·653, which when touched explodes with fearful violence. Its hypothetical formula is NCl_3.

COMPOUNDS OF CHLORINE WITH CARBON.

These can only be made indirectly, and amongst them are the following:

Carbon tetrachloride, CCl_4.
Ethylene chloride, C_2Cl_4.
Carbon perchloride, C_2Cl_6.
Carbon oxy-chloride, $COCl_2$.

With marsh gas (CH_4) the following stages in the substitution of hydrogen by chlorine occur:—

(1) $CH_4 + 2Cl = CH_3Cl + HCl$.
(2) $CH_3Cl + 2Cl = CH_2Cl_2 + HCl$.
(3) $CH_2Cl_2 + 2Cl = CHCl_3 + HCl$.
(4) $CHCl_3 + 2Cl = CCl_4 + HCl$.

The properties of these compounds must be left for discussion under organic chemistry.

BROMINE—(bromos, a stench).

Symbol, Br. Combining weight, 80. Density, 80.

Description.—A fluid; the only element liquid at ordinary temperatures except mercury. Of a dark reddish-brown colour by reflected light, but hyacinth-red by light transmitted through thin layers, and emitting an irritating, poisonous vapour. A monad replacing one atom of hydrogen, as seen in the composition of hydrobromic acid, H/Br.; specific gravity at 4°C is 2·966. Freezes at -22°C to a black solid, and boils at 63°C. About 30 parts of water dissolve one part of Br at 15°C. The solution has bleaching powers, but these are feebler than those of chlorine. Bromine is very soluble in alcohol, and more so in ether. Forms salts called bromides. Discovered by Balard in 1826.

Sources. — Not free in nature. Found combined with sodium and magnesium in some mineral springs, and in sea water.

Preparation.—From "bittern," the residue of sea water, after the crystallisation of common salt (NaCl). Here it exists in the form of bromide of magnesium ($MgBr_2$), and through this chlorine gas is passed. Thus—

$$MgBr_2 + 2Cl = MgCl_2 + 2Br.$$

The freed bromine is shaken up with ether, which rises with it to the surface, and is then separated by a pipette. Caustic potash (KHO) is now added, and the solution evaporated to dryness. Thus, bromide of potassium (KBr) is obtained, and to this black oxide of manganese (MnO_2), and sulphuric acid (H_2SO_4) are added. Thus—

$$2KBr + MnO_2 + 2H_2SO_4 = K_2SO_4 + MnSO_4 + 2H_2O + 2Br.$$

Sulphate of potash, sulphate of manganese, and water result, the bromine being collected and condensed in cold water.

HYDROBROMIC ACID.

Symbol, HBr. Molecular weight, 81. Density, 40·5.

Description.—A gas, colourless, strongly acid, fuming in moist air; very soluble in water.

Preparation.—H and Br will not unite directly, even in the sunlight, but can be made to do so :

(1) By passing them through a red-hot porcelain tube.

(2) By the action of Br and phosphorus (P) upon water. Thus—

$$P + 5Br + 4H_2O = H_3PO_4 + 5HBr.$$

Violent action takes place, and phosphoric acid and hydrobromic acid result.

COMPOUNDS OF BROMINE WITH OXYGEN.

(1) HYPOBROMOUS ACID ($HBrO$) is known only in aqueous solution, and the corresponding monoxide (Br_2O) is altogether unknown. This acid bleaches vegetable colouring matters ; and bromine forms with slaked lime an analogue to bleaching powder, which consists of calcium bromide, and calcium hypobromite ($CaBr_2$, $CaBr_2O_2$).

Preparation.—By the action of bromine water upon red oxide of mercury (HgO). Thus—

$$HgO + 4Br + H_2O = HgBr_2 + 2HBrO.$$

Bromide of mercury and hypobromous acid are formed.

(2) BROMIC ACID ($HBrO_3$) corresponds to chloric acid ($HClO_3$) and forms bromates with metallic oxides, which are decomposed by heat in a similar manner to chlorates.

Preparation.—By the action of chlorine (Cl) upon bromine water ($Br + H_2O$). Thus—

$$Br + 3H_2O + 5Cl = 5HCl + HBrO_3.$$

Hydrochloric acid and bromic acid are formed.

(3) BROMINE PENTOXIDE (Br_2O_5) has not as yet been isolated, but

(4) PERBROMIC ACID ($HBrO_4$) has been prepared by the action of bromine upon perchloric acid ($HClO_4$). Thus—

$$Br + HClO_4 = Cl + HBrO_4.$$

Chlorine and perbromic acid resulting.

BROMIDE OF NITROGEN (NBr_3) is an oily detonating fluid.

Tests for Bromine.—(1) The *orange* bromide of starch, formed by the addition of starch to this substance.

(2) Nitrate of silver gives a light *yellow* precipitate of *bromide of silver*, sparingly soluble in liquor ammoniæ.

IODINE—(ion, a violet, eidos, like).

Symbol, I. Combining weight, 127. Density, 127.

Description.—A solid element occurring in black scales or laminar crystals, with a grey metallic lustre. Fuses at 107°C ; boils at 180°C. Specific gravity, 4·95. Only slightly soluble in water, but very soluble in alcohol and ether. Upon heating gives off *violet vapours*, whence its name (*ion*, a violet, and *eidos*, like). Forms salts called *iodides;* a monad element, replacing one atom of hydrogen, as shown in the composition of hydriodic acid, H/I. Its properties are not so active as those of chlorine and bromine, by which substances it is liberated from its compounds. Discovered by Courtois in 1812.

Sources.—Found combined with metals in sea-water and in various springs.

Preparation.—From a solution of "kelp," the vitrified ashes of sea-wrack. After the removal of various salts (the iodine existing as iodide of sodium, (NaI), black oxide of manganese (MnO_2) and sulphuric acid (H_2SO_4) are added. Thus—

$$2NaI + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + 2I.$$

Sulphate of soda, sulphate of manganese, water, and iodine are formed.

Tests.—(1) The *violet vapours* produced by heating free iodine.

(2) The *blue* colour which its solution forms with starch (the iodide of starch).

With regard to the preparation of the foregoing three substances, Cl, I, and Br, it will be seen that one equation will serve for them all, making, of course, the requisite substitutions. Thus—

$$2\left\{\begin{array}{l}NaCl\\NaI\\KBr\end{array}\right. + MnO_2 + 2H_2SO_4 = \left\{\begin{array}{l}Na_2SO_4\\K_2SO_4\end{array}\right. + MnSO_4 + 2H_2O + 2\left\{\begin{array}{l}Cl.\\I.\\Br.\end{array}\right.$$

IODINE WITH HYDROGEN forms
HYDRIODIC ACID.

Symbol, HI. Molecular weight, 128. Density, 64.

Description.—A gas; colourless, irritating and fuming, with a strong acid reaction; very soluble in water; gradually decomposed by air. Solidifies at -55°C.

Preparation.—(1) By heating iodine and hydrogen together.

(2) From tri-iodide of phosphorus (PI_3) and water (H_2O). Thus—

$$PI_3 + 3H_2O = H_3PO_3 + 3HI.$$

Phosphorous acid and hydriodic acid are formed.

IODINE WITH OXYGEN AND HYDROGEN forms the following acids :—

(1) IODIC ACID, HIO_3. Molecular weight, 176. Occurs in white crystals, and corresponds to chloric acid.

Preparation.—(1) By the oxidation of iodine by nitric acid.

(2) By the action of chlorine upon iodine water. Thus—

$$I + 3H_2O + 5Cl = 5HCl + HIO_3.$$

Hydrochloric acid and iodic acid result.

By heating HIO_3 to 170°C, we obtain iodine pentoxide (I_2O_5), a white crystalline solid.

(2) PERIODIC ACID, HIO_4. Molecular weight, 192. A white crystalline solid, which, by heat, breaks up into I_2O_5, water and oxygen.

Preparation.—From perchloric acid ($HClO_4$) and iodine. Thus—

$$HClO_4 + I = Cl + HIO_4.$$

Chlorine and periodic acid are produced.

By heating HIO_4 to 160°C we obtain *iodine heptoxide* (I_2O_7).

IODINE WITH NITROGEN

Forms a black powder (NI_3), iodide of nitrogen. This, when touched in the dry state, decomposes with a sudden loud report, or may even sometimes explode spontaneously.

Preparation.—By the action of a strong alcoholic solution of iodine upon ammonia. This may be expressed as follows :—

$$6I + 4NH_3 = 3NH_4I + NI_3.$$

Iodide of ammonium and iodide of nitrogen are formed.

FLUORINE—(fluo, to flow).

Symbol, F. Combining weight, 19.

Description.—A gas ?; colourless ; not acting upon glass like hydrofluoric acid. A monad element replacing one atom of hydrogen, as shown in the composition of hydrofluoric acid, H/F. Is absorbed by caustic potash (KHO). Thus—

$$2KHO + 2F = H_2O_2 + 2KF.$$

Forming hydrogen dioxide and fluoride of potassium.

Fluorine forms no compounds with oxygen.

Sources.—Found combined with calcium as fluorspar (Derbyshire spar), or fluoride of calcium. Also in cryolite ($3NaF + AlF_3$), a double fluoride of sodium and aluminium. It has been detected in the teeth and blood of animals.

Preparation.—Has been obtained with great difficulty by passing dry iodine (I) over dry fluoride of silver (AgF). Thus—

$$AgF + I = AgI + F.$$

Iodide of silver and fluorine being formed.

FLUORINE WITH HYDROGEN forms HYDROFLUORIC ACID.

Symbol, HF. Molecular weight, 20. Density, 10.

Description.—A gas; colourless; very corrosive; produces painful wounds when handled; fumes strongly in the air. In contact with water it dissolves with a hissing noise, forming the hydrate ($HF, 2H_2O$).

Preparation.—From fluoride of calcium (CaF_2) by the action of sulphuric acid (H_2SO_4). Thus—

$$CaF_2 + H_2SO_4 = CaSO_4 + 2HF.$$

Sulphate of lime and hydrofluoric acid are formed.* This acid has the peculiar property of *etching* glass, by uniting with the silicon of its silica (SiO_2). Thus—

$$SiO_2 + 4HF = 2H_2O + SiF_4.$$

Water and fluoride of silicon are formed.

THE ANALOGIES, GRADATIONS, AND RELATIONS OF THE HALOGEN GROUP.

(1) Chlorine is a *gas;* bromine, a *liquid;* and iodine, a *solid* at ordinary temperatures.

(2) Liquid chlorine is *transparent.* Liquid bromine *slightly so,* and liquid iodine is *opaque.*

(3) The vapour of chlorine is *yellowish-green,* that of bromine is *orange,* and that of iodine is *violet.*

(4) The sp. gr. of liquid chlorine is 1·33; of liquid bromine 2·97; and of liquid iodine, 4·95.

(5) The combining weight and, therefore, the density of bromine (80) is nearly the mean of chlorine (35·5) and iodine (127). Thus—

$$\frac{35{\cdot}5 + 127}{2} = 81{\cdot}25$$

(6) They all form, with hydrogen, compounds containing equal volumes of the constituent gases united without condensation. Thus—

$$H/Cl;\ H/Br;\ H/I;\ H/F.$$

(7) All these last are colourless gases which fume in air; HCl (hydrochloric acid) is *very stable;* HBr (hydrobromic acid) *not* very stable; HI (hydriodic acid) *very unstable;* HF (hydrofluoric acid) is stable.

(8) Chlorine is *readily* soluble in water, bromine only *moderately* so, and iodine is *scarcely* soluble.

(9) Chlorine displaces bromine and iodine from their com-

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* Prepared in leaden or platinum vessels.

pounds; bromine displaces iodine and fluorine; and iodine displaces fluorine.

(10) All their *crystalline forms* with metals are *cubes.*

SULPHUR.

Symbol, S. Combining weight, 32. Density, 32.

Description and Sources.—A solid element, occurring native in volcanic districts, as Sicily and Iceland, crystallising in yellow rhombic octahedra; in combination, as orpiment, or arsenic trisulphide (As_2S_3), greenockite, or sulphide of cadmium (CdS); Realgar (As_2S_2); iron pyrites (FeS_2); magnetic pyrites (Fe_7S_8); silver-glance (Ag_2S); cinnabar, or sulphide of mercury (HgS); cobalt-glance, containing cobalt, arsenic and sulphur ($CoAsS$); nickel-glance, containing nickel, arsenic and sulphur ($NiAsS$); sulphide of lead, or galena (PbS); zinc sulphide, or blende (ZnS); copper sulphide (CuS). In combination with metals and oxygen as gypsum, or calcium sulphate ($CaSO_4 + 2H_2O$); heavy spar, or barium sulphate ($BaSO_4$); Glauber's salts, or sodium sulphate ($NaSO_4 + 10H_2O$); as sulphuretted hydrogen (H_2S), in certain springs, as those of Harrogate. Sulphur crystallises in two irreconcileable geometrical forms, and is hence called di-morphous. A dyad element.

Preparation.—To obtain sulphur pure, the mineral in which it is contained is heated in earthenware pots. The sulphur distils over as vapour, and is condensed in similar pots outside the furnace.

Flowers of Sulphur, is the name given to the fine crystalline powder, into which the vapour of sulphur solidifies, when it is quickly cooled below its melting point. This occurs in the same manner that aqueous vapour is deposited as snow.

Brimstone, or Roll Sulphur, is formed when sulphur is gently heated, after which it melts, and is cast into sticks.

Sulphur exists in three modifications, which are insoluble in water, and in most organic fluids, viz.:

(1) The rhombic octahedron in nature, of specific gravity 2·07; soluble in disulphide of carbon (CS_2).

(2) The long transparent needle-shaped prismatic crystals, entirely different to the first form, also soluble in CS_2. These are produced by allowing melted sulphur to cool slowly, and have the specific gravity of 1·98. The crystals become opaque after some days' exposure to air, since they split up into crystals of the natural form.

(3) A soft tenacious caoutchouc mass of specific gravity 1·96 and insoluble in CS_2, obtained by pouring melted

sulphur, heated to 230°C into cold water; at the ordinary temperature of the air, this form of sulphur assumes the ordinary brittle variety, and if heated to 100°C, it instantly changes to this form.

These modifications may be rendered apparent by simply heating sulphur: at 115°C, this substance melts, and forms an amber-coloured mobile liquid. With the rise of the temperature a dark-coloured thick treacly liquid is formed, and this at 250°C can scarcely be poured out of the vessel: above 250°C a reddish-black thin liquid is formed, which remains in this condition until the temperature of 490°C is attained, when it begins to boil, giving off a red vapour.

Sulphur is inflammable, and when heated in the air, burns with a blueish flame, forming a gas, sulphur dioxide (SO_2), which emits a suffocating odour.

Direct compounds of sulphur with chlorine, carbon, and most other elements, are known, and many metals burn in sulphur vapour, forming sulphides.

The compounds of SULPHUR WITH OXYGEN AND HYDROGEN are as follows:

(1) ... ... H_2SO_2 Hydrosulphurous acid.
(2) SO_2 Sulphur dioxide, yielding H_2SO_3 Sulphurous acid, thus:

$$SO_2 + H_2O = H_2SO_3.$$

(3) SO_3 Sulphur trioxide, yielding H_2SO_4 Sulphuric acid, thus:

$$SO_3 + H_2O = H_2SO_4.$$

(4) ... ... $H_2S_2O_3$ Hyposulphurous acid.
(5) ... ... $H_2S_2O_6$ Dithionic acid. θεῖον =
(6) ... ... $H_2S_3O_6$ Trithionic acid.
(7) ... ... $H_2S_4O_6$ Tetrathionic acid.
(8) ... ... $H_2S_5O_6$ Pentathionic acid.

The oxides corresponding to the acids (1) (4) (5) (6) (7) (8) are unknown. The acids sulphurous, sulphuric, and hyposulphurous, are of importance, but little is as yet known concerning the others.

HYDROSULPHUROUS ACID.

Symbol, H_2SO_2.

Description.—A yellow liquid which instantly bleaches vegetable colouring matters, and is a far more powerful reducing agent than sulphurous acid. It forms a series of salts which, although stable when dry, are, in solution, rapidly converted into hyposulphites.

Preparation.—By the action of sulphurous anhydride (SO_2) and water (H_2O) upon metallic zinc (Zn). Thus—

$$Zn + 2SO_2 + H_2O = ZnSO_3 + H_2SO_2.$$

Sulphite of zinc and hydrosulphurous acid are formed.

SULPHUR DIOXIDE.

Symbol, SO_2. Molecular weight, 64. Density, 32.

Description.—A gas; pungent, colourless, irrespirable and suffocating; is always formed when sulphur is burnt, and is given off from volcanic craters.

Preparation.—(1) By acting upon metallic copper (Cu) with sulphuric acid (H_2SO_4) and heat. Thus—

$$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O + SO_2.$$

Sulphate of copper, water, and sulphur dioxide result.

(2) By the deoxidation of sulphuric acid (H_2SO_4) by means of wood charcoal (C) and heat. Thus—

$$2H_2SO_4 + C = 2H_2O + CO_2 + 2SO_2.$$

Water, carbonic anhydride, and sulphur dioxide, result.

This gas may be collected over mercury, or by displacement. Cold water takes up 30 times its volume of SO_2. When cooled to -10°C it condenses to a colourless liquid, and below -76°C the liquid freezes to a transparent solid.

A solution of SO_2 in water consists of true sulphurous acid or hydrogen sulphite, H_2SO_3. Upon boiling this liquid SO_2 escapes as a gas. Upon cooling a solution of the gas in water below 5°C sulphurous acid separates as a crystalline hydrate ($H_2SO_3 + 14H_2O$).

SO_2 is largely used for bleaching purposes, especially for substances not acted upon by chlorine, and also as an antichlor for getting rid of the excess of chlorine contained in the bleached rags from which paper is made. Thus—

$$SO_2 + 2H_2O + 2Cl = H_2SO_4 + 2HCl.$$

Sulphuric and hydrochloric acids are formed.

Tests.—(1) H_2SO_3 is a colourless liquid, with an odour of burning sulphur.

(2) It reduces gold chloride, precipitating metallic gold.

(3) It liberates iodine from its compounds, and, if starch be present, produces the blue iodide of amiden.

SO_2, when moistened with H_2O, bleaches in an exactly opposite manner to Cl, since SO_2 abstracts the oxygen and liberates the hydrogen, whilst Cl abstracts the hydrogen and liberates the oxygen.

SULPHUR TRIOXIDE. SULPHURIC ANHYDRIDE.

Symbol, SO_3. Molecular weight, 80. Density, 40.

Sulphur dioxide gas (SO_2) and oxygen (O) will not, under ordinary circumstances, unite directly to form SO_3, but if they be passed together over finely divided and heated metallic platinum, they combine to form dense white fumes which condense to long prismatic crystals of SO_3, changing after a time to white silky needles. This substance does not redden litmus, and when moulded by the fingers, does not char the dry skin; when in contact with water, however, combination takes place with loud hissing, like a red-hot iron, sulphuric acid, H_2SO_4, being formed. By gently heating the Nordhausen sulphuric acid (see below) SO_3 sublimes.

SULPHURIC ACID. HYDROGEN SULPHATE.

Symbol, H_2SO_4. Molecular weight, 98.

Description.—A heavy, oily liquid, "oil of vitriol," of specific gravity 1·848, and boiling at 338°C. It chars organic bodies, and is one of the most powerful acids known.

A dibasic acid, as indicated by its composition, $\left.\begin{matrix}H\\H\end{matrix}\right\} SO_4$. Most of the acids are prepared by its agency. Discovered by Valentine in the 15th century.

Preparation.—This acid was first prepared by the distillation of ferrous sulphate ($FeSO_4+7H_2O$), and in this mode is known as *the fuming or Nordhausen acid*, having the formula $H_2SO_4 + SO_3$ (a mixture of sulphuric acid and sulphuric anhydride), a heavy, dark, fuming liquid, used only in the arts, chiefly for dissolving indigo.

The usual method of preparation is, however, *by the combustion of sulphur* (S) *and the oxidation of the resulting sulphurous anhydride* (SO_2) *by means of nitrous anhydride* (N_2O_3). The operation is conducted in huge leaden chambers, often of a capacity of 100,000 cubic feet, sulphur (S) or iron pyrites (FeS_2) being burnt at one end, and nitrate of potash (KNO_3) at the other. From the sulphur SO_2 is given off, while from the KNO_3 arises N_2O_3, which immediately parts with one atom of oxygen (O) to the SO_2, forming SO_3, or sulphuric anhydride; thus N_2O_2 is left, and this acquiring more O from the air, becomes again N_2O_3, ready to part with a fresh supply of O for the SO_2 continually coming off from the burning sulphur.

Jets of steam (H_2O) are now blown into the chamber, and uniting with the SO_3 form H_2SO_4. This acid falls to the floor of the chamber, and is continually drawn off, the excess of water being removed by evaporation. The chamber acid is then heated as follows:

(1) In *leaden pans* until it attains a specific gravity of 1·72; then known as *the brown oil of vitriol of commerce*, and—

(2) Concentrated in *glass or platinum vessels* until the maxi-

mum specific gravity and strength are attained. We may represent the changes in the preparation as follows:

	Sulphurous anhydride		Nitrous anhydride		Nitric oxide		Sulphuric anhydride
(a)	SO_2	+	N_2O_3	=	N_2O_2	+	SO_3

	Sulphuric anhydride		Steam		Sulphuric acid
(b)	SO_3	+	H_2O	=	H_2SO_4

Tests.—For the *concentrated* sulphuric acid:

(1) Its great weight.

(2) Its energetic union with water, giving out great heat.

(3) Its charring organic bodies.

(4) With metallic copper (Cu) and heat giving off SO_2, which is known by its odour.

For the *diluted* acid or a *soluble* sulphate.

Any soluble salt of barium (Ba) as the chloride ($BaCl_2$) or the nitrate ($Ba2NO_3$) gives a white precipitate of sulphate of baryta ($BaSO_4$), insoluble in all alkalies and in all acids except boiling sulphuric, but from that deposited upon cooling. $BaSO_4$, reduced with charcoal (C) by the blow-pipe flame, yields BaS (sulphide of barium), and this gives up H_2S (sulphuretted hydrogen) upon the addition of a mineral acid.

Action of sulphuric acid upon the metals.

Upon the addition of water, zinc (Zn) and iron (Fe) are converted by H_2SO_4 into sulphate of zinc ($ZnSO_4$) and sulphate of iron ($FeSO_4$) respectively, with evolution of hydrogen (H); whilst copper (Cu) and mercury (Hg) become with heat and the same reagent sulphate of copper ($CuSO_4$) and sulphate of mercury ($HgSO_4$), with the production of sulphurous anhydride (SO_2).

HYPOSULPHUROUS ACID. HYDROGEN HYPOSULPHITE.

Symbol, $H_2S_2O_3$?; only known in metallic combination as sodium hyposulphite ($Na_2S_2O_3 + 5H_2O$), or potassium hyposulphite ($K_2S_2O_3 + 5H_2O$). It cannot be freed from the sodium or potassium. Since these salts have the power of dissolving the silver salts which have escaped the action of light, they are largely used for fixing the image in photography. Sodium hyposulphite is prepared by passing sulphur dioxide (SO_2) into a mixture of sodium sulphide (Na_2S) and caustic soda (NaHO). Thus—

$$2Na_2S + 2NaHO + 4SO_2 = H_2O + 3Na_2S_2O_3,$$

Water and sodium hyposulphite resulting.

$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O, +$

DITHIONIC ACID.

Symbol, $H_2S_2O_6$; a colourless, odourless, sour liquid. All dithionates are soluble in water.

Preparation.—(a) By acting upon manganese dioxide (MnO_2) with sulphur dioxide (SO_2). Thus—

$$MnO_2 + 2SO_2 = MnS_2O_6.$$

Manganese dithionate is formed.

(b) By the addition of barium hydrate (BaH_2O_2) to manganese dithionate (MnS_2O_6). Thus—

$$MnS_2O_6 + BaH_2O_2 = MnH_2O_2 + BaS_2O_6.$$

Manganese hydrate is precipitated, and barium dithionate left in solution.

(c) By acting upon barium dithionate (BaS_2O_6) with sulphuric acid (H_2SO_4). Thus—

$$BaS_2O_6 + H_2SO_4 = BaSO_4 + H_2S_2O_6.$$

Barium sulphate and dithionic acid are formed.

TRITHIONIC ACID.

Symbol, $H_2S_3O_6$. This acid decomposes spontaneously into sulphur (S), sulphurous anhydride (SO_2), and sulphurous acid (H_2SO_3).

Preparation.—From potassium hyposulphite ($K_2S_2O_3$), and sulphurous anhydride (SO_2). Thus—

$$2K_2S_2O_3 + 3SO_2 = S + 2K_2S_3O_6.$$

Sulphur and potassium trithionate are formed.

The acid is freed by hydrofluosilicic acid (H_2SiF_6). Thus—

$$K_2S_3O_6 + H_2SiF_6 = K_2SiF_6 + H_2S_3O_6.$$

Potassium fluosilicate and trithionic acid being formed.

TETRATHIONIC ACID.

Symbol, $H_2S_4O_6$. Decomposes by heat, like trithionic acid.

Preparation.—(a) By acting upon barium hyposulphite (BaS_2O_3), with iodine (I). Thus—

$$2I + 2BaS_2O_3 = BaI_2 + BaS_4O_6.$$

Iodide of barium and tetrathionate of barium result.

(b) By acting upon BaS_4O_6, with sulphuric acid (H_2SO_4). Thus—

$$BaS_4O_6 + H_2SO_4 = BaSO_4 + H_2S_4O_6.$$

Barium sulphate and tetrathionic acid are formed.

PENTATHIONIC ACID.

Symbol, $H_2S_5O_6$. Colourless, odourless, with an acid and bitter taste; a most unstable substance; gives a yellow precipitate with the subnitrate of mercury, and a yellow precipitate (turning black) with nitrate of silver.

Preparation.—From sulphurous acid (H_2SO_3) and sulphuretted hydrogen (H_2S). Thus—

$$5H_2SO_3 + 5H_2S = 5S + 9H_2O + H_2S_5O_6.$$

Sulphur, water, and pentathionic acid result.

SULPHUR WITH HYDROGEN forms two compounds, viz.:

(1) H_2S. Hydrogen sulphide, or sulphuretted hydrogen.
(2) H_2S_2. Hydrogen persulphide, or hydrogen disulphide.

SULPHURETTED HYDROGEN.

Symbol, H_2S. Molecular weight, 34. Density, 17.

Description.—A gas; colourless, narcotic, with an odour of rotten eggs; inflammable, burning with a blue flame, forming water and sulphurous anhydride. Discovered by Scheele in 1777.

Preparation.—(1) By passing hydrogen gas (H) through boiling sulphur (S).

(2) By the action of diluted sulphuric acid (H_2SO_4,H_2O), upon sulphide of iron (FeS). Thus—

$$FeS + H_2SO_4,H_2O = FeSO_4 + H_2O + H_2S.$$

Sulphate of iron, water, and sulphuretted hydrogen result.

(3) By the action of hydrochloric acid (HCl) upon sulphide of antimony (Sb_2S_3). Thus—

$$Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S.$$

Chloride of antimony and sulphuretted hydrogen result.

This gas must be collected over warm water, since in cold water it dissolves to a considerable extent, imparting its peculiar odour and slightly acid reaction to the fluid. It can be condensed to a liquid, and frozen to a transparent ice-like solid. H_2S is produced by the putrefaction of such animal matters as albumen, and by the deoxidation of sulphates when decayed organic matters are present. Sulphuretted hydrogen is chiefly used as a reagent in the laboratory for the precipitation of metals, and by it these substances may be separated into two groups. Thus—

The *Copper Group.*

The following metals are precipitated by H_2S from an *acid* solution:—

Bismuthum (Bi)	Bismuth	Black or brown.
Cuprum (Cu)	Copper	
Plumbum (Pb)	Lead	
Hydrargyrum (mercurous salt) (Hg)	Mercury	
Argentum (Ag)	Silver	

Platinum (Pt)	Platinum	Black.
Aurum (Au)	Gold	
Arsenicum (As)	Arsenic	Yellow.
Cadmium (Cd)	Cadmium	
Stannum (Sn)	Tin.	
(*a*) Stannous salts		Brown.
(*b*) Stannic salts		Yellow.
Stibium (Sb)	Antimony	Orange.

The metals of this group give off sulphurous anhydride (SO_2) when heated with H_2SO_4.

The *Iron Group.*

The following are precipitated by H_2S from a neutral or *alkaline solution:*

Ferrum (Fe)	Iron.	
Ferrous and Ferric salts		Black.
Manganesium (Mn)	Manganese,	Flesh Colour.
Cobalt (Co)	Cobalt	Black.
Nickel (Ni)	Nickel	Black.
Chromium (Cr)	Chromium.	
(*a*) Chromous salts		Black.
(*b*) Chromic salts		Greyish-green.
Uranium (U)	Uranium.	
(*a*) Uranous salts		Black.
(*b*) Uranic salts		Brownish-yellow.
Zincum (Zn)	Zinc	White.

The metals of this group give off hydrogen (H) upon the addition of H_2SO_4.

Traces of soluble sulphides in neutral or alkaline solutions give a *splendid purple colour* with nitro-prusside of sodium $(Na_4Fe_2Cy_{10}N_2O_3,4H_2O)$.

HYDROGEN DISULPHIDE. HYDROGEN PERSULPHIDE.

Symbol, H_2S_2.

Description.—An oily liquid, closely resembling H_2O_2; possesses a peculiar smell, bleaches, and is readily decomposed into sulphur and sulphuretted hydrogen.

Preparation.—By the addition of calcium disulphide solution (CaS_2) to hydrochloric acid (HCl). Thus—

$$CaS_2 + 2HCl = CaCl_2 + H_2S_2.$$

Chloride of calcium and hydrogen persulphide are formed.

SULPHUR WITH CARBON forms

CARBON DISULPHIDE.

Symbol, CS_2. Molecular weight, 76. Density, 38.

Description.—A liquid; volatile, colourless, and heavy, with an odour of cabbage water, possessing an acrid pungent taste, and very inflammable; insoluble in water, but soluble in ether and alcohol. The great solvent of gums, caoutchouc, sulphur, phosphorus, iodine, bromine, camphor, gutta-percha, and oils. Discovered by Lampadius in 1796.

Preparation.—By passing the vapour of sulphur over red-hot charcoal.

Direct compounds of sulphur with chlorine are known, viz.:

SCl, Sulphur Mono-chloride
SCl_2, Sulphur Di-chloride.

These are volatile liquids, and are formed by passing a current of chlorine gas over melted sulphur.

A remarkable analogy is observable (not only in their composition, but also in their chemical properties), between the sulphur compounds, and the corresponding bodies in the oxygen series. Thus we have—

H_2O, water.	H_2S, sulphuretted hydrogen.
H_2O_2, hydrogen dioxide.	H_2S_2, hydrogen disulphide.
CO_2, carbon dioxide.	CS_2, carbon disulphide.

PHOSPHORUS—(phos, light, pherein, to bear).

Symbol, P. Combining weight, 31. Vapour Density, 62.

The volume occupied by the atom of this substance weighing 31 is only half as large as that occupied by the atoms of each of the elements previously described. Its atomic volume is therefore ½, that of the previously described elements being 1.

Description.—Never native. Found in combination with oxygen and calcium in the bones of vertebrata, in the seeds of some plants (chiefly the cereals), and in certain minerals; a triad element. Discovered by Brandt in 1669.

Preparation.—By the following successive processes:

(1) From powdered bone-ash, which contains phosphate of lime ($Ca_3P_2O_8$) by adding sulphuric acid (H_2SO_4). Thus—

$$Ca_3P_2O_8 + 2H_2SO_4 = 2CaSO_4 + CaH_4P_2O_8.$$

Sulphate of lime, and superphosphate of lime, resulting.

(2) By the addition of charcoal (C), to the superphosphate of lime. Thus—

$$3CaH_4P_2O_8 + 10C = Ca_3P_2O_8 + 6H_2O + 10CO + 4P.$$

Phosphate of lime, water, carbonic oxide, and phosphorus are formed. The phosphorus distils over in yellow drops, and is collected under water, condensing into a solid mass.

Phosphorus exists in two allotropic forms, viz.:

(1) *A yellow wax-like solid* of specific gravity, 1·83, melting

at 44°C, and boiling at 290°C; emits a pale phosphorescent light in the dark, giving out fumes of phosphorus trioxide, P_2O_3; very inflammable and dangerous to handle. Insoluble in water, alcohol, or ether, slightly soluble in oils, and very soluble in carbon disulphide.

(2) The *red amorphous phosphorus*, of specific gravity 2·14; this does not take fire until heated above 260°C, when it passes into the ordinary form, forming phosphorus pentoxide (P_2O_5). It is *insoluble* in carbon disulphide.

Preparation of the red variety.—(1) By exposing yellow phosphorus to a temperature of 240°C for some hours in an atmosphere incapable of acting upon it chemically, such as hydrogen or carbon dioxide.

(2) By heating ordinary phosphorus in a dry tube with a trace of iodine; phosphorus iodide, and red amorphous phosphorus result.

Test.—(1) For the detection of phosphorus, the substance containing it must be dried, and a thin layer heated on a metal-plate in the dark; it then becomes luminous.

(2) After drying, add carbon disulphide; filter, and place upon a watch-glass; float it in hot water and it will become phosphorescent.

(3) Mitscherlich's test.—Place the suspected substance in a retort, acidulate it with sulphuric acid, heat and collect the products in a well-cooled receiver. A flash of light will be observed at every condensation of the phosphorus vapour.

PHOSPHORUS WITH OXYGEN forms two compounds, viz.:

(1) P_2O_3. Phosphorous anhydride, or the trioxide.
(2) P_2O_5. Phosphoric anhydride, or the pentoxide.

PHOSPHOROUS ANHYDRIDE. PHOSPHOROUS TRIOXIDE.

Symbol, P_2O_3. Molecular weight, 110.

Description.—A white non-crystalline powder; soft and readily volatile; unites with great energy with water (H_2O), forming phosphorous acid (H_3PO_3). Thus—

$$P_2O_3 + 3H_2O = 2H_3PO_3. \quad \text{(Hydrogen Phosphite.)}$$

Preparation.—By burning phosphorus in a *limited* current of dry air.

PHOSPHORIC ANHYDRIDE. PHOSPHOROUS PENTOXIDE.

Symbol, P_2O_5. Molecular weight, 142.

Description.—A white amorphous powder in soft snow-white deliquescent volatile flakes; absorbs water with great avidity, hissing like a hot iron when thrown into water (H_2O), and forming orthophosphoric acid (H_3PO_4). Thus—

$$P_2O_5 + 3H_2O = 2H_3PO_4. \text{ (Hydrogen Phosphate.)}$$

Preparation.—By burning phosphorus in *excess* of air or oxygen.

PHOSPHORUS WITH HYDROGEN AND OXYGEN forms five compounds, viz. :

Hypophosphorous acid	... ...	H_3PO_2.
Phosphorous acid	... ...	H_3PO_3.
Metaphosphoric acid	... ...	HPO_3.
Phosphoric acid (tribasic)	... ...	H_3PO_4.
Pyrophosphoric acid	... ...	$H_4P_2O_7$.

HYPOPHOSPHOROUS ACID.

Symbol, H_3PO_2.

Description.—An acid syrupy fluid and powerful deoxidizer ; precipitates gold and silver from their solutions. All the hypophosphites are soluble in water.

Preparation. — By acting upon barium hypophosphite $Ba(H_2PO_2)_2$ with sulphuric acid (H_2SO_4). Thus—

$$Ba(H_2PO_2)_2 + H_2SO_4 = BaSO_4 + 2H_3PO_2.$$

Sulphate of barium and hypophosphorous acid are formed.

PHOSPHOROUS ACID.

Symbol, H_3PO_3.

Description.—Deliquescent crystals which readily decompose ; throws down gold, silver, and platinum from their solutions.

Preparation.—By acting upon the trichloride of phosphorus (PCl_3) with water (H_2O). Thus—

$$PCl_3 + 3H_2O = 3HCl + H_3PO_3.$$

Hydrochloric acid and phosphorous acid result.

METAPHOSPHORIC ACID.

Symbol, HPO_3.

Description. — A transparent glassy mass, known as "glacial" phosphoric acid. A monobasic acid.

Preparation.—By the addition of sulphuretted hydrogen (H_2S) to solution of metaphosphate of silver ($AgPO_3$). Thus—

$$2AgPO_3 + H_2S = Ag_2S + 2HPO_3.$$

Sulphide of silver and metaphosphoric acid are formed.

Upon the addition of cold water to this glacial acid, a solution of metaphosphoric acid is obtained, and this, upon boiling, is converted into the tribasic phosphoric acid, H_3PO_4.

Tests.—(1) Nitrate of silver gives a *white* precipitate.
(2) Albumen and acetic acid give a *white* precipitate.

ORTHOPHOSPHORIC ACID. PHOSPHORIC ACID.

Symbol, H_3PO_4.

Description.—A sour liquid; a tribasic acid.

Preparation.—(1) By acting upon the tribasic phosphate of silver (Ag_3PO_4) with sulphuretted hydrogen (H_2S). Thus—

$$2Ag_3PO_4 + 3H_2S = 3Ag_2S + 2H_3PO_4.$$

Sulphide of silver and phosphoric acid are formed.

(2) By the action of nitric acid (HNO_3) upon phosphorus (P). Thus—

$$2P + 6HNO_3 = 2N_2O_3 + N_2O_4 + 2H_3PO_4.$$

Brown fumes of the tri- and tetr-oxides of nitrogen are given off, and orthophosphoric acid remains. This operation must be carefully performed.

Tests.—(1) Nitrate of silver gives a *yellow* precipitate of orthophosphate of silver.

(2) Sulphate of magnesia, and ammonia, give a *white* precipitate of triple or ammonio-magnesian-phosphate (NH_4MgPO_4).

PYROPHOSPHORIC ACID.

Symbol, $H_4P_2O_7$.

Description.—Can be obtained as crystals by evaporation in vacuo.

Preparation.—(1) By heating the tribasic phosphoric acid (H_3PO_4) to 213°C. Thus—

$$2H_3PO_4 = H_2O + H_4P_2O_7.$$

Water and pyrophosphoric acid result.

(2) By acting upon pyrophosphate of silver ($Ag_4P_2O_7$) with sulphuretted hydrogen (H_2S). Thus—

$$Ag_4P_2O_7 + 2H_2S = 2Ag_2S + H_4P_2O_7.$$

Sulphide of silver and pyrophosphoric acid result.

Tests.—Nitrate of silver gives a *white* precipitate, but no precipitate is caused by albumen and acetic acid.

From the description of the foregoing substances, it will be seen that there are three distinct forms of phosphoric acid—the meta, the pyro, and the tribasic, or orthophosphoric. Their modes of preparation have been already described, but they may also be prepared by acting upon phosphoric anhydride (P_2O_5) by different proportions of water (H_2O) as follows :

Phosphoric Acids.

$$P_2O_5 + H_2O = 2HPO_3 \text{ Metaphosphoric acid.}$$
$$P_2O_5 + 2H_2O = H_4P_2O_7 \text{ Pyrophosphoric acid.}$$
$$P_2O_5 + 3H_2O = 2H_3PO_4 \text{ Orthophosphoric acid.}$$

It may also be shown that by heating the tribasic phosphate ($2H_3PO_4$) and thus driving off a molecule of water, we can obtain the pyrophosphoric acid ($H_4P_2O_7$), and by the action of heat upon this, with the loss of another molecule of water, we obtain the metaphosphoric acid ($2HPO_3$).

Phosphorus with Hydrogen forms three compounds, to all of which the name of phosphuretted hydrogen is applied, viz.:

Tri-hydride of phosphorus, PH_3
Di-phosphorus tetra-hydride, P_2H_4 } Phosphuretted hydrogens
Tetra-phosphorus di-hydride, P_4H_2

PH_3, tri-hydride of phosphorus, is a colourless gas possessing a powerful garlic-like odour, and burning with a brilliant white flame, with the formation of water and P_2O_5.

Preparation.—(1) By heating phosphorous acid. Thus—

$$4H_3PO_3 + \text{heat} = 3H_3PO_4 + PH_3.$$

Tribasic phosphoric acid and trihydride of phosphorus result.

(2) By the action of caustic potash (KHO) upon phosphorus (P) and water (H_2O). Thus—

$$3KHO + 4P + 3H_2O = 3KH_2PO_2 + PH_3.$$

Potassium hypophosphite and tri-hydride of phosphorus result.

This gas is prepared under water, but as each bubble rises, it takes fire spontaneously in contact with the air, forming white rings of phosphorus pentoxide (P_2O_5) expanding as they rise. When perfectly pure, this PH_3 is not spontaneously combustible, but is usually so from the presence of the following compound:

P_2H_4. Di-phosphorus tetra-hydride is a colourless, very volatile liquid, of high refractive power, and spontaneously inflammable. It can be prepared by passing PH_3 through a tube cooled by a freezing mixture.

P_4H_2. Tetra-phosphorus di-hydride is a solid substance, and is prepared by passing P_2H_4, the liquid hydride, into hydrochloric acid (HCl); tri-hydride of phosphorus and tetra-phosphorus di-hydride resulting.

P_4H_2 precipitates gold and silver from their solutions, but does not affect the salts of lead.

Phosphorus with Chlorine forms two compounds, viz.:

PCl_3. Phosphorous chloride, phosphorus trichloride.
PCl_5. Phosphoric chloride, phosphorus pentachloride.

Phosphorous chloride, PCl_3, is a colourless, volatile, strongly fuming liquid, and is formed by passing chlorine gas over phosphorus. It gradually decomposes into hydrochloric acid, and phosphorous acid. It may also be formed by the spontaneous combustion of phosphorus in chlorine gas.

Phosphoric chloride, PCl_5, is a solid crystalline body, and decomposes by excess of water into hydrochloric acid (HCl), and tribasic phosphoric acid (H_3PO_4). It is prepared by passing excess of chlorine through the phosphorous chloride. Should water be present only in limited quantity, a liquid called *phosphorus oxy-chloride*, PCl_3O, is formed. Thus—

$$PCl_5 + H_2O = 2HCl + PCl_3O.$$

By bringing together nitrate of silver ($AgNO_3$), and PCl_3O. Thus—

$$3AgNO_3 + PCl_3O = Ag_3PO_4 + 3NO_2Cl.$$

Phosphate of silver, and nitroxyl chloride are formed.

Phosphorus forms with Iodine PI_3 and PI_5, with Bromine PBr_3, and PBr_5, and it burns spontaneously in those bodies. By the action of sulphuretted hydrogen (H_2S) upon phosphoric chloride, PCl_5—a substance termed phosphoric sulphochloride, $PSCl_3$, is obtained.

Phosphorus forms several compounds with sulphur, two of them, P_2S_3 and P_2S_5, corresponding in composition with the oxides P_2O_3, and P_2O_5.

ARSENIC—ARSENICUM—(arsenicon, orpiment).

Symbol, As. Combining weight, 75. Vapour density, 150.

The volume occupied by an atom of this substance (in the gaseous state), weighing 75, is only ½ of that occupied by the other elements generally; arsenic, therefore, in this respect resembles phosphorus.

Description.—This substance closely resembles phosphorus in its chemical properties and in its modes of combination, but in its physical characters it presents a strong analogy to the metals; a triad element; rarely or never occurring native, being usually found in combination as mispickel (FeAsS), a compound of iron, arsenic, and sulphur; tin-white cobalt ($CoAs_2$), cobalt and arsenic; cobalt-glance (CoSAs), cobalt, sulphur, and arsenic; nickel-glance (NiSAs), nickel and arsenic; kupfer-nickel (NiAs), nickel and arsenic; arsenical nickel ($NiAs_2$), nickel and arsenic. It is also contained in very small quantities in many mineral springs.

Preparation. — By heating the arsenic tri-oxide (As_2O_3)

mixed with charcoal (C) in a closed crucible, of which the upper part is kept cool. Thus—

$$As_2O_3 + 3C = 3CO + 2As.$$

Carbonic oxide and arsenicum are formed, the latter of which condenses at the upper part of the apparatus as a brilliant steel-grey solid. When exposed to the air, arsenicum tarnishes by oxidation. Its specific gravity is 5·7. Heated to dull redness it entirely volatilizes, without fusion, as a colourless vapour having the odour of garlic.

If heated in the air, As burns with a bluish flame, forming As_2O_3, arsenic tri-oxide.

ARSENIC WITH OXYGEN forms two compounds, viz.:

As_2O_3—Arsenic tri-oxide, arsenious anhydride.
As_2O_5—Arsenic pent-oxide, arsenic anhydride.

ARSENIC TRIOXIDE. ARSENIOUS ANHYDRIDE.

Symbol, As_2O_3. Molecular weight, 198.

Description.—This substance occurs in two modifications, viz.:

(1) The *Crystalline*, in brilliant octahedra.

(2) The *Vitreous*, without crystalline structure; a semi-transparent glass-like solid, becoming opaque, like porcelain, upon standing.

Preparation.—(1) By burning arsenicum (As) in air.

(2) By roasting arsenical ores and purifying by sublimation; As_2O_3 is very feebly soluble in cold water, and, even in boiling water, has a tendency to float in film. With water, arsenious anhydride forms arsenious acid (H_3AsO_3). Thus—

$$As_2O_3 + 3H_2O = 2H_3AsO_3.$$

This acid has a feeble reaction, and dissolves in hydrochloric acid; it is freely soluble in solutions of the alkalies, forming arsenites. All these soluble arsenites are poisonous.

If As_2O_3 be heated to about 220°C, it volatilizes without melting, forming a colourless, inodorous vapour.

The tests for arsenious acid may be divided into three groups:

(1) Solid; (2) Liquid, and (3) Special.

The solid tests are two in number:

(1) Arsenious acid, when heated upon charcoal, emits an odour of garlic.

(2) As_2O_3 is heated in a reduction tube with black flux, *i.e.*, dried carbonate of soda and charcoal. Metallic As is formed, and condenses as a ring upon the cool part of the tube.

The liquid tests are three:

(1) Sulphuretted hydrogen (H_2S) gives a *yellow* precipitate of sulphide of arsenic (As_2S_2) soluble in ammonia.

(2) Ammonio-nitrate of silver, made by adding just enough liquor ammoniæ to the nitrate of silver to precipitate the brown oxide of silver (Ag_2O), gives a canary yellow precipitate of arsenite of silver (Ag_3AsO_3), soluble in excess of ammonia.

(3) Ammonio-sulphate of copper, made by adding to a solution of sulphate of copper just enough liquor ammoniæ to throw down a pale-blue precipitate, gives a *green* precipitate of arsenite of copper or Scheel's green ($CuHAsO_3$), soluble in excess of ammonia.

The special tests are two :

(1) Marsh's test. This consists in the decomposition of arsenious acid by means of nascent hydrogen. A suitable vessel is taken, and in it are placed some strips of zinc with water and sulphuric acid. Hydrogen is thus generated, and escapes through a gas-jet with which the vessel is furnished. This gas burns with a very faintly luminous flame when a light is applied, the result of its combustion being only a few drops of water. The arsenious acid is now added to the contents of the vessel. The hydrogen flame is converted into arseniuretted hydrogen (AsH_3), and burns with a *pale-blue* flame. A white porcelain plate is now placed over this last flame, and a deposit is formed which may be divided into three rings. Thus :

(*a*) A central ring, consisting of metallic arsenic, (*b*) a ring round this, consisting of a mixed deposit of As and As_2O_3, and (*c*) an external ring of As_2O_3. This deposit is soluble in a solution of chlorinated lime.

(2) Reinsch's test. This consists in boiling bright strips of copper in an arsenical solution previously acidulated by hydrochloric acid. The metal arsenicum becomes deposited upon the strips of copper, which are then withdrawn and placed in a reduction tube, with the same result as has been described above under the solid tests.

ARSENIC PENTOXIDE. ARSENIC ANHYDRIDE.

Symbol, As_2O_5. Molecular weight, 230.

Description.—A white deliquescent non-crystalline powder, decomposing when strongly heated into arsenious anhydride (As_2O_3) and oxygen (O).

Preparation.—By acting upon As_2O_3 with strong nitric acid (HNO_3). Thus—

$$As_2O_3 + 2HNO_3 = H_2O + N_2O_3 + As_2O_5.$$

Water, nitrogen trioxide, and arsenic anhydride are formed.

As_2O_5 dissolves in water, and forms arsenic acid, H_3AsO_4. Thus—

$$As_2O_5 + 3H_2O = 2H_3AsO_4.$$

This acid may be also prepared by the action of diluted nitric acid upon As_2O_3. Thus—

$$As_2O_3 + 2H_2O + 2HNO_3 = N_2O_3 + 2H_3AsO_4.$$

Nitrogen trioxide, and arsenic acid are formed.

With ammonio-nitrate of silver, arsenic acid gives a *chocolate-red* precipitate of arseniate of silver.

H_3AsO_4 is a poison, but less energetic than H_3AsO_3.

ARSENIC WITH CHLORINE forms

ARSENIOUS CHLORIDE, $AsCl_3$.

This substance can be prepared—(1) By the combustion of arsenicum in chlorine gas, or (2), by distilling As with mercuric chloride ($HgCl_2$). Thus—

$$4As + 12HgCl_2 = 12HgCl + 4AsCl_3.$$

Mercurous chloride and arsenious chloride are formed.

Corresponding compounds with bromine ($AsBr_3$), iodine (AsI_3), and fluorine (AsF_3), are also known.

ARSENIC WITH HYDROGEN forms

ARSENIURETTED HYDROGEN, AsH_3.

This gas has been, to some extent, described under Marsh's test. Its preparation may be expressed as follows :—

$$6Zn + 6H_2SO_4 + As_2O_3 = 6ZnSO_4 + 3H_2O + 2AsH_3.$$

Zinc, sulphuric acid, and arsenious anhydride yield sulphate of zinc, water, and arseniuretted hydrogen.

ARSENIC WITH SULPHUR forms three compounds :

(1) Di-arsenicum di-sulphide, As_2S_2, occurring native in ruby-red crystals, as "Realgar."

(2) Arsenious sulphide, As_2S_3, called also "sulph-arsenious anhydride," and occurring native as a yellow solid or "orpiment."

(3) Arsenic sulphide, As_2S_5, or "sulph-arsenic anhydride ;" a yellow substance obtained by fusing sulphur (S_2) with As_2S_3.

A general chemical analogy between nitrogen, phosphorus and arsenic, will be observed in the examination of their oxides, hydrides and chlorides, viz.:

N_2O_3	P_2O_3	As_2O_3.
N_2O_5	P_2O_5	As_2O_5.
NH_3	PH_3	AsH_3.
NCl_3?	PCl_3	$AsCl_3$.

BORON (Baurak, *Arabian*, Borax).

Symbol, B. Combining weight, 11.

Description.—A triad element; never native; is found united with oxygen and sodium, as borax; and with oxygen alone as boron trioxide; occurs in three modifications—

(1) *Amorphous boron*, a dull grey powder, which when strongly heated in air burns to boric oxide (B_2O_3).

Prepared by heating the fused boron trioxide (B_2O_3) with metallic sodium (Na). Thus—

$$B_2O_3 + 6Na = 3Na_2O + 2B.$$

Soda and (amorphous) boron result.

(2) *Graphitoidal boron*, in scales with graphite-like lustre.

Prepared by heating boron trichloride (BCl_3), with aluminium (Al). Thus—

$$2Al + 2BCl_3 = 2AlCl_3 + 2B.$$

Chloride of aluminium and (graphitoidal) boron result.

(3) *Diamond boron*, in square octahedra of cupreous lustre; hard enough to scratch a ruby.

Prepared by heating boron trioxide (B_2O_3) with aluminium (Al). Thus—

$$B_2O_3 + 2Al = Al_2O_3 + 2B.$$

Alumina and (diamond) boron result.

Boron, when heated strongly in chlorine or oxygen, takes fire, forming the chloride or oxide. It is remarkable for uniting directly with nitrogen, which gas it absorbs when red hot with the evolution of light, forming—

BORON NITRIDE.

Symbol, BN.

This is a grey mass, and may also be prepared by heating biborate of soda or borax ($Na_2B_4O_7$) with chloride of ammonium (NH_4Cl). Thus—

$$Na_2B_4O_7 + 4NH_4Cl = 2NaCl + 2HCl + 7H_2O + 4BN.$$

Chloride of sodium, hydrochloric acid, water, and boron nitride are formed.

BORON WITH CHLORINE forms a liquid called
BORON TRI-CHLORIDE

Symbol, BCl_3.

Prepared from boron trioxide (B_2O_3), chlorine (Cl), and carbon (C), at a bright red heat. Thus—

$$B_2O_3 + 6Cl + 3C = 3CO + 2BCl_3.$$

Carbon monoxide and boron trichloride result.

BORON WITH FLUORINE forms
BORON TRI-FLUORIDE.

Symbol, BF_3.

An irritating, colourless, irrespirable gas, fuming in air; with water it forms—

HYDRO-FLUO-BORIC ACID.

Symbol, HBF_4.

Thus—

$$4BF_3 + 3H_2O = H_3BO_3 + 3HBF_4.$$

Boracic acid and hydro-fluo-boric acid result.

BORON WITH OXYGEN forms
BORON TRIOXIDE. BORACIC ANHYDRIDE.

Symbol, B_2O_3. Molecular weight, 70.

This fuses to a glass, which retains its clearness on cooling. It is prepared by heating boracic acid (H_3BO_3). Thus—

$$2H_3BO_3 = 3H_2O + B_2O_3.$$

Water and boron trioxide result.

WITH WATER B_2O_3 forms
BORIC OR BORACIC ACID.

Symbol, H_3BO_3. Molecular weight, 62.

Description.—A tribasic acid, crystallising in pearly plates from the solution as it cools.

Found in the fumerolles or soffioni (steam jets), which are constantly escaping from the earth in old volcanic districts of Tuscany, and which collect in the lagoons at the mouth of these jets. The boracic acid is concentrated by the heat of the natural steam jets, and the acid obtained by crystallisation.

Tinkal or sodium borate (Na_3BO_3) also occurs in California and Thibet.

A solution of H_3BO_3 in alcohol, when ignited, communicates a green colour to the flame.

Boracic acid also gives a red colour to turmeric.

This acid is slightly soluble in cold water, but rather more so in hot water.

Boracic acid may also be prepared by the addition of hydrochloric acid (HCl) to a hot solution of borax ($Na_2B_4O_7$). Thus—

$$Na_2B_4O_7 + 2HCl + 5H_2O = 2NaCl + 4H_3BO_3.$$

Chloride of sodium and boracic acid result.

BORAX. BIBORATE OF SODA.

Symbol, $Na_2B_4O_7$, $10H_2O$.

As has been stated above, this substance is a compound of sodium, boron and oxygen. It is a native salt, but can be artificially prepared by heating together boracic acid (H_3BO_3) and carbonate of soda (Na_2CO_3). Thus—

$$4H_3BO_3 + Na_2CO_3 = 6H_2O + CO_2 + Na_2B_4O_7.$$

Water, carbonic anhydride, and borax result.

Borax is much used as a blow-pipe re-agent in the laboratory, since many metallic oxides are soluble in fused borax, yielding coloured glasses as follows:

BORAX BEADS.

		Oxidizing, or Outer Flame.		*Reducing, or Inner Flame.*	
		Hot.	*Cold.*	*Hot.*	*Cold.*
Chromium	(Cr)	Green	Green	Green	Green.
Cobalt	(Co)	Blue	Blue	Blue	Blue.
Nickel	(Ni)	Violet	Reddish-brown	Colourless	Grey and turbid.
Copper	(Cu)	Green	Blue	Colourless	Brownish-red from MetallicCu.
Iron	(Fe)	Brownish-red	Light yellow	Red (Yellowish	Bottle-green on cooling)
Manganese	(Mn)	Amethyst-red or violet	Amethyst-red	Colourless (but not	Colourless quite clear)
Silver	(Ag)	Yellowish to opal	Rather dull	Colourless	Whitish-grey.
Gold	(Au)	Are reduced in all flames, the Au showing blueish-green by transmitted light, and reddish by reflected.			
Platinum	(Pt)				

SILICON—(Silex, a flint).

Symbol, Si. Combining weight, 28.

Description.—A tetrad element; never native, but combined with oxygen as silica (SiO_2). Exists nearly pure in rock crystal or quartz, in sand, flint, and many minerals; also found combined with the metals and oxygen, as silicates. The most abundant element known next to oxygen. There are three modifications of silicon, viz.:

(1) *Amorphous silicon.*—A brown powder, only acted upon by hydrofluoric acid (HF), which dissolves it.

Prepared by acting upon silico-fluoride of potassium ($(KF)_2,SiF_4$) with metallic potassium (K). Thus—

$$(KF)_2,SiF_4 + 4K = 6KF + Si.$$

Fluoride of potassium, and (amorphous) silicon result.

(2) *Graphitoidal silicon.*—Hexagonal plates with metallic lustre.

Prepared by fusing the amorphous form with aluminium (Al), and dissolving the latter in hydrochloric acid.

(3) *Adamantine silicon,* in steel-grey crystals, hard enough to scratch glass. Prepared by heating aluminium (Al), in the vapour of silicon tetrachloride ($SiCl_4$). Thus—

$$3SiCl_4 + 4Al = 2Al_2Cl_6 + 3Si.$$

Chloride of aluminium and (adamantine) silicon result.

SILICON WITH OXYGEN forms

SILICIC ANHYDRIDE. SILICON DIOXIDE. SILICA.

Symbol, SiO_2. Molecular weight, 60.

Description.— A snow-white, gritty, insoluble powder almost infusible, but soluble in hydrofluoric acid (HF). Prepared by heating metasilicic acid (H_2SiO_3). Thus—

$$H_2SiO_3 + \text{heat} = H_2O + SiO_2.$$

Water and silica are formed.

SiO_2 also exists in a crystallised form, as white transparent quartz.

SILICA WITH WATER

forms two acids, viz. :

(1) Meta-silicic acid ($SiO_2 + H_2O = H_2SiO_3$).
(2) Ortho-silicic acid ($SiO_2 + 2H_2O = H_4SiO_4$).

META-SILICIC ACID.

Symbol, H_2SiO_3.

Description.—A clear limpid fluid, with a tendency to become gelatinous.

The chief agent in petrifaction.

Preparation.—By acting upon potassium silicate (K_2SiO_3), by hydrochloric acid (HCl) and heat. Thus—

$$K_2SiO_3 + 2HCl = 2KCl + H_2SiO_3.$$

Chloride of potassium, and meta-silicic acid are formed. This acid must be prepared by

DIALYSIS.

By this term is implied a process used in chemistry for the separation of bodies. It is dependent upon the fact that all crystallisable substances, termed *crystalloids*, will pass in solution through a parchment paper; whilst all gum-like amorphous substances, termed *colloids*, such as gelatinous silicic acid, will not so pass.

The *dialyzer* used in this process consists of a flat sieve, or drum, constructed of parchment paper, into which the substances are thrown, the drum being then floated upon a large surface of water.

ORTHO-SILICIC ACID.

Symbol, H_4SiO_4.

A white and gelatinous substance when first precipitated, and soluble until evaporated to dryness.

Prepared by leading silicon tetra-fluoride (SiF_4) into water. Thus—

$$3SiF_4 + 4H_2O = 2H_2SiF_6 + H_4SiO_4.$$

Ortho-silicic acid is formed, together with a new acid, H_2SiF_6, to which the name of *hydro-fluo-silicic* acid is given.

SILICON WITH HYDROGEN forms
SILICIURETTED HYDROGEN. SILICON HYDRIDE.

Symbol, SiH_4.

This is a colourless gas, inflaming spontaneously in the air, and forming water and silica, the latter separating as a white ring-shaped cloud. It is prepared by acting upon a compound of magnesium and silicon (Mg_2Si), with hydrochloric acid. Thus—

$$Mg_2Si + 4HCl = 2MgCl_2 + SiH_4.$$

Chloride of magnesium and silicon hydride result.

SILICON WITH CHLORINE forms
SILICON TETRACHLORIDE.

Symbol, $SiCl_4$. Molecular weight, 170. Density, 85.

A colourless, pungent, irritating liquid, formed when silicon is heated in chlorine, but also prepared by passing dry chlorine over a red-hot mixture of carbon (C), and finely divided silica (SiO_2). Thus—

$$4Cl + 2C + SiO_2 = 2CO + SiCl_4.$$

Carbonic oxide and silicon tetra-chloride result.

By passing dry hydrochloric-acid gas over silicon, heated to dull redness, a new substance is formed, termed

SILICON CHLOROFORM.

Symbol, $SiHCl_3$.

Analogous in composition to ordinary chloroform ($CHCl_3$). This is very inflammable, and burns with a greenish flame, evolving white clouds of silica. By water it is decomposed into a white powder, *silicon-formic-anhydride* ($Si_2H_2O_3$).

SILICON WITH FLUORINE forms
SILICON TETRA-FLUORIDE.

Symbol, SiF_4. Molecular weight, 104. Density, 52.

Description.—A colourless, pungent gas, fuming strongly in air; always formed whenever hydrofluoric acid comes in contact with silica.

Preparation.—By heating fluoride of calcium (CaF_2) with sand or silica (SiO_2), and sulphuric acid (H_2SO_4). Thus—

$$2CaF_2 + SiO_2 + 2H_2SO_4 = 2CaSO_4 + 2H_2O + SiF_4.$$

Sulphate of lime, water, and silicon tetra-fluoride, are formed.

This substance is decomposed by water, but may be collected over mercury, or by displacement.

A corresponding compound of silicon with bromine is also known, called *silicon bromide*, $SiBr_4$.

With sulphur, silicon forms silicon sulphide (SiS_2), a white, earthy mass, decomposed by water into sulphuretted hydrogen, and ortho-silicic acid.

SELENIUM—(Selene, the moon).

Symbol, Se. Combining weight, 79·5. Density, 79·5.

Description.—A brownish-red, semi-transparent substance, with a metallic lustre, closely allied to sulphur in its properties. A dyad element, and only found in small quantities. When burnt in the air it gives off an odour of decaying horse-radish, and exhibits a bright blue flame, which displays magnificent bands in the spectrum. The vapour condenses to red flowers.

Preparation.—By acting upon selenious acid (H_2SeO_3) with water (H_2O), and sulphurous anhydride (SO_2). Thus—

$$H_2SeO_3 + 2SO_2 + H_2O = 2H_2SO_4 + Se.$$

Sulphuric acid and selenium are formed.

SELENIUM WITH OXYGEN forms two oxides, viz.:

(1) SeO_2. Selenium dioxide.
(2) SeO_3. Selenium trioxide.

SELENIUM DIOXIDE.

Symbol, SeO_2. Molecular weight, 111·5.

Description.—A white, crystalline mass, soluble in water. It may be prepared by burning selenium in air, or oxygen, or by the oxidation of this substance by nitric acid.

SELENIOUS DIOXIDE WITH WATER forms

SELENIOUS ACID.

Symbol, H_2SeO_3.

A powerful acid, resembling sulphurous acid.

SELENIUM TRIOXIDE.

Symbol, SeO_3.

Has never been isolated, but an acid is known called—

SELENIC ACID.

Symbol, H_2SeO_4.

This acid resembles sulphuric acid. In the reducing flame of the blow-pipe it emits the odour of selenium. It is a solvent of gold, but not of platinum.

Preparation.—By the addition of sulphuretted hydrogen (H_2S), to selenate of lead ($PbSeO_4$). Thus—

$$PbSeO_4 + H_2S = PbS + H_2SeO_4.$$

Sulphide of lead is formed, and upon evaporating the solution, selenic acid is left.

SELENIUM WITH HYDROGEN forms

HYDROGEN SELENIDE. SELENIURETTED HYDROGEN.

Symbol, H_2Se. Molecular weight, 81·5. Density, 40·75.

Description.—A colourless, inflammable gas, with a nauseous smell, exciting catarrh, and destroying the sense of smell. Decomposes metallic solutions, like sulphuretted hydrogen.

Preparation.—From selenide of iron ($FeSe$), by the action of sulphuric acid (H_2SO_4). Thus—

$$FeSe + H_2SO_4 = FeSO_4 + H_2Se.$$

Sulphate of iron, and seleniuretted hydrogen result.

TELLURIUM—(Tellus, the earth).

Symbol, Te. Combining weight, 129. Density, 129.

Description.—A very rare substance of silvery, metallic appearance, and brittle. Is found combined with gold, silver, and bismuth, in Transylvania and Hungary. When administered internally, it communicates to the breath a garlic odour.

Tellurium dissolves in cold concentrated sulphuric acid, to which it imparts a fine purple colour. It forms with oxygen two oxides :

(1) Tellurium Dioxide.

Symbol, TeO_2.

Formed when tellurium is oxidised by nitric acid.

TeO_2, with water, forms Tellurous Acid (H_2TeO_3).

(2) Tellurium Trioxide.

Symbol, TeO_3.

Forms, with water, Telluric Acid, $H_2TeO_4 + 2H_2O$.

Tellurium with Hydrogen forms

Telluretted Hydrogen.

Symbol, H_2Te.

A colourless gas, smelling exactly like sulphuretted hydrogen.

It will be noticed that oxygen, sulphur, selenium, and tellurium, each unite with two atoms of hydrogen, to produce an analogous series of bodies, viz. :

H_2O ; H_2S ; H_2Se ; H_2Te.

And of the three, sulphur (32), selenium (79·5) and tellurium (129), the mean of the combining weight of the extremes is nearly that of the mean, viz. :

$$\frac{32 + 129}{2} = 80{\cdot}5.$$

Their specific gravities exhibit a similar gradation, viz. :

Sulphur, 2·0 ; Selenium, 4·5 ; Tellurium, 6·25.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

The *metre* is a unit of length, equal to a little more than one yard, viz., 39·37 English inches. Its length is arbitrary, but a standard metre has been prepared, and of this copies are in use. The French geometricians first intended that the length of this metre should have some reference to the circumference of the earth, and they therefore caused a standard to be made, having the length of the $\frac{1}{10000000}$ of the distance from the equator to the pole. It has been subsequently proved that the metre is not quite, although very nearly, the $\frac{1}{10000000}$ part of this distance.

The metre is divided into tenths, *decimetres*, hundredths, *centimetres*, and thousandths, *millimetres*. The multiples of the metre, tens, hundreds, and thousands, are termed *decametres*, *hectometres*, and *kilometres* respectively.

We can easily obtain the measures of *area* and *capacity*, and thus we have *square* metres, and *square* deci-, centi-, and milli- metres; and also *cubic* metres and *cubic* deci-, centi-, and milli- metres.

10	decimetres	1 metre.
100	centimetres	,,
1,000	millimetres	,,
100	square decimetres ...	1 square metre.
10,000	,, centimetres ...	,,
1,000,000	,, millimetres ...	,,
1,000	cubic decimetres	1 cubic metre.
1,000,000	,, centimetres ...	,,
1,000,000,000	,, millimetres ...	,,

The *litre* is a term used to denote 1 cubic decimetre, which is rather less than a quart English. It is divided into 10ths deci-, 100ths centi-, 1000ths milli- litres; a decalitre = 10 litres, a hectolitre = 100 litres; a kilolitre = 1000 litres.

The arrangers of this system were desirous of obtaining a simple relation between the measure of volume and that of weight, and they therefore took as their unit of weight *the weight of* 1 *cubic centimetre* of water at the temperature of 4° centigrade, and they called this a *gramme*. It is equal to about 15½ grains. Like the metre, this gramme is divided into tenths, hundredths, and thousandths, called deci-, centi-, and milli- grammes; the multiples, tens, hundreds, and thousands are called deca-, hecto-, and kilo- grammes.

MEASUREMENT OF TEMPERATURE.

We ascertain the measurements of changes of temperature by the expansion or contraction which bodies undergo by alternations of temperature. Liquids are generally used for this purpose, since gases expand too much, and solids too little. We commonly employ alcohol and mercury, especially the latter, since its rate of expansion is almost uniform within a certain range, and because it boils at a very high temperature (350°C), and freezes at a comparatively low one (-39·4°C), and is therefore capable of measuring a large range of temperature. We use alcohol for the measurement of very low temperatures, since it has never been frozen. It is only in very delicate experiments in physics that air thermometers are employed.

THE MERCURIAL THERMOMETER.

To prepare this, a straight piece of glass-tubing is taken, with as uniform a bore as possible, and a bulb is blown upon the end. The bulb and the whole of the tube are filled with mercury, and heated to the highest temperature we require to measure. The open end of the tube, full of mercury, is then completely closed, the glass being melted before the blowpipe. We now have *to graduate* the thermometer, and this is performed as follows:

(1) The bulb and stem are plunged *into finely powdered melting ice*, and the stem marked at the point where the mercury stands.

(2) The bulb and stem are immersed *in the steam given off from water boiling in a metallic vessel*, and the stem marked where the mercury then stands.

There are three thermometric scales at present in use, each of which can be expressed in terms of the other, viz.:

1. Centigrade.
2. Fahrenheit.
3. Réaumur.

In the *Centigrade* scale, the zero is placed at the freezing point, and the boiling point at 100°, so that between these two points there are 100 *degrees*. Above the boiling and below the freezing points divisions equal in size are continued, those below the freezing point being distinguished by a minus sign, viz., -1°C, -2°C, etc.

In the *Fahrenheit* scale the freezing point is fixed at 32°, and the boiling point at 212°, so between these points there are 180 degrees.

In the *Réaumur* scale we have 80° between the boiling and freezing points. The freezing point is zero, and the boiling point 80°.

The numbers 9, 5, 4 consequently express the relation between degrees Fahrenheit, Centigrade and Réaumur. Now, 180° Fahrenheit equals 100° Centigrade, *i.e.*, 1°F = $(\frac{100}{180})$ $\frac{5}{9}$ C; and 1°C = $(\frac{180}{100})$ $\frac{9}{5}$ F. We therefore multiply Fahrenheit degrees by $\frac{5}{9}$ to reduce them to Centigrade, and Centigrade degrees by $\frac{9}{5}$ to reduce them to Fahrenheit. But while on the Centigrade scale the zero is at the freezing point of water, on the Fahrenheit scale it is at 32°. We must therefore add or subtract 32, according to circumstances, in order to obtain the same starting point. In short:

(1) In converting Fahrenheit into Centigrade degrees, subtract 32 from the number of the degrees, and multiply the remainder by $\frac{5}{9}$, thus:

Alcohol boils at 173° F; what is this on the Centigrade scale?

$$173 - 32 = 141 \text{ ; and } 141 \times \tfrac{5}{9} = 78{\cdot}3^\circ\text{C}.$$

(2) In converting Centigrade to Fahrenheit degrees, multiply the number of degrees by $\frac{9}{5}$, and add 32 to the product, thus:

Mercury freezes at -39·4°C; what is this on the Fahrenheit scale?

$$-39{\cdot}4 \times \tfrac{9}{5} = -70{\cdot}9 \text{ ; and } -70{\cdot}9 + 32 = -38{\cdot}9^\circ\textbf{F}.$$

EXPANSION OF GASES BY HEAT.

Gases expand much more for equal increments of heat than solids or liquids; all gases expand alike or nearly so, while solids and liquids all expand differently. Exact and laborious experiments have shown that all gases expand $\frac{1}{273}$ part of their volume at 0°C for every increase in temperature of 1° Centigrade.

	273	volumes of air	or Hydrogen	at 0°C.
Become	274	,,	,,	1°C.
,,	275	,,	,,	2°C.
,,	276	,,	,,	3°C.
Or	273 + t	,,	,,	t°C.

The corresponding decimal fraction to $\frac{1}{273}$ is 0·003,665; 1 volume of air at 0°C becomes 1·003,665 volumes when heated to 1°C. The *co-efficient of the expansion of gases* is the name given to this fraction. Suppose we wish to know the volume which 1000 cubic centimetres of H measured at 0°C will occupy when the temperature is raised to 20°, we have an alteration in bulk in the ratio of the numbers 273 to 273 + 20. We therefore multiply 1000 by 293, and divide by 273. Should we wish to know what volume 1000 cubic centimetres, measured at 20°C, will occupy when the temperature sinks to 0°, we know that diminution in volume follows the same law; therefore, 293 volumes at 20° will become 273 volumes at 0°.

RELATION OF VOLUME OF GASES TO PRESSURE.

Gases are known as *compressible bodies*, because when they are subjected to pressure their volume becomes less, and upon the withdrawal of the pressure they again expand. Solids and liquids cannot be compressed in the same way, and are hence called *incompressible*. Boyle's or Mariotte's law states that *the volume occupied by any gas is inversely proportional to the pressure to which it is subjected.* The volume 1 under pressure 1 becomes the volume 2 under the pressure $\frac{1}{2}$, the volume 3 under the pressure $\frac{1}{3}$, the volume $\frac{1}{2}$ under the pressure 2, and the volume $\frac{1}{3}$ under the pressure 3, and so on.

DIFFUSION OF GASES.

When gases are mixed together, and do not combine chemically, they have the power of becoming intimately mixed together, even when the heavier gas is placed at the bottom, and both remain undisturbed. This property illustrates the *diffusive power of gases.* The rate of diffusion is subject to variation. A bottle of carbonic acid lost only 47 per cent. of gas when left exposed to the air in the same time that a bottle of hydrogen lost 94·5 in the same way. Gaseous diffusion will take place through such solids as stucco, or thin plates of graphite. Experiments show that *the velocity of diffusion of different gases is inversely proportional to the square roots of their densities;* oxygen being 16 times as heavy as hydrogen, 4 volumes of the latter will pass through the diaphragm in the same time that one volume of the former will be able to do so.

FINIS OF PART I.

TABLE OF QUANTIVALENCE OF THE NON-METALLIC ELEMENTS.

Monads.	*Dyads.*	*Triads.*	*Tetrads.*
Hydrogen	Oxygen	Nitrogen	Carbon
Chlorine	Sulphur	Phosphorus	Silicon
Bromine	Selenium	Boron	
Iodine	Tellurium	Arsenic	
Fluorine			

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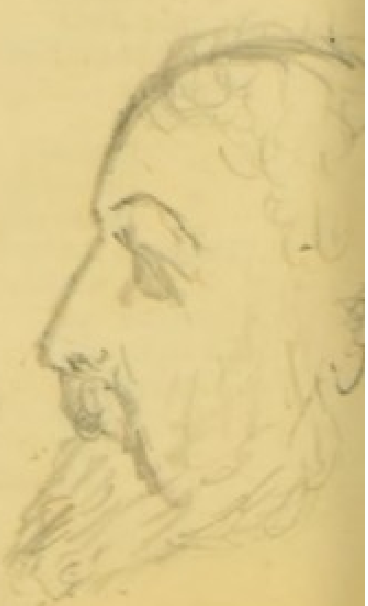

AIDS
TO
CHEMISTRY.

SPECIALLY DESIGNED FOR
STUDENTS PREPARING FOR EXAMINATIONS.

PART II.—INORGANIC (Double Part).

THE METALS,
QUANTIVALENCE, ELECTRICITY, TABLES OF ANALYSIS, ETC.

BY

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Henry Work Dodd M.R.C.

PREFACE.

THE contents of the following pages are simply intended as an introduction to an elaborate, and, I may say, an almost unlimited science. They are simply an abstract of lectures delivered to my pupils during the last ten years. Many of the metals, as Vanadium, Titanium, Tungsten, and others, have been purposely omitted, the endeavour having been, throughout the work, to embrace as many of the leading facts as possible, and to omit all details of apparently minor importance.

In preparing this, the second edition of Part II., I have deemed it expedient to add the following, viz. :

A brief description of Electricity and Electric Batteries, together with some rules and examples, with their solution, for determining the percentage composition and chemical formulæ of substances, with Tables of Analysis. This addition has been made since questions on these subjects are set and asked at the present day at most of the Examining Boards.

I am fully aware how infinitesimal is the amount of justice which it is possible to bestow upon the above matters in the few following pages, and I can only hope that the present volume may prove serviceable to the tyro upon the threshold of his study.

ARMAND SEMPLE.

8, TORRINGTON SQUARE, W.C.
February, 1882.

AIDS TO CHEMISTRY.

THE METALS.

THERE are no less than 50 known metals, but inasmuch as some of these are found only in very small quantities, and their properties are but little ascertained, the most important only will be considered in the following pages.

All metals, except mercury, are solid at ordinary temperatures. They are good conductors of heat and electricity; many are susceptible of being polished, and of reflecting light; in the latter quality giving rise to the so-called metallic lustre. They are usually dense and heavy, ductile, malleable and tenacious; are all opaque, except in the very thinnest films, as with gold-leaf, through which light is capable of passage. They differ considerably from one another, both in chemical and physical properties; the lightest presenting the greatest affinity for oxygen; the heavier, the reverse.

If a solution of a metallic salt be decomposed by electrolysis, the metal will invariably be found at the negative pole, proving that metals are electro-positive. A salt is formed by the junction of a metal with a non-metallic element, and may be defined as the union of an electro-positive with an electro-negative.

If the name of the acid terminate in *ous*, as sulphurous, nitrous, etc., the resulting salt is termed an *ite*. If the acid terminate in *ic*, as sulphuric, nitric, etc., the salt then receives the name of *ate;* either being *sub—mono—sesqui—di—tri—tetra*—sulphite or sulphate, according to circumstances.

Those substances termed *Haloid salts* have already been described under Halogens.

The monads chlorine, bromine, iodine, fluorine, form, with *one* atom of hydrogen, *normal acids*, viz., HCl, HBr, HI, HF; and with an atom of any basylous radical,* ordinary *normal salts*, viz., $NaCl$ (chloride of sodium or common salt), KBr (bromide of potassium), KI (iodide of potassium), etc. Dyad radicals, as sulphur, selenium, etc., since they form with *two* atoms of hydrogen *normal acids*, viz., $\left.\begin{matrix}H\\H\end{matrix}\right\}SO_4$ (sulphuric acid), and with two atoms of monad metals, *normal salts*, as $\left.\begin{matrix}K\\K\end{matrix}\right\}SO_4$, (sulphate of potash) will clearly give rise to intermediate bodies consisting of one atom of hydrogen and one of metal, viz., $\left.\begin{matrix}K\\H\end{matrix}\right\}SO_4$. These are termed *acid salts*, being neither normal acids nor normal salts: they do not always redden litmus, and in a few cases have even an alkaline reaction.

An acid is a compound body, having usually a sharp, sour taste, and its solutions reddening litmus. It always contains hydrogen, and this can be replaced by a *basylous radical*,* or metal, thus giving rise to a salt.

The quantivalence or atomicity of a metal is determined by its combination with the monad chlorine; but it is frequently found that more than one compound is formed, as with tin, where we have $SnCl_2$ (stannous chloride), and $SnCl_4$ (stannic chloride). We have no *positive* means of determining whether this metal is a dyad or tetrad, but it is customary to consider the compound which contains the more chlorine as indicating its atomicity. Those salts containing the lesser amount of acid are termed *ous;* those containing the greater amount *ic*, viz., stannous and stannic chlorides, ferrous and ferric sulphates. (See pp. 52, 62).

It is convenient to consider the metals in groups, and thus we commence with

GROUP I.—THE METALS OF THE ALKALIES.

Potassium (K)	Lithium (Li)	Cæsium (Cs)
Sodium (Na)	Ammonium (NH_4) hypothetical	Rubidium (Rb)

POTASSIUM—Kalium (Kali, ashes).

Symbol, K. Combining weight, 39. Specific gravity, 0·865.

Description.—A bluish-white, lustrous, soft metal, very rapidly tarnishing in air from the formation of a film of oxide.

---

* Any substance playing the part of a base, as methyl (CH_3), ethyl (C_2H_5), etc.

When thrown upon water (hot or cold) it instantly takes fire, liberating hydrogen (potassiuretted*) and burning with a *violet* flame. This substance combines with many non-metals, as chlorine and sulphur, evolving light and heat.

Preparation.—(1). Potassium was discovered by Sir Humphry Davy, who, by electric action, decomposed caustic potash (KHO) into potassium, hydrogen, and oxygen. Until this experiment was performed, KHO was considered an elementary substance.

(2) By heating potassium monoxide (K_2O) to a high temperature in an iron retort with charcoal (C). Thus—

$$K_2O + C = CO + 2K.$$

Carbonic oxide is formed, which escapes as a gas, and potassium, which is volatile at a red-heat, distils over, and is collected under rock-oil or naphtha (these substances containing no oxygen). A second distillation is requisite, since a black explosive compound is formed in the first preparation.

Sources of the Potassium Compounds.—The felspar of the granitic rocks contains from 2 to 3 per cent. of potassium, but this source is not generally available.

Plants are capable of slowly assimilating potash from rocks and soils, and by burning these plants and extracting the ashes with water, a soluble potassium salt is obtained. This is the "crude potassium carbonate," and when purified by re-crystallisation is called "pearl-ash." Nitrate and chloride of potassium occur in large quantities in various localities, as deposits upon or within the earth. Sea-water is another source of these compounds.

POTASSIUM WITH OXYGEN forms three compounds, viz. :—

(1.) Potassium monoxide, K_2O ;
(2.) Potassium dioxide, K_2O_2 ;
(3.) Potassium tetroxide, K_2O_4.

POTASSIUM MONOXIDE, K_2O,

Is a greyish-white, brittle substance, volatilising only at very high temperatures. It combines with water, evolving great heat, and producing potassium hydroxide (KHO). Thus—

$$K_2O + H_2O = 2KHO.$$

Preparation.—(1). By exposing thin pieces of potassium to dry air, oxidation rapidly taking place.

(2) By the action of potassium (K) upon potassium hydroxide (KHO). Thus—

$$KHO + K = H + K_2O.$$

Hydrogen and potassium monoxide are formed.

---

* Impregnated with potassium.

POTASSIUM DIOXIDE, K_2O_2,

Is produced during the formation of the following substance—K_2O_4. It has never been obtained pure.

POTASSIUM TETROXIDE, K_2O_4,

Is of a chrome-yellow colour, prepared by the combustion of potassium in dry oxygen. Thus—

$$K_2 + O_4 = K_2O_4.$$

CAUSTIC POTASH. POTASSIUM HYDROXIDE, KHO,

Is a white substance, occurring in deliquescent rods or masses. It is soluble in water, is a powerful cautery, and in solution is used for soap-making, and as a test reagent in the laboratory.

It is prepared (1) by the addition of potassium monoxide (K_2O) to water (H_2O). Thus—

$$K_2O + H_2O = 2KHO.$$

(2). By adding potassium carbonate (K_2CO_3) to slaked lime (CaH_2O_2). Thus—

$$K_2CO_3 + CaH_2O_2 = CaCO_3 + 2KHO.$$

Carbonate of lime is precipitated as a heavy powder, and the clear liquid in which the caustic potash is contained is evaporated to dryness, then fused by exposure to a stronger heat and obtained in sticks by being cast into moulds.

POTASSIUM CARBONATE, K_2CO_3,

Termed, commercially, "pearl-ashes," is very soluble in water. It occurs in white deliquescent crystals, possesses a strong alkaline reaction, and is prepared by the lixiviation of wood-ashes, *i.e.*, by boiling out the ashes of plants with water, the solution being subsequently evaporated to dryness, and a pure salt obtained by crystallisation.

POTASSIUM BICARBONATE. POTASSIUM HYDROGEN CARBONATE, $KHCO_3$,

Occurs in white crystals, not so soluble as the preceding compound, requiring four parts of water for its solution, which is nearly neutral to test paper. It is prepared by passing carbon dioxide (CO_2) through potassium carbonate (K_2CO_3) and water (H_2O). Thus—

$$K_2CO_3 + H_2O + CO_2 = 2KHCO_3.$$

POTASSIUM NITRATE. NITRE. SALTPETRE, KNO_3,

Is found as an efflorescence upon the soil of dry, tropical climates, especially that of India, occurring in six-sided rhombic prisms, soluble in seven parts of water. It is prepared artificially by

NITRIFICATION.

In this process animal matter, containing nitrogen, together with wood-ashes and lime, is exposed in heaps to the action of air. Oxidation of the organic matter takes place gradually, nitric acid is formed, and, uniting with the lime and potash, produces nitrate of lime ($Ca2NO_3$) and nitrate of potash (KNO_3). After boiling with water, potassium carbonate (K_2CO_3) is added; this decomposes the nitrate of lime and the nitrate of potash crystallises out.

Nitre is much used in the preparation of *gunpowder*, the best of which should contain nearly two molecules of nitre, three of carbon, and one of sulphur. Upon firing the substance, the decomposition is as follows: nitrogen (N) is liberated, the charcoal (C) combining with the oxygen (O) of the nitre (KNO_3) and the sulphur (S) with the potassium (K), carbonic anhydride (CO_2) and potassium sulphide (K_2S) being formed.* The explosion is due to the large quantities of gas evolved, and the sudden increase of bulk caused by the rapid rise of temperature. Since sufficient oxygen is contained in gunpowder for its combustion, the substance is capable of burning under water or in a closed space.

POTASSIUM CHLORIDE, KCl,

Crystallises in cubes like chloride of sodium or common salt; exists in large quantities in sea-water and in certain saline deposits, as at Stassfurt. It may be prepared by heating potassium chlorate ($KClO_3$). Thus—

$$KClO_3 + \text{heat} = 3O + KCl.$$

Oxygen and chloride of potassium are formed.

POTASSIUM CHLORATE, $KClO_3$.

This salt crystallises in flat tabular crystals which taste like nitre.

It is prepared (1) by the action of chloride of potassium (KCl) upon chlorate of lime ($Ca2ClO_3$). Thus—

$$Ca2ClO_3 + 2KCl = CaCl_2 + 2KClO_3.$$

Chloride of calcium remains in solution, and potassium chlorate crystallises out.

(2) By passing chlorine through a solution of caustic potash.

---

* Thus $2KNO_3 + 3C + S = 2N + 3CO_2 + K_2S$.
The expansion is 1,500 times that of the powder.

Potassium Iodide, KI.

Opaque milk-white cubes, fusible and anhydrous, prepared

(a) By the addition of iodine (I) to caustic potash (KHO). Thus—

$$6KHO + 61 = 5KI + 3H_2O + KIO_3.$$

Iodide of potassium, water, and iodate of potassium result.

(b) Iodate of potassium is acted upon by carbon (C). Thus—

$$2KIO_3 + 3C = 3CO_2 + 2KI.$$

Carbonic anhydride and potassium iodide result.

Potassium Bromide, KBr,

Is similar to the iodide, and is prepared in the same manner by substituting bromine for iodine.

Potassium Sulphate, K_2SO_4,

Is found in the ashes of land and sea plants, and is sparingly soluble in water. It may be obtained in rhombic prisms during the preparation of nitric acid (HNO_3). Thus—

$$2KNO_3 + H_2SO_4 = 2HNO_3 + K_2SO_4.$$

Nitric acid and sulphate of potash result, to the latter of which carbonate of potash is added until effervescence ceases.

Potassium Hydrogen Sulphate. Potassium Bisulphate, $KHSO_4$,

Is a soluble salt occurring in flattened six-sided prisms. It is obtained in the same process as the foregoing by adding to K_2SO_4 more sulphuric acid, then evaporating, drying, re-dissolving and re-crystallising.

Potassium Sulphides.

There are five of these compounds, viz. :—
Potassium Monosulphide, K_2S, the Disulphide, K_2S_2, the Trisulphide, K_2S_3, the Tetrasulphide, K_2S_4, and the Pentasulphide, K_2S_5.

All these substances are soluble, and when heated with an acid evolve sulphuretted hydrogen.

Potassium Hydrosulphate, KHS,

Is a colourless solution which becomes yellow from absorbing oxygen. It is obtained by passing sulphuretted hydrogen gas through a solution of caustic potash. Thus—

$$KHO + H_2S = H_2O + KHS.$$

Water and potassium hydrosulphate are formed.

Tests for the Potassium Compounds.—(1) All these compounds yield a *violet* colour to flame. Seen thro' Cobalt glass

(2) The spectrum of this flame exhibits two bright lines; one in the red, the other in the violet.

(3) Tartaric acid ($H_2C_4H_4O_6$) gives a white precipitate of Cream of Tartar ($KHC_4H_4O_6$), on standing or stirring. The addition of a little alcohol increases the delicacy of this test.

(4) Perchloride of platinum ($PtCl_4$) throws down a yellow granular precipitate, falling slowly, and consisting of potassio-platino-chloride ($KPtCl_5$).

SODIUM—NATRIUM (Natron, soda).

Symbol, Na. Combining weight, 23. Specific gravity, 0·97.

Description and Preparation.—This metal was discovered by Sir Humphry Davy in a similar manner to that by which he obtained potassium. It may be readily prepared by reducing the carbonate of soda in the presence of carbon. The metal distils over when condensed, and is received into rock-oil or naphtha. which contain no oxygen

Sodium is a silver-white metal, soft and easily cut, the cut surface being at first brilliant, but soon becoming tarnished from the formation of a film of oxide.

When thrown upon water (H_2O) the metal floats, separates the hydrogen and leaves a solution of soda; if the water be heated or thickened with starch, the globule of metal becomes so heated that the hydrogen (sodiuretted*) takes fire and burns with a *yellow* flame.

Sources of the Sodium Compounds.—Spectrum analysis has shown that these compounds are contained in every speck of dust; enormous quantities exist in the primitive granitic rocks. The chief source, however, is sea-water, which contains nearly 3 per cent. of sodium chloride or common salt. At the present time sodium carbonate is manufactured upon an enormous scale from sea-salt.

SODIUM WITH OXYGEN forms two compounds, viz.:—

(1) Sodium Monoxide, Na_2O;
(2) Sodium Dioxide, Na_2O_2.

SODIUM MONOXIDE, Na_2O,

Is produced when sodium is oxidized in oxygen or dry air at a low temperature, a white powder being formed; this rapidly absorbs water with the formation of

Sodium Hydroxide ($NaHO$) or *Soda.*—From this compound

---

* Impregnated with sodium.

the water cannot be separated by heat alone, but the hydroxide may again be converted into the oxide by heating with sodium. Thus—

$$NaHO + Na = Na_2O + H.$$

Sodium monoxide and hydrogen result.

SODIUM DIOXIDE, Na_2O_2,

Is formed when sodium is heated in oxygen to 200° C. It is a yellowish-white powder, soluble in water, its solution readily decomposing into oxygen and sodium monoxide.

CAUSTIC SODA. SODIUM HYDROXIDE, NaHO.

A white solid, fusible below red-heat, very soluble in water, powerfully alkaline, a caustic, largely used for making hard soap. It is prepared by boiling lime-water (CaH_2O_2) and carbonate of soda (Na_2CO_3) together, and evaporating down the clear solution. Thus—

$$CaH_2O_2 + Na_2CO_3 = CaCO_3 + 2NaHO.$$

Carbonate of lime and caustic soda are formed. also

$Na_2O + H_2O = 2NaHO$

SODIUM CHLORIDE. Common Salt, NaCl,

Occurs in thick beds in various parts of the world. Is also prepared from sea-water by evaporation or freezing; and from certain brine-springs by evaporation. It does not dissolve sensibly more in hot than in cold water.

SODIUM CARBONATE, Na_2CO_3, $+ Na_2$

Is known commercially as *Soda-ash*. It is prepared from chloride of sodium by the following processes—

(1) The *Salt-cake* process, viz.:—the manufacture of sodium sulphate (the salt-cake) from common salt. Sulphuric acid (H_2SO_4) is added to common salt (NaCl.) Thus—

$$2NaCl + H_2SO_4 = 2HCl + Na_2SO_4.$$

Hydrochloric acid and sodium sulphate, or the salt-cake, are produced.

(2) The *Soda-ash* process, viz.:—(*a*) the preparation of sodium carbonate, and (*b*) its separation and purification.

(*a*) The Salt-cake (Na_2SO_4) is heated with powdered coal (C). Thus—

$$Na_2SO_4 + 4C = 4CO + Na_2S.$$

Carbonic oxide is given off and sulphide of sodium remains.

(*b*) The sulphide of sodium (Na_2S) is heated with chalk ($CaCO_3$). Thus—

$$Na_2S + CaCO_3 = CaS + Na_2CO_3.$$

Sulphide of lime and carbonate of soda result.

Sodium Hydrogen Carbonate. Bicarbonate of Soda, $NaHCO_3$.

A white crystalline powder which is readily converted into the carbonate by heating. It is prepared by passing a stream of carbonic acid (H_2CO_3) through the carbonate of sodium (Na_2CO_3). Thus—

$$Na_2CO_3 + H_2CO_3 = 2NaHCO_3.$$

Sodium Nitrate, $NaNO_3$,

Is found in large beds in Northern Chili, and termed Chili Saltpetre. It is used as a manure, and also as a substitute for nitrate of potash in the preparation of nitric acid.

Sodium Sulphate, $Na_2SO_4 + 10H_2O$,

Is known commercially as Glauber's Salts, and in the anhydrous state as salt-cake.

Other important salts are—

Sodium Hyposulphite	$Na_2S_2H_2O_4 + 4H_2O$.
Sodium Biborate, Borax	$Na_2B_4O_7 + 10H_2O$.
Sodium Sulphide	Na_2S.
Monosodic Orthophosphate ...	$NaH_2PO_4 + H_2O$.
Disodic Orthophosphate	$Na_2HPO_4 + 12H_2O$.
Trisodic Orthophosphate	$Na_3PO_4 + 12H_2O$.
Microcosmic salt or Sodium ammonium hydrogen phosphate	$NaNH_4HPO_4 + 4H_2O$
Sodium Metaphosphate	$NaPO_3$.
Sodium Pyrophosphate	$Na_4P_2O_7 + 10H_2O$.
Sodium Silicate	$Na_2SiO_3 3SiO_2$.

Tests for the Sodium Compounds—

(1) These are all soluble in water except the antimoniate.

(2) Antimoniate of potash* throws down a *white* precipitate of antimoniate of soda, providing that the liquid has been previously freed from all bases except the alkalies.

(3) They tinge flame *yellow*.

(4) Their spectrum shows a bright line in the yellow band.

---

* $K_2H_2Sb_2O_7$.

Carbon: Liq: Aff: Citrus

LITHIUM—(Lithos, a stone).

Symbol, L. Combining weight, 7. Specific gravity, 0·59.

Description, Sources, etc.—A soft reddish-white metal. The lightest solid known; prepared by the decomposition of the fused chloride by electricity. It occurs in two minerals called *spodumene* and *petalite*, and in small quantities in almost all waters, in tobacco, milk, and human blood.

All the volatile compounds of lithium give a splendid crimson to flame, and the spectrum presents one bright red line by which the minutest trace of lithium may be detected.

AMMONIUM—(From Jupiter Ammon).

In all the ammoniacal salts the existence of a quasi-metal *Ammonium* (NH_4) is supposed, since, if we substitute this for an atom of sodium or potassium in the alkaline salts, a corresponding ammonium salt is obtained. Thus—

Potassium Chloride	KCl.	Ammonium Chloride	NH_4Cl.
Potassium Nitrate	KNO_3.	Ammonium Nitrate	NH_4NO_3.
Potassium Sulphate	$\left.\begin{matrix}K\\K\end{matrix}\right\} SO_4$.	Ammonium Sulphate	$\left.\begin{matrix}NH_4\\NH_4\end{matrix}\right\} SO_4$.
Potassium Hydrosulphide	$\left.\begin{matrix}K\\H\end{matrix}\right\} S$.	Ammonium Hydrosulphide	$\left.\begin{matrix}NH_4\\H\end{matrix}\right\} S$.

The radical (NH_4) in the free state is a dark-blue liquid possessing a metallic lustre, but only existing under very high pressure, and at a very low temperature, and readily decomposing into hydrogen (H), and ammonia (NH_3).

An amalgam of ammonium may be obtained by placing sodium amalgam ($NaHg$) into a solution of chloride of ammonium (NH_4Cl), when chloride of sodium ($NaCl$) is formed, and the liberated ammonium combines with the mercury to form a light bulky metallic mass (NH_4Hg) which rises to the surface of the liquid, but soon decomposes into mercury (Hg), hydrogen (H) and ammonia (NH_3). The decomposition may be represented thus—

$$NaHg + NH_4Cl = NaCl + NH_4Hg.$$

Sodium amalgam and chloride of ammonium yield chloride of sodium and ammonium amalgam.

AMMONIUM CHLORIDE. SAL-AMMONIAC, NH_4Cl,

Occurs in white tough fibrous masses, difficult to powder, but easily soluble in water; on heating it entirely volatilises without fusion. It is prepared by (1) neutralising the ammoniacal liquor of the gas-works with hydrochloric acid; or, (2) by subliming sulphate of ammonia [$(NH_4)_2SO_4$] with common salt ($NaCl$). Thus—

$$(NH_4)_2SO_4 + 2NaCl = Na_2SO_4 + 2NH_4Cl.$$

Sulphate of sodium and chloride of ammonium result.

AMMONIUM CARBONATE, $(NH_4)_2CO_3$,

Is a very unstable substance, decomposing in contact with air, with evolution of ammonia.

It is prepared by submitting chloride of ammonium (NH_4Cl) and chalk ($CaCO_3$) to sublimation. Thus—

$$2NH_4Cl + CaCO_3 = CaCl_2 + (NH_4)_2CO_3.$$

Chloride of calcium and carbonate of ammonia are formed.

This $(NH_4)_2CO_3$ absorbs water and carbonic acid gas from the air and passes into the

AMMONIUM HYDROGEN CARBONATE OR BICARBONATE OF AMMONIA, NH_4HCO_3.

The SESQUICARBONATE, $(NH_4)_4H_2(CO_3)_3$ or $N_4H_{18}C_3O_9$, is the salt much used in medicine.

AMMONIUM NITRATE, NH_4NO_3,

Occurs in long transparent elastic needles, very soluble in water, and when heated above 230° C. decomposes into water (H_2O) and nitrous oxide gas (N_2O). It is prepared by the addition of nitric acid to ammonia.

AMMONIUM PHOSPHATE, $(NH_4)_3PO_4$,

Is formed when ammonia and phosphoric acid are mixed in hot concentrated solutions from which, upon cooling, the salt crystallises out. Upon drying, one molecule of ammonium is lost, and thus is obtained the salt $(NH_4)_2HPO_4$, upon boiling which another molecule of ammonium disappears and we obtain the salt $NH_4H_2PO_4$. Upon ignition all these salts leave a residue of metaphosphoric acid (HPO_3).

Microcosmic salt or ammonium sodium hydrogen phosphate, NH_4NaHPO_4 is much used for blow-pipe experiments.*

AMMONIUM SULPHATE, $(NH_4)_2SO_4$,

Occurs in long flat six-sided prisms, very soluble in water. It is prepared by the addition of sulphuric acid to gas-water. It is also a native salt, and is much employed as a manure and for the manufacture of alum.

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* Since at a high temperature it is converted into sodium metaphos-phate, which is valuable as a flux.

Ammonium Sulphide, $(NH_4)_2S$.

This substance separates out in colourless crystals, when dry sulphuretted hydrogen gas and excess of dry ammoniacal gas are brought together at —18C. At the ordinary temperature this substance loses NH_3 and becomes converted into a crystalline mass of the *hydrosulphide* NH_4HS, a volatile body, and very prone to decompose into ammonia and sulphuretted hydrogen. An aqueous solution is much used as a reagent. This is obtained by saturating aqueous ammonia with sulphuretted hydrogen. The colourless solution soon becomes yellow from the formation of polysulphides of ammonium.

Tests for the Ammonium Compounds—

(1) All the salts are white, are volatilised by heat, and if heated with caustic potash, soda, or lime, yield ammonia gas, known by its pungent odour and alkaline reaction on litmus.

(2) Perchloride of platinum gives a yellow precipitate of ammonio-platino-chloride (NH_4PtCl_5).

(3) Nitrate of silver and a solution of arsenious acid with liquor ammoniæ (NH_4HO) gives a yellow precipitate.

(4) Nessler's test consists in the addition of caustic potash (KHO) together with a solution of mercuric iodide (HgI_2) and potassium iodide (KI) to a solution containing ammonia or any of its salts; a brown colouration or precipitate is instantly produced which consists of dimercur-ammonium-iodide. Thus—

$$4KI + 2HgI_2 + NH_3 + 3KHO = 2H_2O + 7KI + NHg_2I,\ H_2O.$$

This is a most delicate test.

Hydroxylamine, NH_3O or $N\left\{\begin{matrix}H\\H\\OH\end{matrix}\right.$

This substance may be regarded as an intermediate compound between ammonia and water, or as ammonia NH_3 in which one atom of H is replaced by hydroxyl (OH). It acts as a base and unites with acids to form a well-defined series of salts. An aqueous solution of hydroxylamine has been prepared, and forms an inodorous, colourless liquid with strong alkaline reaction, but hydroxylamine itself has never as yet been isolated. It may be prepared synthetically by the direct union of nascent hydrogen (H) and nitric oxide (N_2O_2). Thus—

$$N_2O_2 + 6H = 2NH_3O.$$

The following are the best known salts of hydroxylamine.

NH_3OHCl	Hydrochlorate	of	Hydroxylamine.
$(NH_3O)_2H_2SO_4$	Sulphate	,,	,,
NH_3OHNO_3	Nitrate	,,	,,
$(NH_3O)_3H_3PO_4$	Phosphate	,,	,,

CÆSIUM—(Cæsius, sky-blue), AND RUBIDIUM—(Rubidus, dark-red).

These metals were discovered by spectrum analysis. They were originally found in the mineral water of Durckheim, but since then have been discovered in many other springs, in varieties of mica, as well as in the ashes of several plants, as the beet-root, tobacco, coffee, grapes. They are prepared by decomposing their fused chlorides by means of electricity.

Cæsium may be separated from rubidium by taking advantage of the greater solubility of the acid tartrate of the former. Cæsium gives two bright lines in the blue of the spectrum. Rubidium gives two bright lines in the red and two in the blue of the spectrum.

General Characteristics of the Metals of the Alkalies.

All the metals of this group are monads. Are soft, volatile at high temperatures and easily fusible. They combine very energetically with oxygen, and decompose water at all temperatures with the formation of basic oxides, which are freely soluble in water, producing powerful caustic alkaline substances termed hydroxides from which it is impossible to expel water by heat. Each metal forms only one chloride, and their carbonates are soluble in water.

Sodium (23), which in its properties stands between potassium (39) and lithium (7), has a combining weight which is the arithmetic mean of the other two. Thus—

$$\frac{39 + 7}{2} = 23.$$

GROUP II.—THE METALS OF THE ALKALINE EARTHS.

CALCIUM. STRONTIUM. BARIUM.

CALCIUM—(Calx, lime).

Symbol, Ca. Combining weight, 40. Specific gravity, 1·58.

Description and Sources.—A light yellow metal, readily oxidizing. When heated in the air it burns with a bright white light forming lime (CaO), the only oxide. In combination calcium forms whole mountain chains, and under the forms of limestone, chalk, and gypsum is very extensively diffused over the earth.

Preparation.—(1) By passing an electric current through the fused chloride ($CaCl_2$).

(2) By heating the iodide of calcium (CaI_2) with sodium (Na). Thus—$CaI_2 + 2Na = 2NaI + Ca$.

CALCIUM WITH OXYGEN forms

CALCIUM OXIDE. LIME, CaO.

Description.—A white caustic infusible substance giving an intense white light in the oxyhydrogen flame.

Preparation.—(1) By heating limestone (the carbonate) $CaCO_3$ in kilns by the aid of coal mixed with the stone. Carbonic anhydride (CO_2) escapes, and quick or caustic lime remains.

(2) By heating carbonate of lime ($CaCO_3$) to redness. Thus—

$$CaCO_3 + \text{heat} = CO_2 + CaO.$$

Lime combines very readily with H_2O, giving out great heat, and precipitating a white powder called *slaked lime* (CaH_2O_2) or calcium hydroxide. This is slightly soluble in water, one part dissolving in 730 parts of cold, but only in 1,300 of boiling water, and forming *lime-water*, which has a great power of absorbing carbonic acid from the air. *Mortar* is a mixture of slaked lime, water and sand,* the lime gradually combining with the silica. *Hydraulic mortars* harden under water, and are prepared by heating impure lime containing clay and silica; silicate of lime and alumina form upon moistening the powder, which then sets to a solid, and is unaffected by water. Lime is used in agriculture,

(1) To destroy excess of vegetable matter in the soil.

(2) To liberate potash for the use of plants by decomposing the silicate in heavy clay soils.

CALCIUM CARBONATE, $CaCO_3$,

Occurs widely diffused as chalk, limestone, coral and marble; also crystalline as Iceland spar (rhombohedral), and as arragonite (rhombic); this substance is therefore polymorphous or crystallising in different systems.

$CaCO_3$ is almost insoluble in *pure* water, but if the water contain carbonic acid it readily dissolves, causing *temporarily hard water*. Upon boiling the water the carbonic acid is given off, and thus a crust of $CaCO_3$ is deposited. The for-

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* Sand contains silicic acid or silica (SiO_2).

mation of this crust may be obviated by the addition of sal-ammoniac (NH_4Cl) to the water. Thus—

$$CaCO_3 + 2NH_4Cl = CaCl_2 + (NH_4)_2CO_3.$$

Chloride of calcium and carbonate of ammonia are produced.

Water may be softened by suspending sufficient lime to neutralise the excess of CO_2 in the water hardened by the dissolved carbonate.

CALCIUM SULPHATE, $CaSO_4$.

Occurs as a mineral *Anhydrite* and combined with $2H_2O$ as *gypsum* and *alabaster*. It is soluble in 400 parts of water, and forms a common impurity of spring water, causing *permanent hardness*, since boiling will not remove it. *Plaster of Paris* is formed by the application of moderate heat to gypsum which by this means loses its $2H_2O$, and upon again moistening, the $2H_2O$ is again taken up, and the substance sets to a solid mass.

CHLORIDE OF CALCIUM, $CaCl_2$.

A soluble salt formed from limestone or marble ($CaCO_3$) by the addition of hydrochloric acid (HCl). Thus—

$$CaCO_3 + 2HCl = CO_2 + H_2O + CaCl_2.$$

Carbonic anhydride, water, and chloride of calcium are formed.

Upon evaporating the solution, colourless, needle-shaped crystals of $CaCl_2 + 6H_2O$, the hydrated chloride, are formed. Upon drying, this substance forms a porous mass which absorbs water very greedily, and is used for drying gases.

BLEACHING POWDER, OR CHLORIDE OF LIME.

$CaCl_2$, $Ca2ClO$ or $Ca\left\{\begin{matrix}Cl\\OCl\end{matrix}\right.$ has been described earlier under the head of Chlorine.* Other compounds of calcium are

Calcium Fluoride, or Fluor Spar, CaF_2.
Calcium Phosphate, $Ca_3P_2O_8$.
Calcium Sulphide, CaS.
Calcium Pentasulphide, CaS_5.

Tests for the Calcium Compounds—

(1) The spectrum of calcium contains a number of bright lines of which a green line and an orange line at about an equal distance on each side of the sodium line are the most characteristic.

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* Part I., p. 33.

(2) Any salt of calcium held on platinum wire in a Bunsen burner flame acquires a bright orange tint.

(3) Oxalate of ammonium gives a white precipitate of oxalate of lime. This is a very delicate test, since by it the $\frac{1}{50,000}$ of a grain of calcium may be detected.

STRONTIUM—(Strontian, a village in Scotland).

Symbol, Sr. Combining weight, 87·5. Specific gravity, 2·54.

Description.—A pale yellow metal, found only in a few mineral deposits, especially as the carbonate (Strontianite) and the sulphate (Celestine). It occurs also in small quantities in certain spring waters, and closely resembles calcium in its properties.

Preparation.—By passing a current of electricity through the fused chloride ($SrCl_2$).

When heated in the air strontium forms

STRONTIUM MONOXIDE, SrO. STRONTIA.

Description and Preparation.—A white substance obtained by decomposing the nitrate of strontia, ($Sr2NO_3$) by heat. With water it evolves great heat, forming the *hydrate*, ($SrO + 9H_2O$), which is soluble in water and greedily absorbs carbonic anhydride.

The carbonate and sulphate of strontia are insoluble in water, and are employed in the preparation of the other salts of this metal. The nitrate of strontia ($Sr2NO_3$), and the chloride ($SrCl_2$) are soluble in water, and are the only salts used in the arts, in which they are employed in preparing *Red Fires.* "Red Fire" is composed of a mixture of 40 parts of $Sr2NO_3$, 10 of chlorate of potash ($KClO_3$), 13 of sulphur (S), and 4 of tri-sulphide of antimony (Sb_2S_3).

Tests for the Strontium Compounds—

(1) The salts of strontium tinge flame carmine-red.

(2) The spectrum shows five or six lines in the red, and (if with the high temperature of the blow-pipe flame) one line in the blue.

(3) Hydrofluosilicic acid gives no precipitate. This acid gives a white precipitate with soluble Barium salts.

(4) Sulphuric acid gives a white precipitate of sulphate of strontia, nearly as insoluble as sulphate of baryta.

BARIUM—(Barus, heavy).

Symbol, Ba. Combining weight, 137. Specific gravity, 1·5.

Description and Sources.—A metallic powder of a pale yellow colour, closely resembling calcium and strontium in its properties. The most common minerals in which barium

$BaO + H_2SO_4 = BaSO_4 + H_2O$

$aSO_4 + 2C = BaS + 2CO_2$

occurs are the sulphate, *heavy spar*, and the carbonate or *Witherite.*

Preparation.—By passing a current of electricity through the fused chloride ($BaCl_2$).

BARIUM WITH OXYGEN forms two oxides—

(1) Barium monoxide or baryta, BaO.
(2) Barium dioxide, BaO_2.

BARYTA, BaO,

Is a grey substance, prepared by decomposing the nitrate ($Ba2NO_3$) by heat. It fuses at a high temperature, takes up water with the evolution of great heat and the formation of a crystalline hydrate ($BaH_2O_2 + 8H_2O$). This hydrate is soluble in twenty parts of cold water, and by exposure to air the solution absorbs carbonic anhydride and becomes milky.

BARIUM DIOXIDE, BaO_2.

A grey substance formed by gently heating baryta in a current of oxygen. It is used for preparing hydrogen dioxide * (H_2O_2).

BARIUM CHLORIDE, $BaCl_2$.

A soluble salt, and one of the most important salts of barium. May be prepared from barium carbonate ($BaCO_3$) and hydrochloric acid (HCl). Thus—

$$BaCO_3 + 2HCl = CO_2 + H_2O + BaCl_2.$$

It is much used as a precipitant of sulphuric acid.

BARIUM SULPHATE, $BaSO_4$,

Occurs native as *heavy spar*. Specific gravity, 4·6. Is one of the most insoluble salts known, and may be prepared from a soluble salt of barium by the addition of sulphuric acid. Thus—

$$BaCl_2 + H_2SO_4 = 2HCl + BaSO_4.$$

Hydrochloric acid and sulphate of baryta are formed.

It is employed as a paint, termed *blanc-fixe,* when precipitated, and the native *heavy spar*, when ground, is largely used as an adulterant for white lead.

Other salts of barium are the nitrate ($Ba2NO_3$), a soluble salt; the sulphide (BaS) (obtained by heating $BaSO_4$ with coal), decomposing when added to water into barium hydroxide BaH_2O_2, and hydrosulphide of barium BaH_2S_2, both soluble.

The carbonate ($BaCO_3$), barium silico-fluoride (BaF_2SiF_4),

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* Part I., p. 14.

and the phosphate ($Ba_3P_2O_8$) are insoluble. The soluble salts of barium are poisonous.

Tests for the Barium Compounds—

(1) The salts of barium tinge flame green.

(2) The spectrum shows a series of bright bands in the green, and fainter bands in the red.

(3) Hydrofluosilicic acid gives a white precipitate with barium, but none with strontium and calcium.

General Characteristics of the Metals of the Alkaline Earths.

These metals are all dyads. They are irreducible by carbon or hydrogen alone. They are capable of decomposing water at all temperatures, with the production of oxides, which in combination with water form hydroxides; and from some of these it is possible to drive off the water by heat. Their carbonates are insoluble in water. Carbonates of lime and magnesia may be readily rendered soluble if the water contains excess of carbonic acid. & are all pois-

GROUP III.—THE METALS OF THE EARTHS.

There are no less than six* of these, but the only one of importance is the following, viz.:

ALUMINIUM.

Symbol, Al. Combining weight, 27·4. Specific gravity, 2·6.

Description.—A silver-white metal, unaffected by air, extremely light, and consequently much employed for the manufacture of optical instruments.

Aluminium is a triad element, and decomposes water at a very high temperature.

Sources.—Found combined with oxygen and silicon in large quantities in the older rocks, in felspar (a compound of silicon, potassium, aluminium and oxygen, Si_3AlKO_8), in clay (silicate of aluminium), and in many crystalline minerals.

Preparation.—By passing the vapour of chloride of aluminium (Al_2Cl_6) over metallic sodium (Na). Thus—

$$Al_2Cl_6 + 6Na = 6NaCl + 2Al.$$

Common salt and aluminium are formed.

ALUMINIUM CHLORIDE, Al_2Cl_6,

Is a transparent, waxy, colourless substance, with crystalline structure, prepared by heating alumina (Al_2O_3) and charcoal (C) in a current of chlorine (Cl). Thus—

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* Yttrium, Erbium, Cerium, Lanthanum, Didymium.

$$Al_2O_3 + 3C + 6Cl = 3CO + Al_2Cl_6.$$

Carbonic oxide and aluminium chloride are formed.

ALUMINIUM SULPHATE, $Al_2(SO_4)_3$,

Occurs in soluble thin pearly plates, with sweet astringent taste and acid reaction. It is prepared by the action of sulphuric acid upon clay (Silicate of Aluminium).

ALUMEN—ALUM, $NH_4Al(SO_4)_2 + 12H_2O$.

This substance is a double sulphate of alumina and ammonia. It is prepared by roasting alum-schist, which contains sulphide of aluminium. By the roasting and exposure to air the sulphide becomes sulphate, and thus sulphate of alumina is formed. A solution of sulphate of ammonia is now added, and the whole crystallises out as alum.

H_2S
+
Ga

ISOMORPHISM—(*isos* equal, *morphe* form).

Those bodies are said to be *isomorphous* which crystallise in the same form, but differ in their chemical and physical properties. Alum may be taken as a type of these substances, since the ammonium may be replaced by any other alkaline metal. Thus—

$NH_4Al(SO_4)_2 + 12H_2O$ = Ammonia Alum.
$Na\ Al(SO_4)_2 + 12H_2O$ = Soda Alum.
$Li\ Al(SO_4)_2 + 12H_2O$ = Lithia Alum.
$K\ Al(SO_4)_2 + 12H_2O$ = Potash Alum.

Again, the sesquioxide of aluminium (Al_2O_3)* may be replaced by the isomorphous sesquioxides of iron (Fe_2O_3), of chromium (Cr_2O_3), and of manganese (Mn_2O_3). Thus—

$NH_4Al(SO_4)_2 + 12H_2O$ = Alumina Alum.
$NH_4Fe(SO_4)_2 + 12H_2O$ = Iron Alum.
$NH_4Cr(SO_4)_2 + 12H_2O$ = Chromium Alum.
$NH_4Mn(SO_4)_2 + 12H_2O$ = Manganese Alum.

It may here be explained that after stating that the sesquioxides are substituted, we find Al, Fe, Cr, Mn, in the formulæ, but it must be remembered that alum is really composed of $(NH_4)_2SO_4$ (sulphate of ammonia), and $Al_2(SO_4)_3$* (sulphate of alumina), and the original formula for this alum would be $(NH_4)_2Al_2(SO_4)_4 + 24H_2O$, but to simplify the equation we divide by 2 and obtain $NH_4Al(SO_4)_2 + 12H_2O$.

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* $Al_2O_3 + 3H_2SO_4 = 3H_2O + Al_2(SO_4)_3$.

ALUMINIUM WITH OXYGEN FORMS ALUMINA.

Symbol, Al_2O_3. Specific gravity, 3·9.

The only known oxide, occurring native in the ruby and sapphire. Is attacked with difficulty by acids, but the hydrate ($Al_2O_3,3H_2O$) is easily dissolved by acids and by fixed caustic alkalies. It is largely used in dyeing as a mordant,* since it forms "*lakes*" (insoluble compounds) with vegetable colouring matter, producing the so-called *fast* colours. By adding ammonia to a solution of alum, the hydroxide ($Al_2O_3,3H_2O$) falls down as a white precipitate, and this, upon heating, yields pure alumina as a white amorphous powder.

Tests for the Aluminium Compounds—

(1) The caustic alkalies give white precipitates, soluble in excess.

(2) Ammonia gives a white precipitate insoluble in excess.

(3) Any salt of aluminium, with a solution of cobalt, acquires an *ultramarine blue* colour before the blow-pipe.

Glass.

This is a compound produced by fusing the silicates with the alkaline metals. There are four varieties, viz. :

(1) *Crown, window, and plate-glass,* containing sodium and calcium silicates.

(2) *Bohemian glass,* containing potassium and calcium silicates.

(3) *Flint glass, or crystal,* containing potassium and lead silicates.

(4) *Common green bottle-glass,* containing sodium, calcium, iron, and aluminium silicates.

The addition of oxide of lead increases the lustre of the glass, as well as its fusibility and specific gravity.

Coloured Glasses.

Ferrous oxide (FeO) produces a deep green (bottle glass), and manganese oxide communicates a purple tint to glass. It is difficult to obtain materials entirely free from iron, which gives a green tinge ; in order therefore, to obtain a colourless glass, a small portion of manganese dioxide (MnO_2) is added, and the violet colour thus formed being complementary to the green, a nearly colourless glass is produced. Arsenious anhydride (As_2O_3) will ensure the same end by converting the ferrous into ferric-oxide. "Paste" is a brilliant lead glass, and upon the addition of certain oxides to this the colours of precious stones may be imitated. The blue of the sapphire is yielded by cobalt oxide ; a ruby-red by cuprous oxide, whilst the yellow of the topaz is imparted by ferric oxide.

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* A substance the colouring matter of which has a strong affinity for the fibre of a fabric.

$Mg + H_2SO_4 = MgSO_4$ [illegible]

GROUP IV.—THE ZINC GROUP.

MAGNESIUM. ZINC. CADMIUM.

MAGNESIUM—(Magnesia, a town in Asia Minor).

Symbol, Mg. Combining weight, 24·0. Specific gravity, 1·74.

Description.—A white, ductile, malleable metal, which fuses at a low red heat, and when soft may be pressed into wire. When strongly heated in the air it ignites and burns with a dazzling white light, forming magnesia (MgO), the oxide. So rich is this light in chemically active rays, that it has been used as a substitute for sunlight, and has been made available for photographing the interior of the pyramids. This metal rapidly dissolves in sulphuric and hydrochloric acids, evolving hydrogen.

Sources.—Found in large quantities as the carbonate or *dolomite* in mountain limestone, combined with calcium carbonate; also in certain mineral springs as sulphate and chloride, and in sea-water.

Preparation.—By heating magnesium chloride ($MgCl_2$) with metallic sodium (Na). Thus—

$$MgCl_2 + 2Na = 2NaCl + Mg.$$

Common salt and magnesium are formed.

MAGNESIA, MgO.

A soft, white, insoluble powder, known in medicine as calcined magnesia. It unites with acids to form the magnesium salts, and is prepared by heating the nitrate or carbonate.

H.P. [illegible]

MAGNESIUM CHLORIDE, $MgCl_2$.

A white, crystalline, deliquescent, fusible salt, prepared by the addition of hydrochloric acid (HCl) to magnesium carbonate ($MgCO_3$.) Thus—

$$MgCO_3 + 2HCl = H_2CO_3 + MgCl_2.$$

Carbonic acid and magnesium chloride are formed.

MAGNESIUM SULPHATE, $MgSO_4 + 7H_2O$.

A soluble substance, known as Epsom Salts, occurring in right rhombic prisms. This salt forms with the alkaline sulphates, double salts in which the alkaline sulphate supplies the place of one molecule of water of crystallisation. Thus—

$$MgSO_4, K_2SO_4 + 6H_2O.$$

Preparation.—By the addition of sulphuric acid (H_2SO_4) to dolomite ($CaCO_3, MgCO_3$). Thus—

$$CaCO_3, MgCO_3 + 2H_2SO_4 = CaSO_4 + 2CO_2 + 2H_2O + MgSO_4.$$

Sulphate of lime, carbonic anhydride, water, and magnesium sulphate result.

MAGNESIUM CARBONATE, $MgCO_3$.

An insoluble compound, occurring as a mineral termed *magnesite.* "Magnesia alba" consists of a varying mixture of carbonate and hydrate of magnesia ($MgCO_3MgH_2O_2 + 6H_2O$).

Tests for the Magnesium Compounds—

(1) Any phosphate with a little ammonia gives a white precipitate of ammonio-magnesian phosphate, soluble in acids.

(2) The salts are white, but when heated before the blowpipe with nitrate of cobalt acquire a pink tinge.

ZINC.

Symbol, Zn. Combining weight, 65·2. Specific gravity, 6·8 to 7·2.

Description.—A blueish white metal, crystalline when broken transversely, and brittle at the ordinary temperature; when heated to 130° C. it may be hammered easily, but if more strongly heated to 200° C. it again becomes brittle.

Zinc melts at 423° C. and boils at a bright red heat; should air be present, it ignites and burns with a luminous green flame, forming the oxide ZnO. Since neither moist nor dry air act upon zinc, this metal is used in the form of sheets as a protecting covering for iron, which latter metal is then said to be *galvanized.* One part of zinc and two of copper form brass, and an alloy of zinc, nickel and copper forms German silver.

Sources.—The chief ores of zinc are the sulphide *Blende,* and the carbonate *Calamine.*

Preparation.—The powdered ore (carbonate or sulphide) is roasted in order to convert it into oxide. Fine coal is then mixed with the roasted ore, and strongly heated in crucibles of a peculiar shape. Carbon monoxide is given off, and the metallic zinc distills over and is condensed.

ZINC OXIDE, ZnO.

The only known compound of zinc with oxygen. It is an insoluble white amorphous powder, becoming yellow on heating, but losing that colour on cooling. It is used as a pigment, termed zinc white.

It is prepared by (1) precipitating a soluble zinc salt with an alkali, or (2) by heating the carbonate. Thus—

$$ZnCO_3 + \text{heat} = CO_2 + ZnO.$$

Carbonic anhydride and zinc oxide are formed.

ZINC SULPHATE, $ZnSO_4 + 7H_2O$.

Is called "white vitriol," and crystallises in long prisms. It is prepared by the action of sulphuric acid upon zinc. Thus—

$$Zn + H_2SO_4 = 2H + ZnSO_4.$$

Hydrogen is evolved, and sulphate of zinc is formed.

ZINC CHLORIDE, $ZnCl_2$.

A white, fusible, deliquescent substance, prepared by the action of hydrochloric acid upon zinc. Thus—

$$Zn + 2HCl = 2H + ZnCl_2.$$

Hydrogen and zinc chloride result.

ZINC SULPHIDE, ZnS,

Occurs as a mineral called *Blende.* It is formed when an alkaline sulphide is added to a soluble salt of zinc.

ZINC CARBONATE, $ZnCO_3$.

An insoluble substance, occurring native as *Calamine.* May be prepared from sulphate of zinc ($ZnSO_4$), and carbonate of soda (Na_2CO_3). Thus—

$$ZnSO_4 + Na_2CO_3 = Na_2SO_4 + ZnCO_3.$$

Sulphate of soda and zinc carbonate are formed.

Tests for the Zinc Compounds—

(1) Sulphuretted hydrogen gives a *white* precipitate in neutral solutions ; none in acid solutions.

(2) Ferrocyanide of potassium gives a white precipitate.

(3) Sodium carbonate, charcoal, and the blow-pipe give yellow (ZnO), which becomes white on cooling ; the latter, heated with cobalt nitrate in the outer flame of the blow-pipe, acquires a fine green colour.

CADMIUM.

Symbol, Cd. Combining weight, 112. Specific gravity, 8·6.

A comparatively rare metal, occurring in small quantities in most zinc ores. It closely resembles zinc, but is more volatile, and distils over first in the preparation of that metal.

Cadmium is a white ductile metal which melts at 315° C, It takes fire when heated in the air, forming CdO, the brown oxide. The iodide of cadmium is sometimes used in photography, and the yellow sulphide has been used as a pigment.

Test for the Cadmium Compounds—

Sulphuretted hydrogen gives a yellow precipitate insoluble in alkalies.

General Characteristics of the Zinc Group.

All these metals are dyads, are all volatile at high temperatures, and burn when heated in the air. They each form only one oxide and one chloride, and decompose water at a high temperature.

GROUP V.—THE IRON GROUP.

MANGANESE.
NICKEL.
IRON.
CHROMIUM.
COBALT.

MANGANESIUM.

Symbol, Mn. Combining weight, 55. Specific gravity, 8·0.

Description.—A reddish, lustrous, brittle metal, hard enough to scratch glass. Decomposes water at ordinary temperatures, with evolution of hydrogen. Must be kept under naphtha, as it rapidly undergoes oxidation in air. An alloy of manganese and iron is much employed in the manufacture of steel. Occurs in nature as the black and red oxide.

Preparation.—Is obtained, but with difficulty, by heating the oxide very strongly with charcoal.

The compounds of manganese with oxygen are five in number, viz.:

(1) *Manganous oxide or manganous monoxide,* MnO.
(2) *Manganic oxide or manganese sesquioxide,* Mn_2O_3. 5
(3) *Mangano-manganic oxide or red oxide,* Mn_3O_4.
(4) *Manganese dioxide or black oxide,* MnO_2.
(5) *Manganese heptoxide,* Mn_2O_7.

MANGANESE MONOXIDE, MnO.

A green powder, prepared by passing hydrogen gas (H) over the heated carbonate ($MnCO_3$). Thus—

$$MnCO_3 + 2H = CO + H_2O + MnO.$$

Carbonic oxide, water, and manganese monoxide are formed.

This substance forms with acids the pink-coloured salts.

The chief soluble manganous salts are the *sulphate* $MnSO_4,5H_2O$ (*pink vitriol*), and the *chloride* $MnCl_2,4H_2O$.

The chief insoluble manganous compounds are the flesh-coloured *sulphide* MnS, and the *carbonate* $MnCO_3$, a white powder.

MANGANIC OXIDE, Mn_2O_3,

Occurs in nature as a mineral *Braunite*. It forms salts of somewhat unstable nature, the most important being the manganese alum, in which the Al_2O_3 of the common alum is replaced by Mn_2O_3 (p. 19).

MANGANO-MANGANIC OXIDE, Mn_3O_4,

m red ox

Is a neutral body, occurring native as *Hausmannite*, and corresponding to the magnetic oxide of iron.

MANGANESE DIOXIDE, MnO_2,

Occurs in the minerals *Pyrolusite* and *Varvacite*, and is the common black ore of manganese. It is much used for the preparation of oxygen and chlorine.*

MANGANESE HEPTOXIDE, Mn_2O_7,

Is a dark green heavy liquid, prepared by the addition of strong cold sulphuric acid (H_2SO_4) to permanganate of potassium. This salt is easily decomposed by heat, with the evolution of oxygen which is rich in ozone.

MANGANIC AND PERMANGANIC ACIDS.

These acids have never been isolated, but they are known in composition, for should a caustic alkali, such as caustic potash (KHO), be fused with an oxide of manganese, a *bright green mass* is formed, and this, with water, will yield a dark green solution containing *potassium manganate* (K_2MnO_4). Upon standing, this dark green solution changes to a bright purple, and deposits the hydrated manganese dioxide. A new salt is now contained, viz. : *potassium permanganate* ($KMnO_4$). The following are therefore the theoretical formulæ :

Manganic acid H_2MnO_4.
Permanganic acid $HMnO_4$.

Tests for the Manganesium Compounds :

(1) The alkalies give *white* precipitates, becoming *brown.*

(2) Sulphide of ammonium (NH_4HS) gives a *flesh-coloured* sulphide of manganese. MnS (insoluble)

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* Part I., pp. 7, 8, 31.

$KClO_3 + H_2SO_4$

H_2S in alkaline sol: gives flesh colour

(3) With borax bead before the blow-pipe, the salts yield an amethyst-red colour to the outer flame, but give no colour to the inner.

(4) These salts, when heated upon platinum foil with carbonate of soda (Na_2CO_3), yield a *bluish-green opaque bead* of sodium manganate (Na_2MnO_4).

FERRUM—IRON.

Symbol, Fe. Combining weight, 56. Specific gravity, 7·8.

Description.—A bright, white metal, exceedingly tough, although soft. Pure metallic iron is found only in very small quantity, and almost alone composing the "Meteoric stones," which are supposed to be of extra-terrestrial origin. The chief ores of this metal are the iron-pyrites (FeS_2), the magnetic oxide (Fe_3O_4), red-hæmatite and Elba-iron (Fe_2O_3), and the carbonate, or clay-ironstone. $FeCO_3$

In commerce, iron exists in three forms, viz.:

(1) Wrought iron (nearly pure iron).

(2) Cast iron (iron with varying quantities of carbon and silicon).

(3) Steel (iron with less carbon than that needed to form the cast variety).

Pure iron, as powder, may be prepared by moderately heating the oxide in a current of hydrogen gas, and since, when exposed to the air, finely divided iron takes fire, it is necessary to retain it in an atmosphere of hydrogen.

After being uniformly hammered and broken, this metal presents a *crystalline granular* structure, which becomes *fibrous* when rolled into bars, and this fibrous texture, after long-continued vibration, returns to the original crystalline state; hence the accidents that have taken place from the snapping of railway axles.

Some of the compounds and the metal itself are highly magnetic, losing this property when red-hot, and receiving it again on cooling.

Iron in a solid mass will not tarnish in dry air, but when heated it oxidizes in black scales of oxide, and if more strongly heated it takes fire, forming the same black oxide. In water containing a trace of carbonic acid, iron gradually becomes coated with *rust* ($Fe_2O_33H_2O$), but in pure water the metal remains unchanged.

IRON MANUFACTURE.

Wrought-iron was at one time manufactured by reducing it from its ore by heating it with coal in a wind furnace and hammering out the resulting spongy mass.

The present method consists in first forming *cast-iron*, and separating out subsequently the carbon and silicon which it contains. The chief source of this cast iron is the clay-iron-stone (ferrous carbonate ($FeCO_3$) united with silicate of alumina or clay). This is first submitted to roasting, by which process the carbonic acid is driven off and the ferric oxide formed, the ore being then thrown with coal and lime-stone into a *blast furnace*, the construction of which is as follows:

THE BLAST FURNACE

Consists of a double cone of strong fire-brick, about 50 feet in height, and from 15 to 18 feet wide at the broadest part. It is closed at the bottom, air being blown in near that part in a powerful blast by means of tuyeres or pipes. The fuel and ore are thrown in at the top, the burning mass sinking down, and the molten mass being drawn off at the bottom. At the lowest part is the hearth, where the melted metal and fused slag collect; the latter, which swims upon the surface of the metal, runs continuously from an aperture in the upper part of the hearth, and the former is from time to time tapped from the bottom of the hearth and cast into pigs (as they are called) in moulds made in the sand. The ferric oxide, in passing from the top to the bottom of the furnace, is first reduced to porous metallic iron by the carbonic oxide gas generated from the burning coal; then, meeting with the clay and lime-stone in a hotter part of the furnace, a slag or fusible silicate is formed, and the heated metal encountering carbon, unites with this to form cast-iron in a fusible form, the silica of which in the hottest part of the furnace is reduced to silicon, and thus cast-iron is formed.

Cast-iron is not a definite chemical compound of carbon and silicon with iron, since the carbon may exist in it as scales of 2
graphite, occasioning the *mottled cast-iron*, or in combination as *white cast-iron*. Sulphur and phosphorus are sometimes found in cast-iron, but these must be looked upon as impurities.

Wrought-iron is obtained from cast-iron by the process of 1
"refining" and "puddling." Here the carbon, silicon, phosphorus and sulphur are burnt out by exposing the heated metal to a current of air in a reverberatory furnace, a coat of oxide gradually accumulating upon the melted cast-iron, which is then rolled into balls. The whole of the carbon passes off as carbonic oxide, the silicon being oxidized to

silica, which forms a fusible slag by uniting with the oxide of iron; the phosphorus and sulphur also undergo oxidation. The liquid slag is squeezed out of the balls by hammering, and the mass finally rolled into plates or bars.

Although wrought-iron melts only at a very high temperature and with great difficulty, it becomes soft at a much lower one, and when hot possesses the property of "welding," *i.e.*, two clean surfaces of hot metal when hammered together uniting firmly.

Steel is formed by heating bars of wrought-iron to redness in contact with charcoal; it is then found that the bar, instead of being fibrous, has become fine-grained; it is at the same time more flexible, and capable of taking a fine edge, is more fusible, and contains from one to two per cent. of carbon.

THE BESSEMER PROCESS

Consists in burning away the whole of the silicon in cast-iron by means of a blast of air through the molten metal, and then adding sufficient pure cast-iron to yield enough carbon to convert the whole into steel.

Iron is a tetrad* element, and forms the following oxides. With all tetrads it will be observed that the formulæ are usually written with half their molecular weight. Thus—

Ferrous oxide	FeO.
Ferric oxide	Fe_2O_3.
Black, or Magnetic oxide	Fe_3O_4.

FERROUS OXIDE, FeO,

Has never been prepared pure, since it greedily absorbs oxygen, and forms higher oxides. It may be prepared as a white precipitate in total absence of oxygen, by precipitating a soluble ferrous salt by means of caustic alkali. If oxygen be present, a greenish precipitate is formed. With this oxide the ferrous salts are formed, the most important of which are—

FERROUS SULPHATE—PROTOSULPHATE OF IRON, $FeSO_4 + 7H_2O$,

Commonly called *green vitriol*, or copperas. May be prepared (1) by the addition of sulphuric acid (H_2SO_4) to metallic iron (Fe). Thus—

$$Fe + H_2SO_4 = H_2 + FeSO_4.$$

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* See p. 59.

Hydrogen and ferrous sulphate being formed ; or (2) by slowly oxidising metallic iron (Fe) with iron pyrites (FeS_2). Thus—

$$FeS_2 + Fe + 8O = 2FeSO_4.$$

Ferrous Chloride, $FeCl_2$,

May be prepared by passing dry hydrochloric acid gas (HCl) over hot metallic iron (Fe). Thus—

$$Fe + 2HCl = 2H + FeCl_2.$$

Hydrogen escaping and ferrous chloride being formed.

Ferrous Carbonate, $FeCO_3$,

Occurs as a mineral, called spathose-iron-ore, and less pure in clay ironstone.

Ferrous Sulphide, FeS,

Is a black substance, obtained by fusing together equivalent quantities of iron and sulphur. The disulphide FeS_2 is found in large quantities. iron pyrites

All the ferrous compounds are readily prone to oxidation, passing into the ferric salts.

Ferric Oxide, Fe_2O_3,

Sometimes called iron sesquioxide, occurs native as red-hæmatite, and specular-iron-ore ; with water it forms brown hæmatite. May be prepared (1) by heating ferrous sulphate to redness, or (2) by adding liquor ammoniæ (NH_4HO) to a solution of ferric chloride (Fe_2Cl_6). Thus—

$$Fe_2Cl_6 + 6NH_4HO = 6NH_4Cl + 3H_2O + Fe_2O_3.$$

Chloride of ammonium, water, and ferric oxide are formed.

With this oxide the ferric salts are formed, the most important of which are the following—

Ferric Chloride, Fe_2Cl_6.

Obtained in anhydrous brilliant red crystals ; by (1) passing chlorine gas over hot metallic iron, or in a hydrated form ; by (2) acting upon ferrous chloride ($FeCl_2$) with a mixture of hydrochloric acid (HCl), and nitric acid (HNO_3). Thus—

$$6FeCl_2 + 6HCl + 2HNO_3 = N_2O_2 + 4H_2O + 3Fe_2Cl_6.$$

Nitric oxide, water, and ferric chloride result.

By passing sulphuretted hydrogen (H_2S) through Fe_2Cl_6, a white precipitate of sulphur is produced, together with hydrochloric acid and ferrous chloride. Thus—

$$Fe_2Cl_6 + H_2S = S + 2HCl + 2FeCl_2.$$

FERRIC SULPHATE, $Fe_2(SO_4)_3$,

Is obtained as a buff-coloured amorphous mass by acting upon ferrous sulphate ($FeSO_4$) with a mixture of sulphuric acid (H_2SO_4), and nitric acid (HNO_3). Thus—

$$6FeSO_4 + 3H_2SO_4 + 2HNO_3 = 4H_2O + N_2O_2 + 3Fe_2(SO_4)_3.$$

THE MAGNETIC OR BLACK OXIDE, Fe_3O_4,

Occurs native as the mineral *lode-stone*, sometimes called *ferroso-ferric oxide*. It is formed when iron is oxidised at a high temperature in aqueous vapour, air, or oxygen.

FERRIC ACID, H_2FeO_4, ?

Is only known in combination. By fusing together nitrate of potash (KNO_3), and ferric oxide (Fe_2O_3), and placing the result in ice-cold water, a deep amethyst-coloured solution is produced, which contains *potassium ferrate* (K_2FeO_4).

Tests for the Iron Compounds—

For the *Ferrous* salts :

These are of a *light green* colour, and in solution give—

(1) With alkalies, a white precipitate turning *greenish-brown.*

(2) With ferrocyanide of potassium (K_4FeCy_6), a white precipitate passing through *light blue* to dark blue.

(3) With ferricyanide of potassium (K_3FeCy_6), a *dark blue* precipitate.

(4) With sulphuretted hydrogen (H_2S), no precipitate.

(5) With sulphide of ammonium (NH_4HS), a black precipitate.

(6) With sulphocyanide of potassium (KSCy), no precipitate.

(7) With tincture of galls, no precipitate.

For the *Ferric* salts :

These are of a *reddish-brown* colour, and in solution give—

(1) With alkalies, a *foxy-red* precipitate.

(2) With K_4FeCy_6, a *Prussian blue* precipitate.

(3) With K_3FeCy_6, no special precipitate, but usually a green colour.

(4) With H_2S, a precipitate of sulphur (white), and the ferric salts are reduced to the ferrous.

(5) With KSCy, a *blood-red* precipitate.

(6) With tincture of galls, a bluish-black precipitate.

COBALT.

Symbol, Co. Combining weight, 58·7. Specific gravity, 8·5.

Description.—A reddish-white, very tenacious metal, strongly magnetic and infusible. Does not occur native, but is found combined with sulphur and arsenic as tin-white cobalt ($CoAs_2$) and cobalt-glance ($CoAsS$). The cobalt compounds are characterised by their brilliancy of colour; they give a splendid blue tint to glass, and are used as pigments. There are three oxides of cobalt—

(1) The monoxide ... ... CoO.
(2) The sesquioxide ... ... Co_2O_3.
(3) An oxide ... ... Co_3O_4.

The monoxide, with acids, forms a series of salts which when hydrated are pink, and when anhydrous are blue. The sesquioxide forms no salts.

There are two series of salts, the Cobaltous and Cobaltic.

Tests—

For the *Cobaltous* salts:
(1) Liquor potassæ gives a blue precipitate turning red.
(2) Liquor ammoniæ gives a blue, turning brown.
(3) Ferrocyanide of potassium gives a greyish-green.
(4) Sulphide of ammonium gives a black.
(5) Carbonate of ammonia gives a pink.

For the *Cobaltic* salts:
(1) Liquor potassæ gives a dark-brown precipitate.
(2) Liquor ammoniæ gives a brownish-red.
(3) Sulphide of ammonium gives a black.
(4) Carbonate of ammonia gives a green.

Cobalt salts with the borax bead on platinum wire yield a very characteristic blue bead.

NICKEL.

Symbol, Ni. Combining weight, 58·7. Specific gravity, 8·8.

Description.—A white, tenacious metal, strongly magnetic, but losing this property when heated to 350°C.

There are two oxides of nickel—

(1) The monoxide ... ... NiO.
(2) The sesquioxide ... ... Ni_2O_3.

The monoxide gives rise to those nickel salts which possess a green colour.

Tests—

(1) The alkalies and their carbonates give a pale apple-green precipitate.
(2) Ferrocyanide of potassium gives a green precipitate.
(3) Sulphide of ammonium gives a black precipitate.

CHROMIUM—(*Chroma*, colour).

Symbol, Cr. Combining weight, 52·2. Specific gravity, 6·8.

Description.—The chief ore of chromium is the chrome ironstone $FeOCr_2O_3$.

The compounds of chromium are chiefly used in the arts as pigments, since many of them possess fine bright colours. The green of porcelain is communicated by the sesquioxide (Cr_2O_3). **Chromium is the most infusible of all the metals : it is prepared by** passing sodium vapour (Na) over chromic chloride (Cr_2Cl_6). Thus—$6Na + \cancel{2}Cr_2Cl_6 = 6NaCl + \cancel{4}Cr$.

There are four compounds of chromium with oxygen, viz.:

(1) Chromium monoxide	CrO.
(2) Chromium sesquioxide	Cr_2O_3.
(3) Chromo-chromic oxide	$CrOCr_2O_3$.
(4) Chromium trioxide	CrO_3.

The two first oxides are basic, and form corresponding salts.

The third oxide corresponds to the magnetic oxide of iron, and chromium trioxide forms an acid with water—chromic acid (H_2CrO_4)—which neutralises bases forming red or yellow coloured chromates.

There are three potassium chromates known, viz. :

(1) Neutral potassium chromate ...	K_2CrO_4.
(2) Potassium anhydro-chromate, or bichromate	$K_2CrO_4CrO_3$
(3) Potassium dianhydrochromate or terchromate	$K_2CrO_42CrO_3$.

Other salts of Chromium are the Chromic chloride, Cr_2Cl_6, the chromic sulphate, $Cr_2(SO_4)_3$, both insoluble salts. The insoluble chromates are lead chromate, $PbCrO_4$, or chrome yellow; silver chromate, Ag_2CrO_4, a deep-red coloured salt, and barium chromate, $BaCrO_4$, a yellow insoluble powder. Chloro-chromic oxide, CrO_2Cl_2 is a volatile compound, intermediate between chrome trioxide and chromic chloride, and is a dark-red, strongly fuming liquid.

Tests for the Chromium Compounds—

For the *Chromous* salts :

(1) Sulphide of ammonium gives a black precipitate.

(2) Liquor ammoniæ gives a blue precipitate, turning green.

(3) Tungstic acid gives a blue precipitate.

For the *Chromic* salts :

(1) Sulphide of ammonium gives a greyish-green precipitate.

(2) Liquor ammoniæ gives a greyish-green precipitate.

(3) Barium salts give pale yellow precipitates.

(4) Lead salts give bright yellow precipitates.
(5) Mercurous salts give brick-red precipitates.
(6) Silver salts give crimson precipitates.

All the salts of chromium yield with borax and the blowpipe an emerald-green glass in the reducing flame.

General Characteristics of the Iron Group.

These metals are all dyads, except iron, which is a tetrad. They decompose water, like the preceding class, form several oxides, chlorides, and sulphides, and are not volatile at the temperature of our furnaces.

GROUP VI.—THE TIN GROUP.

Titanium, Zirconium, Thorium, Niobium and Tantalum belong to this group, but Tin is the only one employed in the arts, and is therefore the only one here described.

STANNUM (Stan, *Saxon,* a stone)—TIN.

Symbol, Sn. Combining weight, 118. Specific gravity, 7·3.

Description.—A white metal, like silver, soft, and malleable, but possessing no tenacity. Emits a peculiar crackling when bent. Tin melts at 235°C., and does not lose its lustre on exposure to air, but when strongly heated it takes fire, a white powder (stannic oxide), or "putty powder," being formed. Tin is a tetrad.

Sources.—Metallic tin is not found native, and the tin ores are found only in a few localities. The chief sources are the Cornish mines, in which it occurs as tin-stone or tin dioxide; but it is also found in Malacca, Mexico, and Borneo. It is common to find traces of copper, arsenic, and other metals in English tin.

Preparation.—The tin ore is crushed and heated with charcoal and lime; the tin then fuses out.

TIN WITH OXYGEN forms two oxides—

(1) Stannous oxide, SnO.
(2) Stannic oxide, SnO_2.

Stannous oxide (SnO) is a black powder, and forms with acids the stannous salts, the most important of which is stannous chloride, $SnCl_2$. This is termed "the salts" in commerce, and is used as a "mordant." Stannic oxide (SnO_2) occurs as the native tin-stone, but it can be artificially prepared in two conditions, possessing entirely different properties. If nitric acid be added to tin, a white powder* is produced which is insoluble in acids; but if an alkali be

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* Meta-Stannic Acid ($H_2Sn_5O_{11}$, $4H_2O$).

$SnCl_4$

added to stannic chloride, a white precipitate of stannic oxide results, and this is easily soluble in acids. The salts formed by the soluble stannic oxide are termed stannates, those produced by the insoluble oxide, meta-stannates. "Tin prepare liquor" is a sodium stannate ($Na_2SnO_3,4H_2O$.)

Stannic oxide forms with acids the stannic salts, the most important of which is the following: Stannic chloride ($SnCl_4$).

Two sulphides of tin also exist:

(1) Stannous sulphide, SnS, a blackish-grey substance, and

(2) Stannic sulphide, SnS_2, a bright yellow crystalline powder called *Mosaic gold.*

Tests for the Tin compounds—

For the *Stannous* salts:

(1) Sulphuretted hydrogen gives a dark brown precipitate.

(2) Gold chloride gives the beautiful "*purple of Cassius.*"*

(3) The stannous salts have also the property of reducing other metallic solutions. Thus—

$$HgCl_2 + SnCl_2 = HgCl + SnCl_3 = Hg + SnCl_4.$$

The mercuric chloride ($HgCl_2$) is reduced first to white mercurous chloride ($HgCl$), and finally to black metallic mercury (Hg), the stannous chloride ($SnCl_2$) acquiring more chlorine, and passing into the stannic chloride ($SnCl_4$).

For the *Stannic* salts:

(1) Sulphuretted hydrogen gives a yellow precipitate.

(2) Gold chloride gives *no* precipitate.

GROUP VII.—THE ANTIMONY GROUP.

ANTIMONY. | BISMUTH.

Arsenic is often included in this class, but it has been deemed advisable to place it among the non-metallic elements.

ANTIMONY—STIBIUM.

Symbol, Sb. Combining weight, 122. Specific gravity, 6·71.

Description.—A blueish white, brittle, crystalline metal, melting at 450°C. It undergoes no change in the air at the ordinary temperature, but when heated strongly, takes fire, burning with a white flame, and giving off dense white fumes of antimonic oxide (Sb_2O_5). It is unattacked by diluted sulphuric or hydrochloric acids, but is converted by nitric acid into white insoluble antimonic acid ($HSbO_3$). Alloys of antimony are used extensively in the arts. The most important alloy is type metal (lead and antimony), which contains 17 to 20 per cent. of antimony.

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* The composition of "purple of Cassius" is not exactly known; it probably consists of a mixture of metallic gold and stannic oxide.

Antimony with Oxygen forms three oxides—

(1) Antimonious oxide, or trioxide, Sb_2O_3.
(2) *Antimonious-antimonic oxide, Sb_2O_4.
(3) Antimonic oxide, or pentoxide, Sb_2O_5.

Antimonious oxide (Sb_2O_3) sometimes called antimonious acid, is a white powder, and gives rise to the salts of antimony used in medicine. It is best prepared by decomposing the antimonious chloride ($SbCl_3$) with carbonate of soda (Na_2CO_3). Thus—

$$2SbCl_3 + 3Na_2CO_3 = 3CO_2 + 6NaCl + Sb_2O_3.$$

Carbonic anhydride, common salt, and antimonious oxide result.

Tartar emetic ($KSbC_4H_4O_7$) is prepared from acid tartrate of potash ($KHC_4H_4O_6$) and antimonious oxide (Sb_2O_3), and may be regarded as acid tartrate of potash, the hydrogen of which is replaced by a radical SbO. Thus—

Acid tartrate of potash = $K\ H\ C_4H_4O_6$.
Tartar emetic = $K(SbO)C_4H_4O_6$.

Sources and Preparation.—Metallic antimony is found native, but the chief ore is the trisulphide. By heating the sulphide with about half its weight of metallic iron, ferrous sulphide and metallic antimony are formed; and the metal may be reduced by heating the ore, mixed with coal, in a reverberatory furnace.

Antimonic oxide (called sometimes antimonic acid), Sb_2O_5, is a light straw-coloured powder, losing oxygen at a red heat, and being converted into an intermediate oxide, Sb_2O_3,Sb_2O_5, or $2Sb_2O_4$. Antimonic oxide may be prepared by the action of nitric acid upon antimony, and yields monobasic salts termed antimoniates. It may also be prepared by decomposing the pentachloride with water, and in this mode forms dibasic salts, to which the name of met-antimoniates is given.

Antimonious-antimonic oxide (Sb_2O_4) is prepared by heating the metal in the air until no further change occurs.

Metallic antimony, in fine division, takes fire spontaneously in chlorine gas.

The chlorides of antimony are two in number:

(1) Antimony trichloride, $SbCl_3$,

A buttery mass, prepared by passing chlorine gas over an excess of metallic antimony, and

(2) Antimony pentachloride, $SbCl_5$,

A strongly fuming, mobile liquid, prepared by pouring excess of chlorine over the trichloride of antimony.

There are two sulphides of antimony:

The trisulphide, SbS_3, and the pentasulphide, SbS_5.

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* $Sb_2O_3 + Sb_2O_5 = 2Sb_2O_4$.

Antimoniuretted hydrogen (SbH_3) is a gas corresponding to arseniuretted hydrogen (AsH_3). It is given off when zinc and a dilute mineral acid are brought into contact with an antimony salt, exactly in the same manner as arseniuretted hydrogen (AsH_3) is prepared.

Tests for the Antimony Compounds—

(1) Sulphuretted hydrogen gives an *orange* precipitate, soluble in sulphide of ammonium. (This is the *only* orange sulphide.)

(2) The chloride thrown into water gives a white precipitate.

(3) Zinc and iron reduce the antimonial salts to the metallic state as a black powder.

(4) SbH_3 burns and deposits two rings on a white plate held *in* the flame. These rings are soluble in sulphide of ammonium, but not in a solution of chlorinated lime, thus distinguishing the gas from arseniuretted hydrogen.

(5) Infusion of cinchona, and any solution of tannic acid, produces a copious dirty-brown precipitate with the salts of antimony.

BISMUTH (Wismuth, *German,* a beautiful meadow).

Symbol, Bi. Combining weight, 210. Specific gravity, 9·8.

Description, Sources, and Preparation.—A pinkish white, brittle, crystalline metal. Melts at 264°C, and volatilises at a white heat. When heated strongly it burns with a blue flame, and it takes fire when thrown into chlorine gas. Some of the compounds are used in medicine, and some in the arts as pigments.

Bismuth occurs native in small quantities, but its chief ore is the sulphide.

The metal may be procured by the simple exposure of its ore to heat. It forms bivalent, trivalent, and quinquivalent salts.

BISMUTH WITH OXYGEN forms two oxides—

(1) Bismuthous oxide, Bi_2O_3.
(2) Bismuthic oxide, Bi_2O_5.

Bi_2O_3 is a pale yellow powder, formed by roasting the metal in the air. Bi_2O_5 is a reddish-brown powder, prepared by dissolving Bi_2O_3 in potash and precipitating the bismuthic oxide by heat and nitric acid.

Sulphide of bismuth, Bi_2S_3, is an insoluble black substance. The trichloride, $BiCl_3$, is formed by heating the metal in chlorine. The salts used in medicine are the subnitrate, $BiNO_4,H_2O$, the carbonate $2(Bi_2CO_5)H_2O$ and the oxide Bi_2O_3. Bismuthic Nitrate $Bi3NO_3,5H_2O$ is a soluble salt.

Bi_2S_3

Tests for the Bismuth Compounds—

(1) Sulphuretted hydrogen gives a black precipitate.

(2) Solutions of these salts become *milky* upon the addition of water, insoluble basic compounds being formed.

(3) Metallic bismuth is easily reduced from its compounds before the blow-pipe as a brittle bead.

General Characteristics of the Antimony Group.

These metals are triads; they form a junction line between the metallic and the non-metallic substances, and are closely allied to phosphorus in their properties.

GROUP VIII.—THE LEAD GROUP.

LEAD—PLUMBUM (means something heavy).

Symbol, Pb. Combining weight, 207. Density, 11·3.

Description.—A blueish white metal, so soft that it can be scratched with the nail, may be drawn out into coarse wire, or hammered into plate, but has little elasticity or tenacity. Lead melts at 334° C. It is a dyad metal. In dry air, the surface of the metal remains bright, but in moist air it soon tarnishes from oxidation, and the oxidising process proceeds rapidly if a small quantity of weak acid, such as carbonic or acetic acid, be present. Lead preserves its lustre in pure water freed from air; but should air be present, then oxide of lead is formed, and by the solution of this in water successive portions of the metal are exposed for oxidation. Waters containing *nitrates* and *chlorides*, or much *free carbonic acid*, are *prone to impregnation* with lead, but the hard waters in which are *sulphates* and *carbonates* may safely be brought in contact with the metal, since a thin deposit of carbonate or sulphate of lead is formed, which prevents further action.

Sources.—Not found native; chiefly obtained from the sulphide of lead or galena, PbS.

Preparation.—By roasting galena in a reverberatory furnace with a small amount of lime to form a fusible slag with any silicious mineral matter present. A portion of the sulphide of lead is oxidised to sulphate ($PbSO_4$), another portion of sulphur comes off as sulphur dioxide (SO_2), and oxide of lead (PbO) is left. The lead sulphate and lead oxide both decompose the remaining sulphide, and sulphur dioxide and metallic lead remain. Thus—

(1) $PbSO_4 + PbS = 2Pb + 2SO_2$.

(2) $2PbO + PbS = 3Pb + SO_2$.

Lead with Oxygen forms three compounds :

(1) PbO, lead monoxide, litharge, a straw-coloured powder.

(2) PbO_2, lead dioxide, the puce-coloured oxide.

(3) Pb_3O_4 ($2PbO + PbO_2$), red lead.

PbO, litharge, or massicot, is prepared in scaly crystals (1) by heating the carbonate of lead to dull redness. Thus—

$$PbCO_3 + \text{heat} = CO_2 + PbO.$$

Or (2) by heating lead in a current of air.

This oxide is soluble in caustic potash (KHO), and forms with acids the important series of lead salts, most of which are white, and the soluble ones are poisons. With silica, PbO forms an easily fusible silicate or glass.

PbO_2, the puce-coloured oxide, is prepared by (1) passing chlorine through the hydrated monoxide (PbH_2O_2). Thus—

$$PbH_2O_2 + 2Cl = 2HCl + PbO_2.$$

Or by (2) digesting red lead (Pb_3O_4) with nitric acid (HNO_3). Thus :

$$Pb_3O_4 + 4HNO_3 = 2H_2O + 2Pb2NO_3 + PbO_2.$$

Water, lead nitrate, and the puce-oxide are formed. PbO_2 forms no salts with acids.

Pb_3O_4 is prepared by heating the monoxide for a long time, and thus acquiring more oxygen. Thus—

$$3PbO + O = Pb_3O_4.$$

Lead nitrate, $Pb2NO_3$, is the most important of the *soluble* lead salts. It is prepared by dissolving the oxide, the carbonate, or metallic Pb, in warm HNO_3. It crystallises in octahedra, dissolves in eight parts of cold water, and when strongly heated yields N_2O_4.

Lead acetate, $Pb(C_2H_3O_2)_2$, or sugar of lead, is also a soluble salt.

Lead carbonate, $PbCO_3$, occurs native as cerusite, and is insoluble.

White Lead is a compound of lead carbonate and lead hydroxide, and it may be represented by the formula $2PbCO_3 + PbH_2O_2$.

Galena, or lead sulphide (PbS), is the chief ore of the metal, and is found native. It may be prepared as a black precipitate by passing H_2S through a solution of a lead salt. Galena has a bright blueish-white metallic lustre, and crystallises in cubes and octahedra.

Lead sulphate ($PbSO_4$) is a white insoluble salt, found native, but prepared artificially by adding H_2SO_4 to a soluble lead salt.

Lead chloride, $PbCl_2$, is prepared by the addition of hydrochloric acid to a solution of nitrate of lead. It dissolves in thirty parts of boiling water, and appears as shining needles on cooling.

Lead iodide, PbI_2, is precipitated as beautiful yellow spangles by mixing together hot solutions of iodide of potassium and nitrate of lead, and allowing the mixture to cool.

Lead chromate, $PbCrO_4$, is a yellow insoluble salt called chrome yellow.

Tests for the Lead Compounds—

(1) Sulphuretted hydrogen gives a black precipitate. — Galen
(2) Alkalies give white precipitates (hydrated oxide).
(3) Sulphuric acid gives an insoluble white precipitate. — $PbSO_4$
(4) Iodide of potassium gives a yellow precipitate. — PbI_2
(5) Bichromate of potash gives a yellow precipitate. PbC
(6) Charcoal, sodium carbonate, and the blow-pipe yield the metal which is malleable.

GROUP IX.—THE SILVER GROUP.

COPPER. | MERCURY. | SILVER.

COPPER—CUPRUM (from Cyprus).

Symbol, Cu. Combining weight, 63·5. Specific gravity, 8·93.

Description.—A deep-red-coloured metal, very ductile and malleable, and possessed of much tenacity. Melts at a red heat, and slightly volatilises at a white heat, giving a green tint to the hydrogen flame when that gas is passed over it; one of the best conductors of electricity and heat. This metal does not oxidise in pure dry or moist air at ordinary temperatures, but when heated to redness, it readily oxidises to scales of copper oxide.

Brass is an alloy containing about ⅔ of copper and ⅓ of zinc. The yellow or muntz-metal contains 60 per cent. of copper, and is used for sheathing ships. Bronze, gun-metal, bell-metal, and speculum-metal are alloys of tin and copper in varying proportions. These alloys all possess the remarkable property of being hard and brittle when slowly cooled, but of becoming malleable and soft when suddenly cooled by being dipped when red-hot into cold water.

Sources.—Copper occurs native in North America, and in a few other localities, but it is chiefly obtained from the following ores:

(1) Copper pyrites	$Cu_2S + Fe_2S_3$.
(2) Cuprous sulphide	Cu_2S.
(3) Malachite or the carbonate ...	$CuCO_3,CuH_2O_2$.
(4) Cuprous oxide or the red oxide ...	Cu_2O.

The Cornish mines yield considerable quantities of copper, and Chili and South Australia are rich in copper ores.

Preparation.—(1) By reducing the oxide in a current of hydrogen.

(2) By the electrolytic decomposition of a salt of copper.

Metallic copper is easily prepared on a large scale from the carbonate or oxide, but when the copper pyrites ($Cu_2S + Fe_2S_3$) is employed, the process is more difficult. The ore is then roasted continually, to convert the cuprous sulphide into the oxide, and then sand or silicious slag is added to the ore, which is then roasted in a reverbatory furnace; the cuprous oxide becomes converted into the cuprous sulphide, and the iron oxidising and uniting with the silica forms a light fusible slag. The impure cuprous sulphide fuses and sinks to the bottom of the furnace, and in this manner a coarse metal or "mat" is formed. By a repetition of the process, pure cuprous sulphide or "fine metal" is produced. In order to free the metallic copper from sulphur, the fine metal is roasted and subsequently fused in the air. In the earlier part of the process, part of the sulphur is burnt off with the formation of cupric oxide (CuO), and at a later period the remainder of the sulphide is acted upon by the oxide forming sulphur dioxide (SO_2), and metallic copper (Cu). Thus—

$$Cu_2S + 2CuO = SO_2 + 4Cu.$$

The last traces of oxide are got rid of by "poling," *i.e.*, stirring up the molten copper with a piece of green wood.

COPPER WITH OXYGEN forms two oxides—

(1) The cuprous oxide or red suboxide, Cu_2O.
(2) The cupric oxide or black peroxide, CuO.

CUPROUS OXIDE, Cu_2O,

Is found native in ruby-red octahedra, but it may be prepared artificially by (1) heating together equal quantities of the black oxide (CuO) and copper filings; or (2) by boiling a solution of sulphate of copper ($CuSO_4$) and caustic potash (KHO) with glucose, or grape sugar. The black oxide is first precipitated by the caustic potash, and subsequently reduced by the glucose, to a bright red powder. A beautiful ruby-red colour is communicated to glass by cuprous oxide.

All the cuprous compounds rapidly absorb oxygen from the air, and pass into the corresponding cupric salts. Of the cuprous salts the most important is the

CUPROUS CHLORIDE, CuCl.

This is a white solid, and is remarkable for absorbing carbonic oxide gas.

CUPRIC OXIDE, CuO,

May be obtained (1) by heating copper in the air, or (2) by heating cupric nitrate ($Cu2NO_3$) to redness. This black oxide of copper yields the green and blue cupric salts.

The hydrated cupric oxide, CuH_2O_2 is thrown down as a light blue precipitate when liquor potassæ (KHO) is added to a cupric salt, as for instance, to the sulphate of copper ($CuSO_4$). Thus—

$$CuSO_4 + 2KHO = K_2SO_4 + CuH_2O_2.$$

Sulphate of potash and hydrated cupric oxide are formed.

By boiling the hydrate, the water, H_2O is given off, and the black oxide, CuO, is thrown down.

The most important soluble cupric compounds are the following:

CUPRIC SULPHATE, $CuSO_4, 5H_2O$.

This is known as "blue vitriol," and is obtained in large blue crystals by the action of heat, sulphuric acid, and water upon metallic copper; when heated to redness, $CuSO_4, 5H_2O$, loses its water of crystallisation and falls to a white powder.

CUPRIC NITRATE, $Cu2NO_3, 6H_2O$,

Is obtained in large bluish-green rhomboidal prisms by dissolving copper in nitric acid.

CUPRIC CHLORIDE, $CuCl_2, 2H_2O$,

Is formed when finely divided metallic copper is placed in chlorine gas, or when CuO is acted upon by hydrochloric acid. It occurs in green needle-shaped crystals, an alcoholic solution of which burns with a peculiar green flame.

$2HCl + CuO$ [illegible]

Amongst the insoluble cupric salts, are the

CUPRIC SULPHIDE, CuS.

A black precipitate formed by the addition of sulphuretted hydrogen to an acid solution of a copper salt.

CUPRIC CARBONATE, $CuCO_3, CuH_2O_2$.

Malachite

A green precipitate, not known pure, but always containing the hydrated oxide, and obtained by adding any alkaline carbonate to a copper salt.

CUPRIC ARSENITE, SCHEELE'S GREEN, $CuHAsO_3$.

A bright green powder, obtained by mixing an alkaline arsenite with cupric sulphate.

CuH_2O_2

Tests for the Copper Compounds—

(1) Liquor potassæ gives a pale blue precipitate, turning black on boiling. With sulphate of copper ($CuSO_4$)

(2) Liquor ammoniæ (a few drops of) gives a pale blue precipitate, which is dissolved by excess of ammonia, forming a beautiful *sapphire-blue* solution; a remarkable compound is here formed, the composition of which is $CuSO_4 + 2NH_3$, and this is capable of crystallisation. It may be regarded as ammonium sulphate [$(NH_4)_2SO_4$], in which an atom of dyad copper has replaced two atoms of monad hydrogen. Thus—

$$\left.\begin{matrix} NH_4 \\ NH_4 \end{matrix}\right\} SO_4 \quad \cdots \quad \cdots \quad \cdots \quad \left.\begin{matrix} NH_4 \\ NH_2Cu \end{matrix}\right\} SO_4.$$

(3) Ferrocyanide of potassium gives a *chocolate* precipitate of ferrocyanide of copper.

(4) Sulphuretted hydrogen gives a black precipitate. in ac

(5) A polished steel needle or knife dipped in a solution of copper receives a red coating of metallic copper.

MERCURY—HYDRARGYRUM (Hudor, water, arguros, silver).

Symbol, Hg. Combining weight, 200. Specific gravity, at 0°C., 13·596. Density, 100.

Description.—The only metal liquid at the ordinary temperature. White and volatile. Freezes at −39·4°C., and boils at 350°C.; when pure, mercury does not tarnish in dry or moist air, but above 300°C. it absorbs oxygen and passes into the red oxide. It is a dyad metal, and is largely employed in the processes for extracting silver and gold from their ores. Both the metal and its salts are of great medicinal value.

Sources and Preparation.—Found native, and as the sulphide (cinnabar) in Spain, California, Japan, and China. The cinnabar is roasted; the sulphur is evolved as sulphur dioxide (SO_2), the metal volatilises, and the vapour is condensed in earthen pipes.

MERCURY WITH OXYGEN forms two oxides, viz.—

(1) Mercurous oxide or black suboxide, Hg_2O.
(2) Mercuric oxide or red peroxide, HgO.

MERCUROUS OXIDE (Hg_2O),

Is a dark grey powder, seen also in *black wash*, and is propared by precipitating the mercurous chloride ($HgCl$) by means of liquor potassæ (KHO). Thus—

$$2HgCl + 2KHO = 2KCl + H_2O + Hg_2O.$$

Chloride of potassium, water, and mercurous oxide are formed.

MERCURIC OXIDE, HgO, also by heat. Hg above 300°

Occurs in red crystals, which appear yellow when finely powdered, and may be prepared by (1) heating the mercuric nitrate, or (2) by the addition of liquor potassæ (KHO) to the mercuric nitrate ($Hg2NO_3$). Thus—

[illegible]

$$Hg2NO_3 + 2KHO = 2KNO_3 + H_2O + HgO.$$

Nitrate of potash, water, and mercuric oxide result.

MERCUROUS SULPHIDE, Hg_2S,

Is a black substance, obtained by the addition of sulphuretted hydrogen to a mercurous salt.

MERCURIC SULPHIDE, Vermilion, or Cinnabar, HgS,

Is a red substance, and occurs native, but it may be artificially prepared by heating sulphur and mercury together, or by the addition of an excess of sulphuretted hydrogen to a mercuric salt. In this last method the sulphide is black, but when sublimed it becomes red.

MERCURY WITH CHLORINE forms two chlorides, viz.—

(1) Mercurous chloride, or calomel, $HgCl$.
(2) Mercuric chloride, or corrosive sublimate, $HgCl_2$.

MERCUROUS CHLORIDE, SUBCHLORIDE OF MERCURY, CALOMEL, $HgCl$,

Is a white, insoluble powder, and is prepared—

(1) By heating metallic mercury (Hg) with corrosive sublimate ($HgCl_2$). Thus—

$$Hg + HgCl_2 = 2HgCl.$$

Or (2) (*a*) By adding metallic Hg to the mercuric sulphate ($HgSO_4$). Thus—

$$Hg + HgSO_4 = Hg_2SO_4 \text{ (the mercurous sulphate).}$$

(*b*) Chloride of sodium ($NaCl$) is added to the mercurous sulphate (Hg_2SO_4). Thus—

$$Hg_2SO_4 + 2NaCl = Na_2SO_4 + 2HgCl.$$

Sulphate of sodium and calomel are formed.

The calomel sublimes, and forms a solid cake, which is well washed to get rid of any mercuric chloride that may be formed in the preparation.

Mercuric Chloride, Perchloride of Mercury, Corrosive Sublimate, $HgCl_2$,

Occurs in semi-transparent masses or prisms, soluble in 16 of cold and 3 of boiling water; very poisonous.

It is prepared by the addition of chloride of sodium ($NaCl$) to the mercuric sulphate ($HgSO_4$). Thus—

$$HgSO_4 + 2NaCl = Na_2SO_4 + HgCl_2.$$

Sulphate of sodium and mercuric chloride are formed.

When liquor ammoniæ (NH_4HO) is added to $HgCl_2$, "white precipitate," or Hydrargyrum Ammoniatum, NH_2HgCl, is formed. Thus—

$$HgCl_2 + NH_4HO = H_2O + HCl + NH_2HgCl.$$

Water, hydrochloric acid, and "white precipitate" result.

Mercurous Nitrate, $HgNO_3,2H_2O$,

Is a soluble salt, obtained in efflorescent prisms by the action of diluted nitric acid upon an excess of metallic mercury.

Mercuric Nitrate, $Hg2NO_3$,

Is obtained by the action of excess of nitric acid upon metallic mercury, or the mercuric oxide.

Tests for the Mercury Compounds—

(1) All the mercurial salts sublime, and can be decomposed by heat.

(2) By charcoal and sodium carbonate, metallic mercury is obtained. (The reduction test.)

(3) Bright copper strips when placed in an acidulated solution become coated with metallic mercury.

(4) Stannous chloride ($SnCl_2$) in excess precipitates the metal (black).

(5) Bright gold or copper moistened with a solution of mercury, and touched with a pointed steel, becomes coated with a white silvery stain.

Tests for the Mercurous Salts—

(1) Liquor calcis (CaH_2O_2), and all the alkalies, throw down a *black* precipitate ("black wash"). 1-3 grs

(2) Iodide of potassium (KI) gives an *olive green** precipitate.

(3) Chromate of potash (K_2CrO_4) gives a *bright red* precipitate.

(4) Sulphuretted hydrogen gives a *black* precipitate. H_2S

Tests for the Mercuric Salts—

(1) Liquor calcis and all the alkalies, except ammonia, give a *yellow* precipitate ("yellow wash").

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* Mercurous Iodide, HgI.

(2) Liquor ammoniæ gives a *white* precipitate. NH_2HgCl

(3) Iodide of potassium gives the *scarlet* mercuric iodide (HgI_2), soluble in excess of either re-agent. $\frac{1}{16}$ to $\frac{1}{4}$ gr. dose

(4) Sulphuretted hydrogen in excess gives a *black* precipitate, becoming *red* when sublimed. HgS

SILVER—ARGENTUM (Arguros, silver, from argos, white).

Symbol, Ag. Combining weight, 108. Specific gravity, 10·5.

Description.—A brilliant white metal, a great conductor of electricity and heat, and very ductile. Silver is a monad metal, and is easily dissolved by nitric acid, with the evolution of nitric oxide gas; the metal readily unites with sulphur, forming the black sulphide.

Sources.—Found native, but more generally combined with antimony, sulphur, chlorine, and bromine. Galena, or lead sulphide, also contains small quantities of silver.

Preparation.—The silver ore is roasted in a furnace with common salt, by which means the silver chloride is formed. Iron scraps (Fe) are then added. Thus—

$$6AgCl + 2Fe = Fe_2Cl_6 + 6Ag.$$

Perchloride of iron and metallic silver are formed.

Metallic mercury is then added, and thus a liquid amalgam of silver and mercury is formed. By distilling off the mercury, the silver remains. When silver is melted in the air, it absorbs twenty-two times its bulk of oxygen, the gas being again evolved upon the solidification of the metal. This process is known as "spitting." Silver is usually alloyed with small quantities of copper for preparing articles of plate and coinage. English silver money contains 7·5 per cent. of copper.

SILVER WITH OXYGEN forms three oxides, viz.—

(1) Silver suboxide, Ag_4O, a black powder.

(2) Silver monoxide, Ag_2O, a brown substance obtained by the addition of liquor potassæ to a solution of nitrate of silver.

(3) Silver dioxide, Ag_2O_2, a black powder, prepared when ozone acts upon metallic silver.

SILVER NITRATE, $AgNO_3$,

Is the most important of the *soluble* salts of silver. It is prepared by the action of nitric acid upon metallic silver and evaporating the solution. It then appears as large translucent tabular crystals. Upon heating, nitrate of silver fuses easily, and when cast into sticks it is known by the name of "lunar caustic." It blackens the skin.

SILVER CHLORIDE, AgCl,

sol: in Liq: Amm

Is the most important *insoluble* salt of silver. It occurs native as "horn silver," and may be obtained as a white curdy precipitate when a silver salt and a soluble chloride are brought into contact. By exposure to light, this salt becomes of a purple tint, increasing in shade according to the length of time of its exposure.

Chloride of silver is readily soluble in hyposulphite of sodium.

SILVER BROMIDE, AgBr,

Is a white substance, obtained by adding an alkaline bromide to silver nitrate.

SILVER IODIDE, AgI,

Is a yellow powder.

SILVER SULPHIDE, Ag_2S,

Occurs native as "silver-glance," and may be obtained as a black precipitate by passing sulphuretted hydrogen gas through a solution of a salt of silver.

Tests for the Silver Compounds—

(1) Hydrochloric acid gives a *white* precipitate (AgCl), *soluble* in liquor ammoniæ.

(2) Alkalies (KHO, &c.), give a *brown* precipitate of Ag_2O, soluble in excess of liquor ammoniæ.

(3) Sulphuretted hydrogen gives a black precipitate (Ag_2S), insoluble in sulphide of ammonium.

(4) Iron, copper, and mercury give a white precipitate (Ag).

(5) Chromate or bichromate of potash gives a *brown* precipitate.

(6) Tribasic phosphate of sodium gives a *yellow* precipitate.

General Characteristics of the Silver Group.

Under no circumstances is water decomposed by these metals. They are all oxidised by strong sulphuric and nitric acids. Silver is a monad; but mercury and copper are dyads.

GROUP X.—THE GOLD GROUP.

GOLD. | PLATINUM.

GOLD—AURUM.

Symbol, Au. Combining weight, 197. Specific gravity, 19·3.

Description.—A soft, yellow metal, soluble in nitro-hydrochloric acid, and in selenic acid. A triad metal, and the most malleable of all the metals, since it can be beaten into leaves

$\frac{1}{100,000}$ of an inch in thickness. It remains untarnished in dry or moist air at any temperature, and is unaffected by sulphur.

The *Standard Gold* of England is an alloy of copper and gold, and contains 8·33 per cent. of the former. This alloy is less ductile than the pure metal, but possesses greater fusibility and hardness.

Sources.—Always found in the metallic state. It occurs in the plutonic rocks, but is also found in the sand of most rivers. It is a widely diffused metal, although occurring only in small quantities.

Preparation.—The sand, or "detritus" in which the metal is contained, is washed in a "cradle," and thus the lighter mud is washed away, whilst the heavier gold grains sink to the bottom.

To obtain pure gold, the ordinary metal is dissolved in aqua regia, and thus terchloride of gold is formed ($AuCl_3$), then ferrous sulphate ($FeSO_4$) is added. Thus—

$$2AuCl_3 + 6FeSO_4 = 2Fe_2(SO_4)_3 + Fe_2Cl_6 + 2Au.$$

Ferric sulphate and ferric chloride are formed, and metallic gold is precipitated as a brown powder.

GOLD WITH OXYGEN forms two oxides, viz.—

(1) Aurous suboxide, Au_2O.
(2) Auric trioxide, Au_2O_3.

Neither of these substances forms any salts with acids, but Au_2O_3 unites with bases to form *aurates*. Thus aurate of sodium is $NaAuO_2$.

"*Fulminating Gold*" is prepared by the action of excess of liquor ammoniæ upon a solution of gold. In this process a brownish-yellow powder is thrown down, which when dry and heated to 100°C. explodes very readily when struck by a hammer, or even spontaneously.

AUROUS CHLORIDE, $AuCl$,

Is a white insoluble mass, obtained by heating auric chloride to 235°C.

AURIC CHLORIDE, $AuCl_3$,

Is obtained by dissolving metallic gold in aqua regia.

Tests for the Gold Compounds—

(1) Ferrous sulphate gives a *brown* precipitate of metallic gold.

(2) The blow-pipe gives a metallic bead of gold.

(3) Stannous chloride gives the "*purple of Cassius.*"

PLATINUM (Platina, silver).

Symbol, Pt. Combining weight, 197·4. Specific gravity, 21·5.

Description.—A bright white metal, never tarnishing, very infusible, and only to be melted in the oxy-hydrogen blow-pipe flame. A tetrad metal. Is only dissolved by aqua regia. Finely divided metallic platinum is remarkable for its power of condensing gases on its surface.

Sources.—A comparatively rare metal, always occurring native, and generally alloyed with the metals palladium, rhodium, iridium, osmium, and ruthenium.

Preparation.—Platinum was originally prepared by dissolving its ore in aqua regia, and precipitating the metal with chloride of ammonium as ammonio-platino-chloride. When this precipitate is heated, "*spongy*" or finely-divided platinum is formed. If this sponge, when hot, be hammered and forcibly pressed, it gradually assumes a coherent mass by the "*welding*" of the platinum particles.

A method lately adopted has been to melt the ore with the oxyhydrogen blow-pipe in a very powerful furnace. By this means a pure alloy of platinum, rhodium, and iridium is formed, whilst the impurities are volatilised by the intense heat. This pure alloy is harder, and not so easily attacked by acids as the pure platinum.

PLATINUM WITH OXYGEN forms two oxides, viz.—

(1) Platinum monoxide or platinous oxide, PtO.
(2) Platinum dioxide or platinic oxide, PtO_2.

PLATINUM MONOXIDE is a black powder.

PLATINUM DIOXIDE can be prepared as a brown hydrate by the addition of liquor potassæ to a solution of platinum nitrate. Upon heating the hydrate, the anhydrous oxide is first formed, and subsequently the metal is precipitated.

PLATINUM DICHLORIDE, OR PLATINOUS CHLORIDE, $PtCl_2$,

Is an insoluble greenish-grey powder, prepared by heating the following chloride to 200°C.

PLATINUM TETRACHLORIDE, OR PLATINIC CHLORIDE, $PtCl_4$,

Is a red or brown deliquescent mass, obtained by dissolving the metal in aqua regia, and evaporating the solution to dryness.

Tests for the Platinum Compounds—

(1) Sulphuretted hydrogen gives a brown precipitate soluble in excess of sulphide of ammonium.

(2) Metallic zinc throws down metallic platinum.

(3) The platinic chloride ($PtCl_4$) gives a *yellow* granular precipitate (falling slowly) with potash and ammonia, but not with soda, and is of great use in analysis for the separation of potash and soda.

General Characteristics of the Gold Group.

These metals, with silver and mercury, constitute the noble metals. Gold and platinum are not acted upon by nitric acid, but only by chlorine or aqua regia.

Gold is a triad, and platinum a tetrad metal.

ESTIMATION OF SOME OF THE IMPORTANT METALS.

Potassium,	100	parts	of	$KPtCl_5$	contain	15·98	of	K.
Ammonium	,,	,,	,,	NH_4PtCl_5	,,	7·62	,,	NH_3.
Calcium	,,	,,	,,	$CaCO_3$	,,	56·0	,,	CaO.
Strontium	,,	,,	,,	$SrSO_4$	,,	56·52	,,	SrO.
Barium	,,	,,	,,	$BaSO_4$	,,	65·66	,,	BaO.
Magnesium	,,	,,	,,	*$Mg_2P_2O_7$	,,	36·21	,,	MgO.
Zincum	,,	,,	,,	ZnO	,,	80·24	,,	Zn.
Ferrum	,,	,,	,,	Fe_2O_3	,,	70·0	,,	Fe.
Cobaltium	,,	,,	,,	†Cr_3O_4	,,	73·44	,,	Co.
Nickel	,,	,,	,,	NiO	,,	78·67	,,	Ni.
Chromium	,,	,,	,,	Cr_2O_3	,,	68·63	,,	Cr.
Stannum	,,	,,	,,	SnO_2	,,	78·66	,,	Sn.
Plumbum	,,	,,	,,	$PbSO_4$	,,	68·31	,,	Pb.
Cuprum	,,	,,	,,	CuO	,,	79·85	,,	Cu.
Platinum	,,	,,	,,	NH_4PtCl_5	,,	44·17	,,	Pt.

Hydrargyrum is always weighed as Hg.
Aurum ,, ,, ,, ,, Au.

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* Pyrophosphate of Magnesium.

† Cobalto-Cobaltic oxide.

APPENDIX.

An *Atom* is the smallest quantity to which an elementary substance can be reduced. It is to be regarded as a definite quantity, and although the atoms of all bodies are assumed to be of the same size, yet they vary greatly in weight. If the atom of hydrogen be taken as the standard of comparison, and counted to weigh 1, then the atom of oxygen will be found to weigh 16; that of nitrogen 14; and that of sulphur 32. These numbers are therefore termed the *atomic weights.* An atom is the smallest quantity that can enter into combination with another element.

An atom *must be united to another atom,* it cannot exist alone as such, and the two (or more as frequently happens) constitute a molecule. Thus H, O, and N are atoms, and can combine with other bodies, but, when free, they combine with one of their own atoms, and actually exist as H_2, O_2, N_2, *i.e.*, as molecules. One atom in union with another forms a molecule, whether the element be the same or not; thus H and H form a molecule of hydrogen; H and Cl = a molecule of HCl, hydrochloric acid; H, C, and N = a molecule of HCN, hydrocyanic acid. A molecule may, however, consist of 2, 3, 4, or even more atoms, as observed in a molecule of water, H_2O (3 atoms), or of ammonia, NH_3 (4 atoms), &c.

Now although atoms combine in certain definite proportions, their power of replacing one another in compound bodies greatly varies; 1 atom of oxygen may replace 2 atoms of hydrogen in any compound; 1 atom of nitrogen will replace 3 of hydrogen: and 1 atom of carbon will take the place of 4 atoms of hydrogen or 2 atoms of oxygen.

This has led to an arrangement into groups showing the power in atoms of replacing each other in chemical compounds, and this is called their *quantivalence.*

The elementary atoms are divided into monads or univalents, dyads or divalents, triads or trivalents, tetrads or tetravalents, pentads or pentavalents, hexads or hexavalents; the elements themselves being termed monatomic, diatomic, triatomic, tetratomic, &c., in accordance with the number of hydrogen atoms which one atom of each can replace, since the atom H is taken as the standard for comparison, and is the typical monad.

The elements of *even* quantivalence, viz.: the dyads, tetrads, and hexads, are called *Artiads*, and those of *uneven* quantivalence, viz.: monads, triads, and pentads, are known as *Perissads.*

Not only can the elements be considered to possess varying atomicity, but so can the groups of elementary substances, acting collectively as elements, and which are termed "*compound radicals*," viz.: NO_2, SO_2, PO, as will immediately be seen. Nitric acid (HNO_3) may be considered as water (H_2O), in which one atom of H is replaced by a *monad radical*, NO_2. Thus—

$$\left.\begin{matrix}H\\H\end{matrix}\right\}O \text{ water} \quad \ldots \quad \ldots \quad \left.\begin{matrix}H\\NO_2\end{matrix}\right\}O \text{ nitric acid.}$$

Sulphuric acid (H_2SO_4) may be regarded as 2 molecules of water, in which two atoms of H are replaced by the *dyad radical* SO_2. Thus—

$$\left.\begin{matrix}H_2\\H_2\end{matrix}\right\}O_2 \text{ water} \quad \ldots \quad \ldots \quad \left.\begin{matrix}H_2\\SO_2\end{matrix}\right\}O_2 \text{ sulphuric acid.}$$

Tribasic phosphoric acid (H_3PO_4) may be looked upon as 3 molecules of water, in which 3 atoms of H are replaced by the *triad* radical PO. Thus—

$$\left.\begin{matrix}H_3\\H_3\end{matrix}\right\}O_3 \text{ water} \quad \ldots \quad \ldots \quad \left.\begin{matrix}H_3\\PO\end{matrix}\right\}O_3 \text{ phosphoric acid.}$$

But although the non-metallic and metallic radicals are classified into univalent and multivalent groups, it must be stated that with the exception of hydrogen, which is always univalent, all the other radicals may exhibit different degrees of quantivalence. Observe the oxides of nitrogen, N_2O, N_2O_2, N_2O_3, N_2O_4, N_2O_5. Here, from the formulæ, nitrogen may range from a monad to a pentad inclusive. Carbon is *tetrad* in marsh gas, CH_4, and in carbonic anhydride, CO_2, but only *dyad* in carbonic oxide, CO. Sulphur is *hexad* in sulphuric anhydride, SO_3, and *dyad* in sulphuretted hydrogen, H_2S. Iron may be *dyad* at one time, as in ferrous chloride, $FeCl_2$, and *tetrad* at another, as in ferric chloride, Fe_2Cl_6; an apparent abnormality to be subsequently explained.*

LAWS REGULATING CHEMICAL COMBINATIONS

Are as follows :—

1*st.* The law of *Constant proportion.*—The same substance always contains the same elements united in the same proportions.

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* Page 59.

2nd. The law of *Multiple proportion.*—When one body combines with another in several proportions, the higher proportions are always multiples of the first or lowest.

3rd. The law of *Reciprocal proportion.*—If two bodies unite with a third, the proportions in which they combine with that third body are measures or multiples of the proportion in which they combine with each other.

The combining quantity of a compound body is the sum of the combining proportions of its constituents. Thus water, $H_2O = 2$ for H, and 16 for $O = 18$, and this is the combining quantity of that fluid; and H_2SO_4, sulphuric acid, would be 2 for H, 32 for S, and 4 times 16 for O, *i.e.*, 64, proving 98 altogether to be its combining proportion, which is the case.

When one atom of an element unites with an atom of another, in several proportions, distinctive names are applied; thus, a metal might unite with oxygen as follows: M_2O, MO, M_2O_3, MO_2, MO_3, MO_4, and to these the terms *suboxide, monoxide, sesquioxide, dioxide, trioxide,* and *tetroxide* would be respectively applied. The resulting compound is always termed an *ide.* If any non-metallic elements were substituted for the oxygen, such as sulphur, iodine, or chlorine, we should have sub-, mono-, sesqui-, di-, tri-, or tetra-, sulphides—iodides, or chlorides, according to the number of atoms of each united with one of the metal.

If an element form two acids, the name of the lower terminates in *ous,* and the higher in *ic,* as nitrous, nitric, sulphurous, sulphuric. If it forms two salts the same rule holds good; thus we have ferrous and ferric salts, mercurous and mercuric, cuprous and cupric, &c. The termination *ous* is synonymous with a proto or sub-salt, and the termination *ic* with a per-salt. Thus the ferr*ous* sulphate ($FeSO_4$) may be called the *proto*sulphate or *sub*sulphate, and the ferr*ic* sulphate ($Fe_2(SO_4)_3$) is termed the *per*sulphate.

It may here be stated that the termination *ic* always implies the presence of more oxygen or of the radical than that contained in *ous,* but that the termination *ide* (unless ox-ide) denotes the absence of oxygen, viz.:

H_2SO_4 (sulphur*ic* acid), H_2SO_3 (sulphur*ous* acid).

H_2S (sulph*ide* of hydrogen, or sulphuretted hydrogen).

In the case of chlorides, bromides, iodides, fluorides, and sulphides, viz.: mercurous and mercuric chlorides, &c., oxygen clearly takes no part at all, and here the *ic* implies a larger amount of the acidulous radical than that contained in *ous.*

The composition of any substance may be determined by two methods, viz.: (1) By synthesis, and—

(2) By analysis. The latter may be of two kinds.

(*a*) Qualitative, merely discovering the ingredients.

(*b*) Quantitative, determining the amount of each ingredient.

A *chemical formula* represents a molecule of an element, or of a compound, and serves the following purposes :

(1) It indicates the elements entering into the formation of the molecule.

(2) It shows the number of atoms in the molecule.

(3) It represents a constant weight of the compound, the molecular weight, *i.e.*, the sum of the weights of the atoms in the molecule.

(4) In bodies capable of volatilising, it indicates two volumes of the substance in a state of gas or vapour.

By *a volume* is meant a measure.

The combining volumes of all elementary gases and vapours are equal, except in the case of arsenic and phosphorus, which are only half those of the other elements in the gaseous condition, and those of cadmium and mercury, which are double those of the other elements.

A *chemical equation* consists of a collection of symbols and formulæ, illustrating the condition of substances before and after the assault of the molecules one upon another, and showing the new substances formed.

A solid is a substance, the integrant molecules of which, though probably not in absolute contact, are more or less immobile.

A liquid is that in which the molecules freely move around each other ; it therefore readily assumes the form of any vessel in which it may be placed, and retains that form.

A gas is that in which the molecules are so separated that they seem to have lost all attraction to one another, and to have acquired such a property of repulsion that the only obstacle to their still further separation is the pressure of the surrounding matter.

An *amalgam* implies the combination of two or more metals, one of which must be mercury.

An *alloy* implies a combination of metals in which mercury takes no part.

THE ATOMIC THEORY.

John Dalton was the first to enunciate the law of multiple proportion. He asked himself, " Why do the elements combine only in multiples of their several combining proportions ?" and upon this question he theorised as follows :

All matter is composed of minute indivisible particles, and these are called *atoms.* Although these atoms do not all possess the same weight, still their relative weights are represented by the combining weights of the elements; the oxygen atom is considered to be 16 times as heavy as the hydrogen atom, and the weights of the oxygen and nitrogen atoms are as 16 to 14.

He also assumed that chemical combination consisted in the individual atoms approximating one to another, and was thus enabled to explain why compounds must contain their constituents in the combining proportions, or in multiples of their proportions, and in no intermediate proportion.

Take, for instance, the compounds of nitrogen with oxygen. The lowest oxide contains one atom of O combined with 2 atoms of N, thus (N) (N) (O); it is therefore termed nitrogen monoxide, N_2O. The next oxide possible of formation must have an additional atom of oxygen. Thus (N) (N) (O) (O), and this is called nitrogen dioxide, N_2O_2. The next compound possible is (N) (N) (O) (O) (O), or nitrogen trioxide, N_2O_3. The next is (N) (N) (O) (O) (O) (O), or nitrogen tetroxide, N_2O_4; and the next (N) (N) (O) (O) (O) (O) (O), or nitrogen pentoxide, N_2O_5.

An atom being indivisible, no intermediate product can be obtained.

Gravity simply denotes weight. Specific gravity means relative weight, or weight compared to a standard.

Density implies the comparative mass, and is frequently employed synonymously with specific gravity, since the two bear so close a relationship, the weight depending upon the amount of the mass.

*SPECIFIC WEIGHT, DENSITY, OR GRAVITY.

Specific gravity may be defined as *the relative weight of equal volumes of different substances.* Water is taken as the standard of comparison of liquids and solids, and air for gases and vapours. We have to determine the specific gravity of matter in three states, as gas, liquid, and solid.

For Gases.

A glass globe, furnished with a stop-cock, is weighed first full of dry air, then perfectly exhausted by an air pump, and again weighed. The difference gives the weight of the volume of air which the globe contains. We now fill the globe with the gas of which the density is required, and weigh it again, taking care that the changes in pressure and tem-

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* Specific gravity means comparative weight, and density comparative mass; weight and mass are directly proportional to each other.

perature are known. The weight of the empty globe, subtracted from the weight of the globe when filled with gas, gives the weight of gas which the globe contains. Then—

Weight of air : Weight of gas : : 1 : Density of gas.

And thus we obtain the desired density.

For Vapours.

A small globular flask is taken, the neck drawn out to a fine tube, and the whole accurately weighed. The substance of which the vapour density is required, is introduced by warming the flask, and dipping the end of the neck into the fluid. By the cooling and contraction of the air, some of the liquid pressed upon by the external air is forced into the flask, which is now placed in a bath of oil or mercury heated much above the boiling point of the liquid. When the flask is completely filled with the pure vapour of the substance, the neck is sealed by the blow-pipe, and when cool it is again weighed. Thus we know (1) the weight of the flask full of air, and (2) the weight of the flask full of vapour; but we require to know the weight of the empty flask. Now, if we know the capacity of the globe in cubic centimetres, and the weight of 1 c.c. of air, we can obtain this. We break the point of the neck under mercury, which fluid rushes in and fills the flask, excepting the drop of liquid into which the vapour has condensed. Having replaced this by mercury, the latter is measured carefully, and the capacity of the flask is ascertained. Let us suppose this to be 200 c.c. Then the weight of 200 c.c. of air at the temperature of the room, subtracted from the original weight of the flask full of air, gives the weight of the empty flask; this latter weight, subtracted from the weight of the flask filled with vapour, gives the weight of 200 c.c. of the vapour at the temperature at which the flask was sealed. Upon calculating the weight of 200 c.c. of air at the same temperature, we obtain the proportion—

Weight of air : Weight of vapour : : 1 : Density of vapour.

For Liquids.

A vessel of any convenient size is taken, the weight of which is known, and its increase in weight is determined (1) when filled with water, (2) when filled with the given liquid, at the same temperature. We take a flask with a narrow neck, upon which near its middle a mark is made; the weight of this is carefully ascertained. Pure distilled water is now added to the level of the mark, and the flask again weighed. The difference between this and the original weight gives the weight of water taken. After drying, we again fill the flask up to the mark with the liquid the density of which we require, and the weight is again taken. The difference between this and the original weight, is the weight of a volume of the liquid equal to that of the water. Then—

Weight of water : Weight of liquid : : 1 : Density of liquid.

For Solids.

"A solid immersed in a liquid loses a weight equal to the weight of an equal volume of the liquid." We weigh a piece of the solid in air, and then immerse it in water, and again weigh it in that position. By the difference we obtain the weight of an equal volume of water. Then—

$$\left\{\begin{matrix}\text{Weight of equal}\\ \text{volume of}\\ \text{water}\end{matrix}\right\} : \left\{\begin{matrix}\text{Weight of}\\ \text{substance}\\ \text{in air}\end{matrix}\right\} :: 1 : \text{Density of substance.}$$

Or otherwise, divide weight in air by loss of weight in water, and the quotient will be the density.

If the solid *be lighter than water*, we must first weigh it in air, and then attach to it a solid, heavy enough to sink it, and the weight of which we have determined in air and water. The difference between the loss of weight of the heavy body alone, when immersed in water, and that of the combination when similarly immersed, will give the weight of a volume of water equal to that of the light body, the density of which can be determined by the proportion above.

If the substance *be soluble in water*, it must be weighed in a fluid which does not dissolve it, and the density of which is known. Then we have :

(1) "The relative weights of equal bulks of the substance, and of the liquid in which it was weighed.

(2) The relative weights of equal bulks of the liquid and of water. Hence the weight of a volume of water equal to that of the substance is obtained as follows :

$$\text{Density of liquid} : 1 :: \left\{\begin{matrix}\text{Weight of liquid}\\ \text{displaced by the}\\ \text{substance}\end{matrix}\right\} : \left\{\begin{matrix}\text{Weight of an}\\ \text{equal volume}\\ \text{of water.}\end{matrix}\right\}$$

Then the density may be obtained in the usual way."

TABLE OF QUANTIVALENCE OF THE PRECEDING METALS.

Monads.	*Dyads.*	*Triads.*	*Tetrads.*
POTASSIUM	CALCIUM	ALUMINIUM	FERRUM
SODIUM	STRONTIUM	STIBIUM*	STANNUM
LITHIUM	BARIUM	BISMUTHUM*	PLATINUM
AMMONIUM	MAGNESIUM	AURUM	
CÆSIUM	ZINCUM		
RUBIDIUM	CADMIUM		
ARGENTUM	MANGANESIUM*		
	COBALTIUM*		
	NICKEL*		
	CHROMIUM*		
	PLUMBUM		
	CUPRUM		
	HYDRARGYRUM		

* Manganesium, cobaltium and nickel are frequently considered tetrads, whilst chromium is at times hexad, and stibium and bismuthum are sometimes pentad.

ADDENDA TO SECOND EDITION.

MOLECULAR WEIGHT.

The *molecular weight* of any body (gaseous, liquid or solid) is the sum of the atomic weights of the elements which compose its molecule ; thus, taking Oxygen (O), its molecular weight is 32, for

$$O_2 = 2 \times 16 = 32.$$

The molecular weight of Sulphuric Acid (H_2SO_4) is 98. Thus—

$$\begin{array}{lcrcr} H_2 & = & 2 \times 1 & = & 2 \\ S & = & 32 & = & 32 \\ O_4 & = & 4 \times 16 & = & 64 \\ \cline{5-5} & & & & 98 \end{array}$$

The molecular weight of Nitrate of Potash (KNO_3) is 101. Thus—

$$\begin{array}{lcrcr} K & = & 39 \times 1 & = & 39 \\ N & = & 14 \times 1 & = & 14 \\ O_3 & = & 3 \times 16 & = & 48 \\ \cline{5-5} & & & & 101 \end{array}$$

SPECIFIC GRAVITY OF A GAS.

The *specific gravity of a gas* is its weight as compared with the weight of an equal volume of Hydrogen, under the same atmospheric pressure, and at the same temperature.

Hydrogen is taken as the standard, and its specific gravity is represented as unity, or 1.

Now since the molecular weight of H is 2,

$$\text{For. : } H_2 = 1 \times 2 = 2,$$

and its specific gravity is 1, it is evident that the specific gravity is *half* the molecular weight.

This law is true for all gases, simple and compound, viz. : *The specific gravity of any gas is half its molecular weight.*

FORMULÆ OF THE ELEMENTS.

Elements contain as a rule two atoms in the molecule, thus the formula of H is H_2, which may be represented graphically as

$$H - H,$$

in which it appears that the bond or affinity of one H atom unites with the bond of the other H atom, a saturated body or molecule being produced.

For Oxygen the formula is O_2, or

$$O = O,$$

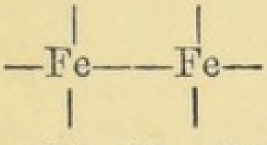
in which it is seen that the two affinities of the one O atom unite with the two affinities of the other O atom.

There are six exceptions to the above statement. Thus, the formula for

Mercury	is Hg,	containing	1 atom	in the molecule
Zinc	,, Zn	,,	1 atom	,,
Cadmium	,, Cd	,,	1 atom	,,
Ozone	,, O_2O	,,	3 atoms	,,
Arsenic	,, As_4	,,	4 atoms	,,
Phosphorus	,, P_4	,,	4 atoms	,,

Mercury, zinc and cadmium are dyads, and it may be supposed that the two affinities satisfy each other. Thus—

Some formulæ are to all appearance abnormal. Thus Iron in the ferric salts is classified as a tetrad. The formula for Perchloride of iron or Ferric Chloride is Fe_2Cl_6 ; here the iron apparently acts as a triad, but it is supposed that an affinity of the one Fe atom is united to an affinity of the other Fe atom, thus leaving only 6 affinities for combination with the chlorine (Cl). Thus—



$$-\overset{|}{\underset{|}{Fe}}--\overset{|}{\underset{|}{Fe}}-$$

Upon heating Ferric Chloride this substance becomes a vapour ; if the specific gravity of the vapour be taken and doubled, we obtain the molecular weight of Ferric Chloride, and this is found to correspond with the molecular weight yielded by the formula Fe_2Cl_6, and not to that given by $FeCl_3$. Thus, specific gravity of Ferric Chloride vapour = 162·5 ; on doubling, this gives 325 = molecular weight given by formula Fe_2Cl_6, for

$$\begin{array}{ll} Fe_2 = 56 \times 2 = & 112{\cdot}0 \\ Cl_6 = 35{\cdot}5 \times 6 = & 213{\cdot}0 \\ \hline & 325{\cdot}0 = \text{molecular weight.} \end{array}$$

And $325 \div 2 = 162{\cdot}5$ = specific gravity.

Supposing the formula of Ferric Chloride to be $FeCl_3$, the specific gravity of its vapour would be only 81·25, for

$$\begin{array}{lr} Fe = & 56 \\ Cl_3 = 35{\cdot}5 \times 3 = & 106{\cdot}5 \\ \hline & 162{\cdot}5 \end{array}$$

And $162{\cdot}5 \div 2 = 81{\cdot}25$

ATOMICITY OR QUANTIVALENCE

Implies the atom-fixing power of an element, *i.e.*, the saturating or equivalent value contained by the atom of an element, and represented by the number of Hydrogen atoms to which it is equivalent.

A *Bivalent* or *Dyad* element has twice the atom-fixing power of a univalent of monad. For example, water, H_2O; here one atom of dyad Oxygen is united to two atoms of monad Hydrogen.

A *Trivalent* or *Triad* possesses three times the atom-fixing power of a monad. Thus, Chloride of Gold, $AuCl_3$, in which one atom of triad Gold is united with three atoms of monad Chlorine.

A dyad will combine with a triad, but in this case two atoms of the triad must be taken and three of the dyad. Thus in the case of Trioxide of Bismuth, Bi_2O_3, two atoms of triad Bismuth are united with three atoms of dyad Oxygen.

A *Quadrivalent* or *Tetrad* possesses four times the atom-fixing power of a monad, and twice that of a bivalent or dyad. Thus in Perchloride of Platinum, $PtCl_4$, one atom of tetrad Platinum is united to four atoms of monad Chlorine, and in Carbonic Anhydride, CO_2, one atom of tetrad Carbon is united to two atoms of dyad Oxygen.

A *Quinquivalent* or *Pentad* possesses five times the atom-fixing power of a monad. Thus, in Pentachloride of Phosphorus, PCl_5, one atom of pentad Phosphorus is united to five atoms of monad Chlorine. When pentad unites with dyad, two of the former must be taken and five of the latter. Thus, in Pentoxide of Phosphorus, P_2O_5, two atoms of pentad Phosphorus are united to five of dyad Oxygen.

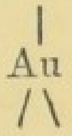
Finally, a *Sexivalent* or *Hexad* possesses six times the atom-fixing power of a monad, and three times that of a dyad. Thus, in Chromium Fluoride, CrF_6, one atom of hexad Chromium is united to six atoms of monad Fluorine, and in Chromic Anhydride, CrO_3, one atom of hexad Chromium is united to three of dyad Oxygen.

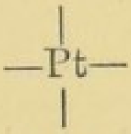
The quantivalence of an element is represented by small dashes or Roman numerals, as follows—

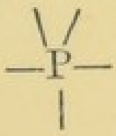
H' ......Univalent, or Monad.
O'' ......Bivalent, or Dyad.
Au''' ...Trivalent, or Triad.
Pt^{iv} ...Quadrivalent, or Tetrad.
P^{v} ......Quinquivalent, or Pentad.
Cr^{vi} ...Sexivalent, or Hexad.

The quantivalence of an element may be thus graphically shown—

H— (one arm, bond, or affinity) ....Monad.
—O— (2 arms, bonds, or affinities) ......Dyad.


(3 ,,) ......Triad.


(4 ,,) ......Tetrad.


(5 ,,) ......Pentad.


(6 ,,) ......Hexad.

VARIATION OF QUANTIVALENCE.

The following elements possess varying quantivalences, viz.—

Sulphur (S)
Chromium (Cr)
Manganesium (Mn)
} sometimes acting as Dyad, Tetrad, or Hexad.

Nitrogen (N)	sometimes acting as Monad, Triad, or Pentad.
Phosphorus (P) Arsenicum (As) Antimony (Sb)	„ „ „ Triad and Pentad.
Carbon (C) Iron (Fe) Tin (Sn)	„ „ „ Dyad and Tetrad.

In the first group, to take Sulphur: this substance as a hexad exerts six affinities; thus—


as in Sulphuric Anhydride, $S^{vi}O_3''$;

but if two of the six affinities no longer exert their atom-fixing power by grasping one another, *i.e.*, becoming latent, the Sulphur atom will only exert four atom-fixing powers, and then act as a tetrad; thus—


as in Sulphurous Anhydride, $S^{iv}O_2''$.

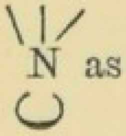
Once more, if two pairs of affinities grasp one another, the Sulphur atom will only exert two atom-fixing powers, and then act as a dyad; thus—


as in Sulphuretted Hydrogen, $S''H_2'$.

Nitrogen, when exerting full atom-fixing power, is pentad; thus—


as in Nitric Anhydride, $N_2^{v}O_5''$.

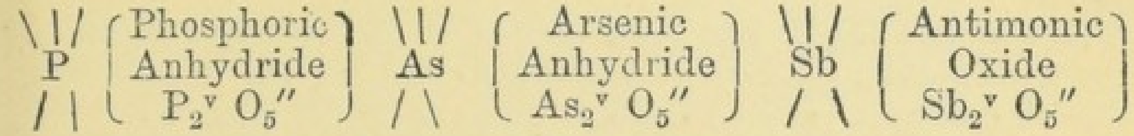
If two affinities become latent, the Nitrogen atom will only act as a triad; thus—


as in Nitrous Anhydride, $N_2'''O_3''$.

Another pair becoming latent, the nitrogen atom will act as a monad; thus—

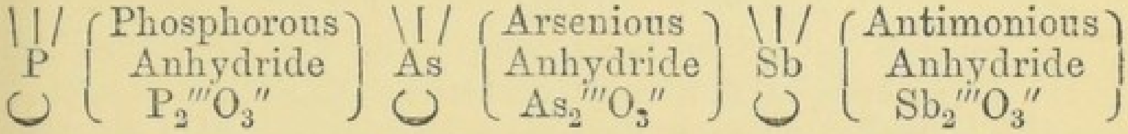

as in Nitrous Oxide, $N_2'O''$.

The preceding remarks are true of Phosphorus, Arsenic, and Antimony, these substances sometimes acting as pentads and sometimes as triads. When acting as pentads, they may be thus represented—



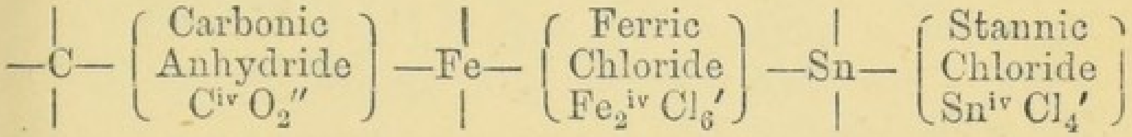
Phosphoric Anhydride $P_2^{v}\,O_5''$ Arsenic Anhydride $As_2^{v}\,O_5''$ Antimonic Oxide $Sb_2^{v}\,O_5''$

When acting as triads, thus—



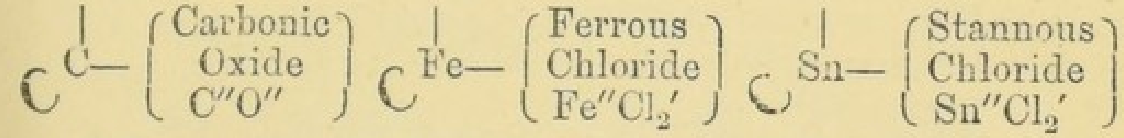
Phosphorous Anhydride $P_2'''O_3''$ Arsenious Anhydride $As_2'''O_3''$ Antimonious Anhydride $Sb_2'''O_3''$

Carbon, Iron, and Tin may exert both tetravalent and bivalent atomicities. When acting as tetrads, they may thus be represented—



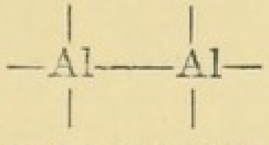
Carbonic Anhydride $C^{iv}\,O_2''$ Ferric Chloride $Fe_2^{iv}\,Cl_6'$ Stannic Chloride $Sn^{iv}\,Cl_4'$

When acting as dyads, thus—



Carbonic Oxide $C''O''$ Ferrous Chloride $Fe''Cl_2'$ Stannous Chloride $Sn''Cl_2'$

All Ferric compounds must be represented as containing at least two iron atoms in the molecule. For a like reason the compounds of Aluminium contain two Aluminium atoms in the molecule; and this metal therefore, although apparently acting as a triad, is really a tetrad. In Aluminium Chloride, Al_2Cl_6, the two Aluminium atoms may thus be represented—



two atoms having grasped or neutralised one another and become latent.

The formulæ of the Mercurous or protosalts of Mercury are apparently abnormal, since the Mercury appears to act as a monad in some salts, *e.g.*, in HgCl, Calomel, and as a dyad in others, *e.g.*, in Corrosive Sublimate, $HgCl_2$; but if we suppose two atoms to be contained in the Mercury molecule, this abnormality may be easily explained, thus—

—Hg——Hg—

It would be, therefore, more correct to write the formula for Calomel thus, Hg_2Cl_2, the formula HgCl being doubled.

Mercury in this state is termed a *false* or *pseudo-nomad*, since, being in reality a dyad, it acts to all appearance as a monad.

The formula HgCl has been given to Mercurous Chloride, since the specific gravity of its vapour is 117·75, or half the molecular weight yielded by the formula HgCl, thus—

$$\text{Hg} = 200 + (\text{Cl} = 35{\cdot}5) = 235{\cdot}5$$
$$\text{And } 235{\cdot}5 \div 2 = 117{\cdot}75$$

This remark is easily reconciled with the undoubtedly correct formula for Calomel or Mercurous Chloride, Hg_2Cl_2, from the fact that when converted into vapour, the Calomel probably splits up into equal volumes of Mercury, Hg, and Mercuric Chloride, $HgCl_2$, and the mean of the specific gravity of the vapour of these substances is 117·75, thus—

$$\text{(a) Hg} = 200 + \left\{(Cl_2 = 35{\cdot}5 \times 2) = 71\right\} = 271 \text{ and}$$
$$271 \div 2 = 135{\cdot}5 = (\text{specific gravity of } HgCl_2 \text{ vapour}).$$
$$\text{(b) Hg} = 200 \text{ and}$$
$$200 \div 2 = 100 = \text{specific gravity of Hg vapour.}$$

$$\begin{array}{l} 100 \quad = \text{specific gravity of Hg vapour} \\ 135{\cdot}5 = \text{specific gravity of } HgCl_2 \text{ vapour} \\ \hline 235{\cdot}5 \div 2 = 117{\cdot}75 = \text{mean of specific gravities} \\ \qquad\qquad \text{of the vapours of } HgCl_2 \text{ and Hg.} \end{array}$$

BASYLOUS AND ACIDULOUS RADICALS.

Every salt consists of two parts, a *Base* or *Basylous Radical* and an *Acid* or *Acidulous Radical*, *e.g.*, Chloride of Sodium or common salt, NaCl. Here the Na is the basylous radical, and the Cl the acidulous radical. The basylous radical may, however, not only be *simple*, as in this instance, but it may also be *compound*, as observed in the radicals (C_2H_5) Ethyl, (C_5H_{11}) Amyl, etc.

By the term RADICAL is implied a body which is not saturated, but is in need of something with which to combine and become saturated before it can exist. The acidulous radicals can be separated into two groups—

Elementary and Compound Radicals.

The *Elementary* radical consists of an unsaturated element, *e.g.*, Br, the acidulous radical of all Bromides, and it always consists of one atom of the element.

The Chlorine *molecule* is represented by the formula Cl_2, and can exist free, since its two affinities unite and saturate each other. Thus—

$$Cl - Cl.$$

The *radical* Chlorine is represented by the symbol Cl, and cannot exist free, since it is unsaturated, and its affinity uncombined ; thus, Cl—. The radical Chlorine must therefore have something to combine with its bond or affinity.

The *Compound* radical is formed by a group of elements not entirely saturating one another, and it must be saturated by some other body or bodies to be capable of existence.

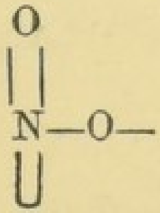
The atomicity or quantivalence of a radical implies its degree of non-saturation ; a univalent radical would need one atom of a univalent element to saturate it ; the bivalent radical would need two atoms of a univalent element to saturate it, and so on.

1. Examples of univalent acidulous radicals are—

Cl'	the	radical	of	Chlorides.
$(NO_2)'$	,,	,,	,,	Nitrites.
$(NO_3)'$	,,	,,	,,	Nitrates.
$(CN)'$	,,	,,	,,	Cyanides.

The radical of Chlorides is Cl— an atom of the element Chlorine, a univalent element having an uncombined affinity.

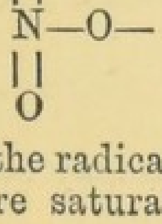
In $N'''O_2''$, the radical of Nitrites, the Nitrogen is only acting as a triad, a pair of its affinities being latent. It is united to two divalent Oxygen atoms ; therefore one affinity of Oxygen will be unsaturated, and thus the radical is univalent.



$$\begin{array}{l} O \\ \| \\ N-O- \end{array}$$

The Radical of Nitrites.

In N^vO_3'', the radical of Nitrates, the Nitrogen acts as a pentad, and therefore one affinity of Oxygen is unsaturated, and the radical is univalent.



$$\begin{array}{l} O \\ \| \\ N-O- \\ \| \\ O \end{array}$$

The Radical of Nitrates.

In C N^v, the radical of Cyanides, four affinities of the Nitrogen atom are saturated by four of the Carbon atoms, and therefore one affinity of Nitrogen is unoccupied. The radical is therefore univalent.

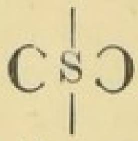
$C\equiv N-$ The Radical of Cyanides.

2. Bivalent acidulous radicals—

O'' the radical of Oxides.
S'' „ „ „ Sulphides.
$(SO_4)''$ „ „ „ Sulphates.

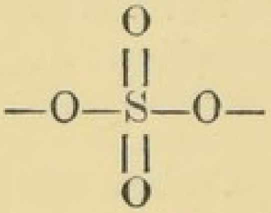
The radical of Oxides is $-O-$ an atom of the element Oxygen, a bivalent element having two uncombined affinities.

In Sulphides the radical S'' only exerts bivalent atomicity, two pairs of affinities of hexad Sulphur being latent.



The Radical of Sulphides.

In $S^{vi}O_4''$, the radical of Sulphates, two atoms of dyad oxygen are unsaturated, and therefore the radical is bivalent.



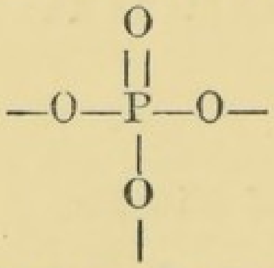
$$\begin{array}{c} O \\ \| \\ -O-S-O- \\ \| \\ O \end{array}$$

The Radical of Sulphates.

3. Trivalent acidulous radicals—

$(PO_4)'''$ the radical of Phosphates.
$(BO_3)'''$ „ „ „ Borates.

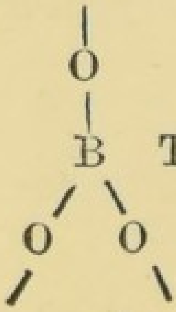
In P^vO_4'' three affinities of Oxygen are uncombined, and therefore the radical is trivalent.



$$\begin{array}{c} O \\ \| \\ -O-P-O- \\ | \\ O \\ | \end{array}$$

The Radical of Phosphates.

In $B'''O_3''$, the radical of Borates, three affinities of Oxygen are uncombined; the radical is therefore trivalent.



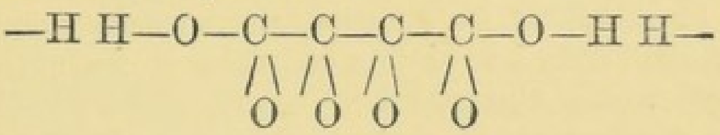
The Radical of Borates.

Among the complex acidulous radicals may be mentioned

$(C_2H_3O_2)'$ the radical of Acetates and $(C_4H_4O_6)''$ the radical of Tartrates.

In $C^{iv}{}_2H'_3O''_2$, the radical of Acetates, the four affinities of the Oxygen atom and the three affinities of the Hydrogen (together equalling seven) combine and saturate seven of the eight Carbon affinities, leaving one Carbon affinity unsaturated, and making the radical a univalent one.

In $C^{iv}{}_4H'_4O''_6$, the radical of Tartrates, the Carbon is exercising tetrad quantivalence, but three pairs of its affinities have become latent; thus six affinities have disappeared and ten affinities are left; these satisfy ten of the twelve Oxygen affinities, leaving two Oxygen affinities, and these combine with two of the four Hydrogen affinities, thus leaving two affinities of Hydrogen uncombined, and constituting the radical a bivalent one ;—thus :



$$\begin{array}{c} -H\;H-O-C-C-C-C-O-H\;H- \\ /\backslash\;\;/\backslash\;\;/\backslash\;\;/\backslash \\ O\quad O\quad O\quad O \end{array}$$

ACIDS.

According to the old theory of Chemistry, it was supposed that every acid must contain Oxygen, whence the name oxus, acid, gennao, I generate; but according to the new theory of the science, it is held that Hydrogen must enter into the composition of every acid, this Hydrogen being replaceable by a metal in order to form a salt; any acidulous radical combining with its equivalent amount of Hydrogen forms an acid. Should the acid contain one atom of displaceable Hydrogen, it is termed *Monobasic.* Should it contain two atoms, *Dibasic.* If three, *Tribasic,* etc. The so-called Sulphurous Acid (SO_2), and Arsenious Acid (As_2O_3) of the British Pharmacopœia, are erroneously termed acids, since they are destitute of Hydrogen; they are really *Anhydrides,* and are derived from the acids H_2SO_3 and H_3AsO_3, respectively, by the abstraction of the elements of water (H_2O) ;—thus :

1. $H_2SO_3 - H_2O = SO_2$ and
2. $2H_3AsO_3 - 3\,H_2O = As_2O_3$.

After the naming of a group of acids, it occasionally happens that an acid is discovered which contains more Oxygen than the acid terminating in *ic.* The prefix *per-* abbreviated from *super*, above, is then affixed to the acid ending in *-ic*, in order to distinguish it;—thus:

Iodic Acid = HIO_3. *Per*-iodic Acid = HIO_4.

Again, an acid may be discovered which contains a smaller amount of Oxygen than that existing in the acid ending in *-ous*. The prefix *hypo*, under, is then affixed to the acid ending in *ous*;—thus:

Bromous Acid = $HBrO_2$. *Hypo*bromous Acid = $HBrO$.

LATENT HEAT.

Definition.—The heat which is stored up in gases and liquids preventing their change of condition.

It cannot be detected by the thermometer.

If a roll of sulphur be heated, a certain amount of heat is made *latent*, and this keeps the sulphur liquid; if the heating be continued until the sulphur boils, more *latent heat* is required, converting the sulphur into a vaporous or gaseous form. By bringing the vapour into contact with some cool substance, the latent heat is converted into *sensible* heat and the sulphur vapour condenses to a liquid, and further cooling of the liquid sulphur produces solidification of the substance.

Let us consider the conversion of ice into water.

Let 1 lb. of ice at 0° C. be mixed with 1 lb. of water at 79° C.; the result will be 2 lb. of water at 0° C. Here the heat which has raised 1 lb. of water through 79° C. has vanished; it is not, however, lost; it has transformed the pound of ice into a pound of water, and during this operation, the melting ice has rendered the heat latent; it has merely changed the ice from a solid to a liquid state, it has not raised the temperature.

Upon freezing the water, the latent heat is rendered sensible.

SPECIFIC HEAT.

Definition.—The amount of heat required to raise equal weights of different substances having the same temperature to a given degree of temperature.

When 1 lb. of water at 100° is mixed with 1 lb. at 40°, a mean temperature of $\frac{100+40}{2} = 70°$, results. The mean temperature is found in the same way when warm and cold mercury, or warm and cold oil, are mixed together.* "But if 1 lb.

---

* Fownes.

of water at 100° be mixed with 1 lb. of olive oil at 40°, or with 1lb. of mercury at 40°, then, instead of the mean temperature of 70°, the temperature actually obtained will be 80° in the first case, 98° in the second ; 20 degrees of heat, which the water (by cooling from 100° to 80°), gave to the same weight of oil, were sufficient to raise the oil 40°, that is, from 40° to 80° ; and 2°, which the water lost by cooling from 100° to 98°, sufficed to heat an equal quantity of mercury 58°, namely, from 40° to 98°." From these experiments it is evident that the quantities of heat required to raise the temperature of equal weights of water, olive oil, and mercury to the same degree are unequal, and that they are in the proportion of the numbers—

$$1 : \frac{20}{40} : \frac{2}{58}, \text{ or } 1 : \frac{1}{2} : \frac{1}{29}.$$

These experiments show that the specific heat of olive oil is $\frac{1}{2}$, *i.e.*, the quantity of heat which would raise the temperature of any given quantity of olive oil from 0° to 1°, would raise that of an equal weight of water only from 0° to $\frac{1}{2}$°, or of half that quantity of water from 0° to 1°.

The specific heat of various substances may be estimated in three ways—

1st. By noting the quantity of ice melted by a given weight of the substance heated to a particular temperature.

2nd. By observing the time which the heated body requires to cool down through a certain number of degrees.

3rd. The method of mixture as above described, which is considered the most accurate.

Each body then has its peculiar specific heat, which increases with increase of temperature.

If the heat which the unit of water loses when cooled from 10° to 0° be marked at 10°, the loss by cooling from 50° to 0° will not correspond with the difference of temperature, but will be 50·1. By cooling from 100° to 0° it is 100·5, and it rises to 203·2 when the water is heated to 200° under great pressure and afterwards cooled to 0°.

The specific heat of a substance is greater in the liquid than in the solid state, *e.g.*, the specific heat of ice is 0·504, *i.e.*, not more than half as great as that of liquid water.

The specific heat of water is greater than that of all other liquid and solid substances, that of Hydrogen being the only one which exceeds it. The specific heat of the solid part of the globe's crust is upon an average $\frac{1}{4}$, and that of the atmosphere nearly $\frac{1}{4}$, that of water. When the specific heat of any body is accurately known (within certain degrees of temperature), then from the amount of heat given off from the body when it is quickly dipped into cold water, the temperature to which the body was heated may be ascertained.

When a gas expands, heat becomes insensible to the thermometer or latent, and the amount of heat requisite to raise a gas to any given temperature increases the more such gas is allowed to expand. The amount of heat requisite for the unit-weight of a gas to raise its temperature 1° without its volume undergoing change, which can only occur by the pressure being simultaneously increased, is termed the specific heat of the gas *at constant volume.*

The amount of heat requisite for the unit-weight of a gas to raise its temperature 1°, it being at the same time permitted to dilate to such an extent that the pressure to which it is exposed remains unaltered, is termed the specific heat of the gas *at constant pressure.* The specific heat, therefore, at constant pressure, must be greater than that at constant volume.

If a gas on expanding is not supplied with requisite heat, its temperature falls, since its own free heat becomes latent, *i.e.*, expended in overcoming pressure. Again, if a gas be compressed, this latent heat becomes free, and produces an elevation of temperature, which may be raised to ignition under favourable circumstances.

THE AIR PUMP

Consists of a metallic cylinder in which a tightly fitting piston moves by means of its rod. The vessel to be exhausted communicates with the bottom of the cylinder, which is furnished with a valve opening upwards. To the piston is fitted a similar valve which also opens upwards. The valves are composed of oiled silk. As soon as the piston is lifted from the bottom of the cylinder, the space which it leaves must be devoid of air, the piston valve opening only in one direction ; the elastic power of the air within the receiver on that side being opposed only by the weight of the little valve, this last is lifted, and the air escapes into the cylinder. When the piston commences its descent, the lower valve shuts by its own weight, or by the pressure transmitted from above, and thus all communication with the receiver is cut off. By the continued descent of the piston the air in the cylinder becomes compressed, and its elasticity increased, and at last it forces the upper valve open and escapes into the atmosphere. By this means at every stroke of the pump a cylinder-full of air is removed from the cylinder. During the ascent of the piston the upper valve remains closed and the lower open.

The principle of the air pump depends upon a peculiar physical constitution of gases. These bodies are exceedingly elastic. The space or volume which a gas occupies is entirely dependent upon the pressure to which it is submitted. An air-tight piston, moving in a cylinder closed at the bottom, is pushed down with a certain force ; the air below it is compressed into a smaller bulk, and if sufficient power be exerted, the bulk of the gas may be diminished to $\frac{1}{100}$th part or even less.

On the other hand, if the piston standing at the middle of the cylinder (the air beneath it being in its normal state) be drawn upwards, the air below it will expand, entirely filling the increased space. The extent of its possible expansion is apparently unlimited.

A volume of air, under ordinary conditions occupying the bulk of a cubic inch, might, by removing the pressure upon it, be caused to expand to the capacity of an entire room ; it would also shrink to its original bulk upon applying the former pressure.

However small the amount of gas introduced into a large exhausted vessel, it becomes diffused through the entire space, an equal quantity existing in every part. The gas fills the vessel also ; it is in a state of extreme tenuity.

This indefinite expansibility is supposed to depend on the particles of material bodies in a gaseous state possessing a self repulsive agency.

It is stated that matter is influenced by two opposite forces, one tending to draw the particles together, and the other to separate them. The conditions termed solid, liquid, or gaseous, depend upon the preponderance of one or other of these forces. If the particles possess only a very slight power of motion, a solid substance is presented ; if these forces are nearly balanced, a liquid ensues ; and if the attractive power is apparently completely vanquished, a vapour or gas results.

The attractive forces receive the name of *cohesion* if exerted between particles of matter divided by an immeasurably small interval. *Gravitation* is the term used when the distance is great.

ELECTRICITY.

The term Electricity is derived from the Greek word *elektron* amber, and may be defined as the peculiar physical agent or force by which, under certain circumstances or conditions, certain phenomena are produced. The chief of these phenomena are those of attraction and repulsion, and in cases where the force exists in great quantity or intensity, of sound, light, heat, chemical action and magnetism.

Thales of Miletus accidentally discovered that when a piece of amber was rubbed by the hand, it acquired the power of at first attracting, and afterwards of supporting minute light substances, which for a time adhered to its surface; and to this circumstance electricity owes its name.

Electricity may be developed or excited in various ways, especially by friction, mechanical and chemical action, heat and magnetism.

It is termed *Frictional* or *Statical Electricity* when developed by friction, concussion, compression, or disruption, and is so named since it tends to remain or *stand* where it is developed, or, having distributed itself over the surface of a body or bodies, there to come to rest.

Thermo-Electricity is the term used when the electricity is developed by heat;

Voltaic or *Galvanic Electricity;* when it is developed by chemical action.

Magneto-Electricity; when developed by magnetism.

The foregoing are essentially the same in kind, and differ only in their relative quantity and intensity.

All bodies when rubbed acquire a power either of electric attraction or of repulsion. When amber, glass, or sealing-wax is rubbed with a dry cloth it acquires the power of attracting light bodies, as dust, pieces of paper, or feathers; the peculiar condition of the rubbed body is termed electrical excitation.

Suspend a light downy feather by a thread and present to it a dry glass tube, previously excited by rubbing; the feather will be powerfully attracted to the tube, and after adhering to its surface for a few seconds, falls off. Now excite the tube afresh, and present the feather to it—it will be powerfully repelled.

The same experiments may be performed with resin or shellac.

Now bring the feather into contact with the excited glass so as to be repelled, and then present to it a piece of excited sealing-wax—a far greater amount of attraction will be observed than that shown by the feather in its ordinary state.

Again, if the feather be made repulsive for sealing-wax, and the excited glass be presented, the feather will be powerfully attracted.

Thus, a body in which one kind of excitement has been induced is attracted by another body in the opposite condition, and repelled by one in the same condition.

Varieties of Electricity. It is usual to term the electricity exhibited by glass rubbed with silk *Vitreous* or *Positive ;* that induced in resin or shellac, or like bodies, rubbed with flannel, *Resinous* or *Negative.* The kind of electricity is somewhat dependent on the nature of the surface and the quality of the rubber. If smooth and quite clear glass is rubbed with silk, it becomes positive, but if ground or made rough by emery or sand and then rubbed it becomes negative. Glass when dried over a wood-charcoal fire is positive, but if dried over a gas flame and rubbed with wood it is negative.

The repulsion of bodies in the same state of electrical excitement may be shown by two balls of elder pith hung by very fine metal wires or threads to a fixed point. If these are excited they open out, since they mutually repel one another, and by their degrees of divergence indicate the extent of the excitement.

The Gold Leaf Electroscope consists of a pair of gold leaves suspended by a metal rod, having a brass plate on its upper end. The rod is covered by a thick coat of shellac, and is fastened by an air-tight cork into a glass flask. The flask should be previously warmed in order to ensure its perfect dryness. When excited by any known kind of electricity the gold leaves manifest by their increased or diminished divergence the condition of any electrified body placed in their vicinity.

One kind of electricity cannot be developed without the other; the body rubbed and the rubber always assume opposite conditions. The positive state on the surface of a mass of matter is without exception associated by a negative condition in all bodies surrounding it.

The intensity of the induced electrical disturbance diminishes with its distance from the body charged ; if the disturbing agency be removed or discharged, its effects instantly cease.

The apparent transfer or discharge of electricity in air and in liquids often gives rise to a bright spark of fire, and this discharge instantly occurs when any electrified body is placed in communication with the earth by any substance called a *Conductor* of Electricity, every symptom of electrical disturbance ceasing.

An *Insulator* or *Non-Conductor* is a body, the resistance of which is sufficiently great to prevent electricity passing to contiguous bodies. It differs from a conductor quantitatively, *i.e.*, in degree only, not qualitatively or in kind. The electrical discharge is restricted to a certain extent by the best conductors, and permitted to a small extent by the most perfect insulators.

The metals are the best conductors; silk, shellac, glass and dry gas the worst; between these there are bodies of all degrees of conducting power.

Electrical discharges take place silently and without disturbance in good conductors of sufficient size; but if the conductor be very small, and the charge very intense, it is often destroyed violently.

If a break is made in a conductor used in producing the discharge of a highly excited body, and the ends of the conductor are not too distant, disruptive or spark-discharge occurs across the intervening air.

The time occupied in the passage of the wave of electricity through a chain of good conducting substances of great length is so small as to be entirely inappreciable to ordinary methods of observation.

It is only upon the surfaces of conductors, or those parts which are directed towards other objects capable of assuming the opposite condition, that electrical excitation is exhibited.

When an insulated ball charged with positive electricity is placed in the centre of a room, it is kept in the positive condition by the inductive action of the walls of the room, which instantly become charged with negative electricity.

There is no electricity to be found in the interior of the insulated ball, even if constructed of open metal gauze, with wide meshes. On the surface of a body the electrical force is not always similarly distributed; it depends upon the shape of the body itself, and its position with regard to the objects surrounding it.

THE CYLINDRICAL ELECTRICAL MACHINE

Consists of a mounted glass cylinder, its axis being horizontal, and having a handle by which it may be turned. A leather cushion is pressed by a spring against one side of the cylinder, whilst upon the other side is a large metal conducting body furnished with a number of points.

The conductor and cushion are both insulated by glass supports; to the upper edge of the latter a piece of silk is fixed sufficient in length to extend half round the cylinder. A quantity of soft amalgam of mercury, zinc, and tin, mixed with grease (glass is powerfully excited by this mixture), is spread upon the cushion.

As the cylinder turns it becomes charged by friction against the rubber, being as rapidly discharged by the row of points fixed to the conductor, the surface of which, as the conductor is completely insulated, becomes charged with positive electricity. This may be communicated by contact to other insulated bodies.

When negative electricity is required, the rubber must be insulated, and the conductor discharged.

THE COMMON PLATE ELECTRICAL MACHINE

Consists of a circular plate of glass which moves upon an axis, and is furnished with two pairs of cushions or rubbers, fixed to the upper and lower parts of a frame of wood, covered by amalgam, between which the plate moves with much friction. The plate as it turns is discharged by an insulated conductor, armed with points, as in the cylindrical machine, and at the same time the rubber is connected with the ground by a strip of metal or by the woodwork of the machine.

Considerable power is afforded by this apparatus.

THE LEYDEN JAR

Consists of a thin glass jar coated with tinfoil on both sides, several inches of the upper part being uncovered, and a wire, ending in a knot of metal, is in communication with the internal coating.

Upon connecting the exterior of the jar with the earth, the knob being placed in contact with the conductor of the machine, the outer and inner surfaces of the glass become respectively negative and positive, until a considerable amount of intensity is acquired. When the connection is completed between the two coatings by a metallic rod or wire, discharge takes place in the form of an intense bright spark, with a loud snap.

If the size of the jar be increased, or a number of such jars be connected so that all of them may be simultaneously charged and discharged, the power of the apparatus may be much increased.

The effects of lightning on a small scale may be presented, such as the shattering of pieces of wood, the fusing of metals, setting combustible substances on fire, etc.

THE ELECTROPHORUS

Consists of a round dish or tray of tinned plate, a stout wire being attached round its upper edge. The depth may be half an inch and the width about twelve inches. Melted shellac fills the tray, its surface being made as even as possible. A brass disc, about nine inches in diameter, with a rounded edge, is also furnished, in which is fitted an insulating handle.

If a spark is required, the shellac plate is struck with a silk handkerchief or a dry, warm piece of fur, and thus excited; the cover is then placed upon it, and touched by the finger, together with the rim of the plate. Upon raising the cover it will be found charged with positive electricity, and will emit a bright spark.

These sparks may be drawn as often as wanted, since the resin is not discharged by the cover, which is only in contact with it at a few points.

ELECTRIC CURRENT. ELECTRIC BATTERIES.

The simplest form of apparatus for the generation and transmission of a voltaic current consists of

1. A jar of earthenware or glass, containing diluted *sulphuric acid* or a solution of *common salt* (chloride of sodium).
2. A *copper* and a *zinc* plate immersed in the liquid.
3. Two copper wires, one fixed to the *upper* part of each plate.

As soon as the two free ends of the copper wires are brought into contact with each other, a current of *positive* electricity is generated, passing from the zinc, *through* the liquid, to the copper, and over the copper plate, through the wires, towards the zinc. Simultaneously a current of *negative* electricity is thought to proceed from the immersed portion of the copper plate, taking an opposite direction, viz., through the liquid to the zinc plate, and *out* of the cell from the zinc, by its connected wire, towards the copper.

If a strip of unamalgamated zinc be placed in diluted sulphuric acid, bubbles of hydrogen gas immediately arise from its surface. As soon, however, as a strip of copper is dipped into the liquid (care being taken that the metals *do not touch*) no apparent change takes place upon the zinc surface. The plates are now said to be *polarised*, the immersed part of the zinc plate becoming + (positive) and the dry portion — (negative), while the immersed part of the copper plate becomes — and the dry portion +. It has, however, been stated that polarisation is only brought about when the zinc is brought into contact with the copper connecting-wire.

Directly the immersed metals are brought into contact below the surface of the liquid, the hydrogen gas instantly appears, being transferred to the surface of the copper, and escaping very freely from all parts of the surface. Scarcely any hydrogen escapes from the zinc if this metal be fairly pure. If contact be made between the metals *out* of the liquid the same results take place.

The same result occurs when the metals are connected by metallic wires.

If properly amalgamated zinc be used, no hydrogen whatever is evolved from its surface. To amalgamate the zinc, the zinc plate should be dipped into diluted sulphuric acid, a little mercury poured on the plate, and the mercury rubbed over the zinc by means of the end of a stick round which tow has been wrapped.

Thus it is observed that a current of positive electricity is considered to originate or be sustained by the chemical action of the fluid on the zinc, and this current, beginning at the surface of the zinc plate, passes from thence through the liquid to the copper, and back again to the zinc through the copper.

The molecular particles of the liquid through which the current passes are supposed to become *polarised*, and thus become *invisibly transferred.*

The — *copper* plate is supposed to attract and turn towards itself the + hydrogen molecule (H_2) of the water (H_2O); the + *zinc* simultaneously and in like manner attracts and turns towards itself the — *oxygen* molecule (O) of the water (H_2O). Thus—

$$\begin{array}{r}\textit{Before}\text{ the}\\ \text{Current}\end{array}\left\{\begin{array}{l}\mathrm{Cu}\ \overbrace{\mathrm{H_2O}}\ \overbrace{\mathrm{H_2O}}\ \overbrace{\mathrm{H_2O}}\ \mathrm{Zn}\\ -\ +\ -\ +\ -\ +\ -\ +\end{array}\right.$$

$$\begin{array}{r}\textit{During}\text{ the}\\ \text{Current}\end{array}\left\{\begin{array}{l}\overbrace{\mathrm{Cu\ H_2}}\ \overbrace{\mathrm{OH_2}}\ \overbrace{\mathrm{OH_2}}\ \overbrace{\mathrm{O\ Zn}}\\ -\ +\ -\ +\ -\ +\ -\ +\end{array}\right.$$

The chemical affinity of the oxygen for the zinc is very powerful. These two substances, therefore, combine to form zinc oxide (ZnO), and this instantly becomes dissolved from the surface of the zinc by the action of the diluted sulphuric acid forming Zinc Sulphate ($ZnSO_4$). If the Zinc Oxide were not dissolved from the surface of the zinc plate, all electric action would terminate.

THE VOLTAIC PILE.

This was the earliest form of battery, and is columnar in arrangement. It consists of a series of zinc and copper discs alternately arranged with layers of cloth or flannel soaked in diluted acid or a solution of common salt, the whole presenting a uniform arrangement, commencing with the zinc as the upper plate and ending with the copper as the lower plate, and thus through the entire series—zinc, copper, flannel;—the terminal plates are connected by wires. Vertical rods of glass are generally used for retaining the discs in their places; and to ensure perfect contact, the zinc and copper discs are usually soldered together.

The electricity thus developed was considered by Volta to be due to the contact of the two dissimilar metals, the moist flannel being merely a conductor.

Although the action of a large Voltaic Pile is at first extremely powerful, it soon becomes comparatively feeble, since the acid is constantly squeezed from between the plates.

By means of this pile, amongst other effects, electric shocks may be given. Sparks may be produced between two pieces of charcoal fixed to the ends of the wires connecting the terminal plates, and the gold leaves of an electroscope may be made to diverge.

THE CROWN OF CUPS—COURONNE DES TASSES.

This was the second form of battery invented by Volta. It consists of a series of glass cups or cells arranged in a circle. In each cell is contained diluted acid, in which are immersed plates of zinc and copper. The plates are alternately arranged, so that the zinc plate of the one vessel is connected by a wire with the copper plate of the next vessel on the one side, the copper plate of that vessel being connected with the zinc plate of the next vessel on the other side of it. If the circuit is closed, the terminal copper and zinc plates are united by their respective wires.

This battery is superior to the Voltaic Pile, since its action continues comparatively uniform for some time, on account of the plentiful supply of the exciting fluid, which is not (as in the case of the pile) squeezed rapidly from the plates by gravity.

THE DRY PILE OF DE LUC

Consists of a series of several hundred circular discs of paper, one side being covered by very thin tin or zinc foil, and the other side by a rubbing of peroxide of manganese, the whole being enclosed by a glass tube terminated by metallic caps. At the manganese end of the pile positive electricity is developed, and from the zinc end negative electricity.

By a dry pile of this description, consisting of 2,000 to 20,000 discs, electric sparks may be produced, electric bells rung for many months continuously, and many other phenomena exhibited.

SMEE'S BATTERY.

Here the negative plate is polarised by mechanical means, each element consisting of a sheet of platinum placed between two vertical plates of zinc, as in Groves' Battery.* There is, however, only a single liquid, viz: diluted sulphuric acid. The elements have much the same form as in Wollaston's Battery. The hydrogen is prevented from adhering to the platinum plate by covering this plate with a deposit of finely divided platinum. Thus the surface is rendered rough, and the disengagement of the hydrogen much facilitated, the resistance of the couple of plates being in consequence diminished. Silver coated with a deposit of finely divided platinum is often substituted for the platinum plate, since it is cheaper.

WALKER'S BATTERY

Resembles Smee's Battery, but the electro-negative plate is of graphite or platinised graphite. The exciting agent is diluted sulphuric acid. This battery has considerable electromotive force.

WOLLASTON'S BATTERY

Is an improved form of the Crown of Cups, and is so arranged, that the action of the battery can be stopped when the current is no longer required. It consists of a number of cells, or glass vessels, united in two parallel series, in which are immersed plates of zinc and copper. The zinc plates consist of thickly-rolled metal, and are generally about eight inches

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* Page 81.

in length by six in breadth. The copper plates are of thin sheet, and are so bent as to surround the zinc plates without touching them. The contact is prevented by small pieces of cork. A narrow strip of copper is soldered to each copper plate, and is bent twice at right angles and soldered to the zinc plate. The first zinc plate is surrounded by the first copper plate. These two constitute a couple, each couple being immersed in the glass vessel containing acidulated water. The copper plate is soldered to the second zinc plate by a narrow strip of copper, and this zinc plate is again surrounded by a second copper plate, and so on.

All the couples are fixed to a cross wooden frame, so that they may be covered or raised at will. The couples are lifted out of the fluid when the battery is not required.

The water is generally acidulated with $\frac{1}{20}$ of nitric acid, or $\frac{1}{10}$ of sulphuric acid.

HARE'S DEFLAGRATOR

Consists of two large copper and zinc sheets rolled together in a spiral, but protected from direct contact by horsehair or leather. The whole is immersed in a vessel containing acidulated water, and the two plates are connected by a conducting wire placed outside the liquid.

CONSTANT BATTERIES.

The energy of a single liquid battery quickly fails when it has been at work a short time, since the hydrogen liberated by the chemical action of the battery collects on the surface of the platinum (negative) plates.

Batteries are termed constant in which this result is prevented by the absorption of the hydrogen by means of strong nitric acid, solution of sulphate of copper, or other suitable agents.

DANIELL'S BATTERY

Consists of a glass or porcelain vessel containing a saturated solution of copper-sulphate, in which is immersed a copper cylinder open at both ends and perforated with holes; at the top of the cylinder is an annular shelf perforated with small holes, and placed below the level of the solution, intended to support crystals of copper-sulphate. To replace the amount of that salt decomposed as electrical action goes on, within the cylinder is a thin porous vessed of unglazed earthenware, containing water or a solution of common salt, or diluted sulphuric acid, in which is placed a cylinder of amalgamated zinc. Two thin strips of copper are fixed by binding screws to the zinc and copper cylinders, and serve to connect the elements in series.

Upon closing a Daniell's arrangement, the hydrogen formed by the action of the diluted sulphuric acid on the zinc is set free upon the surface of the copper plate, but comes in contact there with the copper-sulphate, which is reduced, sulphuric acid and metallic copper being formed, the latter being deposited upon the surface of the copper plate. Thus the sulphate of copper in solution is taken up, and should it be all consumed the hydrogen would be deposited on the copper and the constancy of the current be lost; but this is obviated by the sulphate of copper crystals, which ensure the saturation of the solution. The porous cylinder is permeated by the sulphuric acid formed by the decomposition of the sulphate, and thus the acid used up by the action on the zinc is in a measure replaced. The amount of sulphuric acid formed in the sulphate of copper solution is regular and proportional to the acid employed in dissolving the zinc, and the action of the acid on the zinc being also regular, a continuous current is consequently established.

To form a battery several of these elements are connected together, as follows:

The zinc of one is joined by a copper strip or wire with the copper of the next, and so on, from one element to another.

GROVE'S BATTERY.

In this battery nitric acid is used instead of a solution of sulphate of copper, and platinum instead of copper. It consists of a glass or porcelain vessel partly filled with diluted sulphuric acid, in which is placed a cylinder of zinc open at both ends, internal to which is a vessel of porous pipeclay containing nitric acid, on which is placed a plate of platinum bent in the form of an S. The platinum plate is provided with a binding screw, and the zinc by a similar binding screw.

In this battery the hydrogen disengaged on the platinum meets the nitric acid, and by decomposing it forms hyponitrous acid, which is disengaged as nitrous fumes.

It is the most powerful and most convenient of the two-fluid batteries, but is very expensive from the price of platinum, which becomes brittle after a time and breaks easily.

BUNSEN'S BATTERY, OR ZINC CARBON BATTERY,

Is merely a Grove's Battery in which a cylinder of carbon replaces the sheet of platinum.

The carbon employed is made either of graphitoidal carbon deposited in gas retorts, or by calcining in an iron mould an intimate mixture of coke and bituminous coal finely powdered and strongly compressed. Each element consists of the following parts : An outer vessel of glass or stoneware containing diluted sulphuric acid, in which is placed a hollow cylinder of amalgamated zinc, slit on one side from top to bottom, and containing in its turn a porous vessel holding ordinary nitric acid. In this last fluid is placed the carbon. A binding-screw is attached to the carbon, a copper wire forming the positive pole. A similar screw and wire are attached to the zinc, thus forming the negative pole.

A battery is formed of the elements by joining each carbon cylinder to the succeeding zinc cylinder by means of clamps and a strip of copper. The copper is pressed at one end between the carbon and the clamp, and at the other end it is soldered to the clamp which is fitted on the zinc of the following element, and so on. The clamp of the first carbon and that of the last zinc cylinder are alone provided with binding-screws, to which are attached the wires.

The chemical action of this battery is the same as Grove's, and it is equally powerful and less costly. It is, however, more expensive to work, although the first cost is less, and it is not so convenient to manipulate.

CALLAN'S BATTERY

Is a modified form of Grove's. Zinc and platinised lead are used in the place of zinc and platinum, and instead of pure nitric acid, this inventor used a mixture of sulphuric acid, nitric acid, and a saturated solution of nitrate of potash.

It is a much cheaper battery than Grove's, and is said to be equal to it in action.

RECENT BATTERIES.

M. MARIÉ DAVY'S BATTERY

Is a zinc carbon arrangement, but smaller in dimensions than those arrangements usually are. In the outer vessel ordinary water or brine is placed, in the porous vessel sulphate of mercury. The salt is shaken with about three times its volume of water, in which it only dissolves with difficulty, and the liquid is poured off from the pasty mass. The carbon being placed in the porous vessel the spaces become filled with the residue, and then the decanted liquid is poured into it. It is only when the pile is closed that chemical action occurs. The water is decomposed by the zinc, hydrogen being set free, and this gas, traversing the porous vessel, reduces the sulphate of mercury, forming metallic mercury, which falls to the bottom of the vessel, the sulphuric acid formed meanwhile traversing the diaphragm to act upon the zinc and intensify the action. The deposited mercury may be employed for preparing a quantity of the sulphate equal to that consumed. A little of the sulphate of mercury solution may also pass through the diaphragm, but this is rather an advantage, as its effect is to amalgamate the zinc.

This element's electro-motive force is about a quarter greater than that of Daniell's, but it has greater resistance. If continuously worked it is rapidly exhausted, but it is apparently well suited for discontinuous work, as with alarums and with the telegraph.

GRAVITY BATTERIES.

Porous vessels are open to objection, especially those of the Daniell's Battery, in which these vessels become gradually encrusted with copper, and are thus destroyed. A variety of battery has been invented in which the porous vessel is done away with, and the fluids separated by the difference of density.

M. CALLAUD'S (OF NANTES) BATTERY

Consists of a glass or earthenware vessel, in which is placed a copper plate soldered to a wire insulated by gutta-percha. Upon the plate is a layer of copper-sulphate crystals. The whole vessel is then filled with water, and a zinc cylinder is immersed in it. Thus the lower portion of the liquid is saturated with copper-sulphate. In action the battery is similar to Daniell's. The sulphate of zinc forming gradually floats on the copper-sulphate solution, in consequence of its lower density.

The manipulation of this battery is easy, the copper-sulphate consumed is not expensive, and if it is not shaken, will work continually for months, care being taken to replace the water lost by evaporation.

MINOTTO'S BATTERY.

This is a Daniell's element, the porous vessel being replaced by a layer of sand or sawdust. It consists of an earthenware vessel, at the bottom of which is placed a layer of coarsely-powdered copper-sulphate, upon which layer is placed a copper plate having an insulated copper wire. Upon this plate is a layer of sawdust or sand, and the whole is then filled with water, in which a zinc cylinder rests. In action it is like Daniell's.

The mixture of the liquids is prevented by the sawdust, which offers great resistance, increasing with its thickness. This battery is very simple and economical, and is easily constructed.

LECLANCHE'S ELEMENT.

Here a rod of carbon is placed in a porous pot, and tightly packed with a mixture of black oxide of manganese and coke. Surrounding the whole is an outer vessel containing zinc, the electro-positive element. Chloride of ammonium solution is the exciting liquid. It is desirable not to fill the vessel more than $\frac{1}{3}$rd with the liquid. The electro-motive force of this battery is about $\frac{9}{10}$ that of a Daniell's.

Electro-motive Force of Different Elements.*

The following table shows the electro-motive force of some of the arrangements most in use compared with that of an ordinary Daniell's cell charged as previously described :

Daniell's element set up with water - - - -	1·00
,, ,, pure zinc and pure water, with pure copper and pure saturated solution of sulphate of copper - -	1·02

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* "Ganot's Physics," by Atkinson.

Leclanche's	element:	zinc in saturated solution of chloride of ammonium	1·32
Marié Davy's	,,	- - - - - - -	1·41
Bunsen's	,,	carbon in nitric acid	1·77
,,	,,	carbon in chromic acid	1·87
Groves'	,,	platinum in nitric acid	1·82

RULES AND EXAMPLES FOR THE SOLUTION OF QUESTIONS involving

(a) The determination of the percentage composition of a compound from the chemical formula.

(b) The determination of a chemical formula of the compound from the percentage composition.

A. The formula of a compound being given, to ascertain the percentage composition, and thence the amount of the several constituents in any given quantity of the compound.

Rule.—Add together the atomic weights of the several constituents, and in this manner obtain the molecular weight of the compound; then, as the molecular weight of the whole compound is to 100, so is the weight of each constituent to the percentage quantity of that constituent, thus:—

Example 1. Sulphuric Acid = H_2SO_4

$$\begin{array}{rl} 2H & = 2 \\ S & = 32 \\ 4O & = 64 \\ \hline H_2SO_4 & = 98 \end{array}$$

Then to ascertain the quantity of oxygen (O) in 100 parts of H_2SO_4.

$$98 : 100 :: 64 : x$$

$$\therefore x \text{ (the quantity of O required)} = \frac{100 \times 64}{98} = 65{\cdot}306$$

Since $100 \times 64 = 6400$; and $6400 \div 98 =$

$$\begin{array}{r|l|l}
98 & 6400 & 65 \cdot 306 \\
 & 588 & \\
\hline
 & \;\;520 & \\
 & \;\;490 & \\
\hline
 & \;\;\;300 & \\
 & \;\;\;294 & \\
\hline
 & \;\;\;\;600 & \\
 & \;\;\;\;588 & \\
\hline
 & \;\;\;\;\;12 &
\end{array}$$

65·306 oxygen.

Or by the Unity Method—

If 98 (the sum of the atomic weights) yield 64 parts of oxygen

$$\therefore \quad 1 = \frac{64}{98}$$

$$\therefore 100 = \frac{64}{98} \times 100 = 65 \cdot 306 \text{ of oxygen.}$$

Now if we require to find the quantity of O necessary to make 1 ton of sulphuric acid—

$$\text{as—} \quad \overset{\text{tons}}{100} : \overset{\text{ton}}{1} :: 65 \cdot 306 : x$$

$$\therefore x = \frac{1 \times 65 \cdot 306}{100} = \cdot 65306 = \overset{\text{tons}}{13} \quad \overset{\text{cwt. qrs.}}{0} \quad \overset{\text{lb.}}{6 \cdot 85440}$$

Ex. 2. The formula of a certain salt is NH_4Cl. How is the percentage composition of each of its constituents found?

$$\begin{array}{lcl}
\text{Nitrogen} \quad (N) & = & 14 \\
\text{Hydrogen} \; (H)_4 & = & 4 \\
\text{Chlorine} \quad (Cl) & = & 35 \cdot 5 \\
\hline
\text{The whole compound } NH_4Cl & = & 53 \cdot 5
\end{array}$$

(a) $$\therefore \; 53 \cdot 5 : 100 :: 14 \; (N) : x \; (N)$$

$$\therefore x = \frac{100 \times 14}{53 \cdot 5} = \frac{1400}{53 \cdot 5} = 26 \text{ nearly.}$$

Or (Unity Method)—

If 53·5 parts yield 14 of nitrogen

$$\therefore \quad 1 = \frac{14}{53.5}$$

$$\therefore 100 = \frac{14}{53 \cdot 5} \times 100 = \frac{1400}{53 \cdot 5} = 26 \text{ (N) nearly.}$$

(b) $$\therefore\ 53{\cdot}5 : 100 :: 4\ (\text{H}) : x\ (\text{H})$$

$$\therefore\ x = \frac{100 \times 4}{53.5} = \frac{400}{53{\cdot}5} = 7{\cdot}476\ (\text{H})\ \text{nearly.}$$

Or by Unity—

If 53·5 yield 4 (H)

$$\therefore\quad 1 = \frac{4}{53{\cdot}5}$$

$$\therefore\ 100 = \frac{4}{53{\cdot}5} \times 100 = \frac{400}{53{\cdot}5} = 7{\cdot}476\ (\text{H})\ \text{nearly.}$$

(c) $$\therefore\ 53{\cdot}5 : 100 :: 35{\cdot}5\ (\text{Cl}) : x\ (\text{Cl})$$

$$\therefore\ x = \frac{100 \times 35{\cdot}5}{53{\cdot}5} = \frac{710}{10{\cdot}7} = 66{\cdot}355\ (\text{Cl})$$

Or by Unity—

If 53·5 yield 35·5 Cl,

$$\therefore\quad 1 = \frac{35{\cdot}5}{53{\cdot}5}$$

$$\therefore\ 100 = \frac{35{\cdot}5}{53{\cdot}5} \times 100 = \frac{710}{10{\cdot}7} = 66{\cdot}355\ (\text{Cl})$$

Ex. 3. Nitric acid has the formula HNO_3.

Find the composition of nitric acid in 100 parts ($H=1$, $N=14$, $O=16$).

The molecular weight of nitric acid $=1+14+48=63$.

(a) $\therefore$ 63 (parts) : 100 (parts) :: 1 (H) : x (H).

$$\therefore\ x\ (\text{amount of H}) = \frac{100}{63} = 1{\cdot}59\ (\text{H})\ \text{nearly.}$$

Or by Unity—

If 63 yield 1,

$$\therefore\quad 1 = \frac{1}{63}$$

$$\therefore\ 100 = \frac{1}{63} + 100 = \frac{100}{63} = 1{\cdot}59\ (\text{H})\ \text{nearly.}$$

(b) $\therefore\ 63 : 100 :: 14\ (\text{N}) : x\ (\text{N})$.

$$x\ (\text{amount of N}) = \frac{100 \times 14}{63} = \frac{1400}{63} = 22{\cdot}22\ (\text{N})\ \text{nearly.}$$

Or by Unity—

If 63 yield 14

$$\therefore\quad 1 = \frac{14}{63}$$

$$\therefore\ 100 = \frac{14}{63} \times 100 = \frac{1400}{63} = 22{\cdot}22\ (\text{N})\ \text{nearly.}$$

(c) $\therefore$ $63 : 100 :: 48\ (O) : x\ (O)$.

$$\therefore x\ (\text{amount of O}) = \frac{100 \times 48}{65} = \frac{4800}{65} = 76{\cdot}19\ (O).$$

Or by Unity—

If 63 yield 48

$$\therefore \quad 1 = \frac{48}{63}$$

$$\therefore 100 = \frac{48}{63} \times 100 = \frac{4800}{63} = 76{\cdot}19\ (O).$$

$\therefore$ The following is the percentage composition of the whole HNO_3, viz. :

Hydrogen,	1·59
Nitrogen,	22·22
Oxygen,	79·19

Ex. 4. The following equations represent the manufacture of nitric acid, viz. :

(a)	Nitrate of potash $2KNO_3$	Sulphuric acid $+ H_2SO_4$	Nitrate of potash $= KNO_3$	Hydrogen potassic sulphate $+ HKSO_4$	Nitric acid HNO_3

(b)	Hydric potassic sulphate $HKSO_4$	Nitrate of potash $+ KNO_3$	Neutral potassic sulphate $= K_2SO_4$	Nitric acid $+ HNO_3$

What amounts of H_2SO_4 (sulphuric acid) and KNO_3 (nitrate of potash) are needed to produce 1 lb. of HNO_3 (nitric acid)?

It is evident from the above equations that for every *two* parts of nitrate of potash and one part of sulphuric acid used, *two* parts of nitric acid result. Now the

Molecular weight of (KNO_3) nitrate of potash = 101

$$\begin{array}{rrcr} \text{Since} & K & = & 39 \\ & N & = & 14 \\ & O_3 & = & 48 \\ \hline & & & 101 \end{array}$$

Molecular weight of (H_2SO_4) Sulphuric acid = 98

" " (HNO_3) Nitric acid = 63

$\therefore$ $126\ ((HNO_3)_2) : 1\ (\text{lb. of } HNO_3) :: 202\ ((KNO_3)_2) : x$

And x (weight of KNO_3 needed) =

$$\frac{202}{126} = \frac{101}{63} = 1{\cdot}603 \text{ lb.}$$

Again—

$$126\ ((HNO_3)_2) : 1\ (\text{lb. of } HNO_3) :: 98\ (H_2SO_4) : x$$

$\therefore x$ (weight of sulphuric acid required) =

$$\frac{98}{126} = \frac{7}{9} = {\cdot}7 \text{ lb.}$$

B. Conversely. To ascertain the empirical formula of a compound from its percentage composition, the following process is adopted.

Rule.—Divide the amount of each element by its atomic weight; then divide each of the resulting quotients by their common measure. The quotients which result from this second division will give the number of atoms of each element entering into the compound, and must consequently give its formula.

Example 1. The following is found to be the percentage composition of a compound—

Carbon - - -	27·27
Oxygen - -	72·73

Ascertain its formula (C = 12, O = 16).

27·27 ÷ 12 (the atomic weight of C) = 2·2725. Thus—

$$\begin{array}{r}
12\,)\,27{\cdot}27\,(\,2{\cdot}2725 \\
24\phantom{{\cdot}27\,(\,2{\cdot}2725} \\
\hline
32\phantom{{\cdot}7\,(\,2{\cdot}2725} \\
24\phantom{{\cdot}7\,(\,2{\cdot}2725} \\
\hline
87\phantom{\,(\,2{\cdot}2725} \\
84\phantom{\,(\,2{\cdot}2725} \\
\hline
30\phantom{(\,2{\cdot}2725} \\
24\phantom{(\,2{\cdot}2725} \\
\hline
60\phantom{2{\cdot}2725} \\
60\phantom{2{\cdot}2725} \\
\hline
\end{array}$$

2·2725 Carbon.

And 72·73 ÷ 16 (the atomic weight of O) = 4·5456. Thus—

```
16 ) 72·73 ( 4·5456
     64
     ——
      87
      80
      ——
       73
       64              4·5456 Oxygen.
       ——
        90
        80
        ——
        100
         96
        ———
          4*
```

The common measure of 2·2725 and 4·5456 is 2·2725.

$$\text{Dividing } \therefore \frac{2·2725}{2·2725} = 1 \text{ C}$$

And

$$\frac{4·5456}{2·2725} = 2 \text{ O}.$$

∴ the formula of the compound is CO_2 (Carbonic Anhydride).

Ex. 2. What formula must be given to a salt, the composition of which is as follows?—

Potassium - -	31·837
Chlorine - -	29·000
Oxygen - -	39·183

31·837 ÷ 39, (atomic weight of Potassium) = ·816 (K) nearly.
29·000 ÷ 35·5 (,, ,, ,, Chlorine) = ·816 (Cl) nearly.
39·183 ÷ 16 (,, ,, ,, Oxygen) = 2·45 (O) nearly.

∴ ·816 (K) : ·816 (Cl) :: 2·45 (O) :: 1 : 1 : 3.

∴ The formula = $KClO_3$ (Potassium Chlorate).

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* It is a matter of the utmost difficulty to *exactly* determine the quantitative composition of a compound, and this will account for the slight inaccuracy of the above division.

TABLES OF ANALYSIS

FOR THE

COMMONER METALS AND ACIDS.

EXPLANATORY TABLE OF THE SYMBOLS EMPLOYED IN THE FOLLOWING TABLES OF ANALYSIS.

Ag	Argentum	Silver.
$AgNO_3$	Argenti Nitras	Nitrate of Silver.
Al	Aluminium	Aluminium.
As	Arsenicum	Arsenic.
As_2O_3	Arseniosum Anhydridum	Arsenious Anhydride.
As_2O_5	Arsenicum Anhydridum	Arsenic Anhydride.
Ba	Barium	Barium.
$BaCl_2$	Barii Chloridum	Chloride of Barium.
Bi	Bismuthum	Bismuth.
Ca	Calcium	Calcium.
$CaCl_2$	Calcii Chloridum	Chloride of Calcium.
Cd	Cadmium	Cadmium.
Co	Cobaltium	Cobalt.
$Co(NO_3)_2$	Cobaltii Nitras	Nitrate of Cobalt.
CO_2	Carbonicum Anhydridum	Carbonic Anhydride.
Cu	Cuprum	Copper.
Fe	Ferrum	Iron.
Fe_2Cl_6	Ferri Perchloridum	Perchloride of Iron.
Fe_2O_3	Ferri Peroxidum	Peroxide of Iron.
$FeSO_4$	Ferri Sulphas	Sulphate of Iron.
HCl	Acidum Hydrochloricum	Hydrochloric Acid.
$HC_2H_3O_2$	Acidum Aceticum	Acetic Acid.
Hg	Hydrargyrum	Mercury.
HNO_3	Acidum Nitricum	Nitric Acid.
H_2O	Aqua	Water.
H_2S	Acidum Hydrosulphuricum	Hydrosulphuric Acid or Sulphuretted Hydrogen.
H_2SO_4	Acidum Sulphuricum	Sulphuric Acid.
K	Kalium	Potassium.
K_2CO_3	Potassæ Carbonas	Carbonate of Potash.

K_2CrO_4	Potassæ Chromas	Chromate of Potash.
KCy	Potassii Cyanidum	Cyanide of Potassium.
KHO	Liquor Potassæ	Solution of Potash.
$K_2H_2Sb_2O_7$	Potassæ Antimonias	Antimoniate of Potash.
KNO_3	Potassæ Nitras	Nitrate of Potash.
L	Lithium	Lithium.
Mg	Magnesium	Magnesium.
Mn	Manganesium	Manganese.
Na	Natrium	Sodium.
Na_2CO_3	Sodæ Carbonas	Carbonate of Soda.
Na_2HPO_4	Sodæ Phosphas	Phosphate of Soda.
$NaNH_4HPO_4$	Sodium Ammonium Hydrogen Phosphate	Microcosmic Salt.
NH_3	Ammonia	Ammonia.
NH_4Cl	Ammonii Chloridum	Chloride of Ammonium.
$(NH_4)_2CO_3$	Ammoniæ Carbonas	Carbonate of Ammonia.
$(NH_4)_2C_2O_4$	Ammoniæ Oxalas	Oxalate of Ammonia.
NH_4HO	Liquor Ammoniæ	Solution of Ammonia.
NH_4HS	Ammonii Sulphidum	Sulphide of Ammonium.
$(NH_4)_2HAsO_4$	Ammoniæ Arsenias	Arseniate of Ammonia.
Ni	Nickelium	Nickel.
Pb	Plumbum	Lead.
PbO_2	Plumbi Peroxidum	Peroxide of Lead (Puce-coloured).
Pb_3O_4	Minium	Red Lead.
$PtCl_4$	Platini Perchloridum	Perchloride of Platinum
Sb	Stibium	Antimony.
SbH_3	Antimonii Hydridum	Antimoniuretted Hydrogen.
Sn	Stannum	Tin.
SO_2	Sulphurosum Anhydridum	Sulphurous Anhydride
Sr	Strontium	Strontium.
Zn	Zincum	Zinc.

Before applying the confirmatory tests alluded to in the following tables, the precipitate should be dissolved, if possible, in a suitable solvent.

PRELIMINARY EXAMINATION.

If the substance be a solid, observe whether it is

1. Soluble or insoluble in water.
2. If it be colourless or coloured.
3. Whether alkaline, acid, or neutral to test paper.
4. Add Na_2CO_3. Heat if no precipitate is occasioned in the cold.

If no precipitate falls even upon heating, it is evident that all those metals are absent the carbonates of which are insoluble.

5. Heat on Platinum foil; in dealing with a very diluted solution, it should be heated in a test tube.

   a. Is it completely volatile without residue or volatile with residue; possibly salts of $Hg, NH_3, As_2O_3, As_2O_5$, chlorides of Sb, Sn, etc.

   b. Visibly decomposed with residue; several organic salts, those of the alkalies and alkaline earths, leave an ash which is alkaline to test paper, and upon the addition of HCl effervesces.

   c. Leaving carbonaceous residue burning to CO_2. This is the case with certain organic acids.

   d. Giving colour to flame: Potassium is violet; Sodium, yellow; Lithium, scarlet; Barium, light-green; Strontium, crimson; Calcium, yellow; Free Phosphoric and Boracic Acids, green; Copper, green; Cupric Chloride, blue; Salts of Lead, Arsenic, and Antimony, blue, etc.

   e. Fuse on Platinum foil (almost all the salts of the alkalies and of the alkaline earths).

Add to residue H_2SO_4 and again heat; if phosphates or borates are present they will give a green colour to flame.

6. Deflagrate on charcoal (nitrates, chlorates, bromates, and iodates).

It may be necessary to examine the volatilised substance.

If the substance be solid, transfer it to a narrow glass tube open at both ends, or to a narrow test tube and heat it.

If the substance be insoluble in water add HCl; if still not entirely soluble add HNO_3. Should the whole be insoluble in the mixed acids ($HCl + HNO_3$), fuse it with four times its weight of a mixture of K_2CO_3 and Na_2CO_3.

If a solution of a salt contains one base, the test re-agents should be applied in the following order :—

Test papers — Na_2CO_3, HCl, $HCl + H_2S$, NH_4HS, $(NH_4)_2CO_3 + NH_4Cl$, $NaNH_4HPO_4$, KHO, and lastly $PtCl_4 + HCl$.

For finding the acid in a salt, the chief tests are HCl. $HCl + H_2S$. $BaCl_2$, subsequently adding HNO_3. $AgNO_3$, subsequently adding HNO_3 and NH_4HO to the precipitate carefully washed.

In testing for nitrates the acid should be set free by H_2SO_4, and the characteristic tests applied, viz., metallic Cu and $FeSO_4$.

TABLES OF ANALYSIS FOR THE COMMONER METALS IN SOLUTION.

GROUP I. Add HCl.

Precipitate (Ppt). (Preserve filtrate for Group II).

Hg as Mercurous Salt. Pb.* Ag (as Chlorides).

Wash, boil with much water, and filter.

<table>
<tr><td colspan="2">Precipitate
Hg (mercurous salt). Ag.
Wash, add NH_4HO.</td><td rowspan="2">Filtrate
Pb.
add H_2SO_4.
White Ppt.

For confirmatory tests, see page 39.

Pb must also be sought for in Group II by H_2S, since in a weak solution of a Pb salt HCl may cause no precipitate.</td></tr>
<tr><td>Precipitate
Hg (ous).
Black.
See tests, page 44.</td><td>Filtrate
Ag,
add HNO_3.
White Ppt.
See tests, page 46.</td></tr>
</table>

N.B.—The HCl precipitate may include some salt of Bismuth, Antimony, or Arsenic; these are, however, readily dissolved by excess of the acid.

---

* The Pb precipitate is unchanged by NH_4HO.

GROUP II. H_2S.

Through the filtrate from Group I. pass H_2S and filter.

<table>
<tr><td colspan="8">Precipitate. [Preserve filtrate for Group III.]
Cd, Cu, Hg (mercuric salt), Pb, Bi, As, Sb, Sn (as Sulphides).
Collect, wash, add NH_4HS and filter.</td></tr>
<tr><td colspan="5">Precipitate
Cd, Cu, Hg (ic) Pb, Bi.
Wash, boil with HNO_3, and filter.</td><td colspan="3">Filtrate
As, Sb, Sn,
add dil. HCl, filter, drain well, add strong HCl, boil, slightly dilute and filter.</td></tr>
<tr><td rowspan="3">Precipitate
Hg (ic)
Black.
Dissolve in HNO_3.
Tests, page 44.</td><td colspan="4">Filtrate
Cd, Cu, Pb, Bi,
add NH_4HO, and filter.</td><td rowspan="3">Insoluble
As.
Yellow.
For tests, see Part I, pages 55, 56.</td><td colspan="2">Filtrate
Sn, Sb.
Place in a Hydrogen apparatus.</td></tr>
<tr><td colspan="2">Precipitate
Pb, Bi.
Wash, add a few drops of HNO_3, dilute, filter.</td><td colspan="2">Filtrate
Cd, Cu,
add KCy and H_2S.</td><td rowspan="2">Sb
comes off as SbH_3.
Tests, page 36.</td><td rowspan="2">Sn
remains on the zinc.
Dissolve in HCl.
Tests, page 31.</td></tr>
<tr><td>Precipitate
Bi.
Tests, page 37.</td><td>Filtrate
Pb,
add H_2SO_4, let stand.
White Ppt.
Tests, page 39.</td><td>Precipitate
Cd.
Yellow, insoluble in alkalies.</td><td>Filtrate
Cu,
add $HC_2H_3O_2$.
Brown Ppt.
Tests, page 42.</td></tr>
</table>

N.B.—If the sulphuretted hydrogen precipitate be white it is only sulphur. Care must be taken that the H_2S be passed through the liquid until saturation, since if lead or mercury is present, insufficient H_2S may produce a peculiar oxy-sulphide or hydrato-sulphide of these metals.

GROUP III.

To the filtrate from Group II. add NH_4Cl, NH_4HO and NH_4HS.
Gently warm and filter.

<table>
<tr><td colspan="7">Precipitate. [Preserve filtrate for Group IV.]
Zn, Mn, Co, Ni, Al, Fe, Cr (as Oxides).
Collect, wash, dissolve in HCl, with a few drops of HNO_3, boil, add NH_4HO, stir, filter.</td></tr>
<tr><td colspan="3">Precipitate
Fe, Al, Cr, Mn ?*
Wash, dry, fuse on platinum foil with Na_2CO_3 and KNO_3; boil with water and filter.</td><td colspan="4">Filtrate
Zn, Mn, Co, Ni.
Add $HC_2H_3O_2$. Pass H_2S through solution and filter.</td></tr>
<tr><td rowspan="3">Residue
Fe_2O_3.
Reddish-brown.
Test for ferrous or ferric salt in original soln.
Tests, page 30.</td><td colspan="2">Filtrate.
If yellow, Cr. Divide into two portions.</td><td rowspan="3">Solution
Mn.
Add NH_4HO and NH_4HS.
Pink turning Brown.
Look for Mn in the Fe, Al, Cr, Ppt.
Tests, pages 25, 26.</td><td colspan="3">Precipitate
Zn, Co, Ni.
Boil with HCl, and a little HNO_3; add KHO, and filter.</td></tr>
<tr><td rowspan="2">Solution
Al.
Add NH_4HO, warm and filter.
White Ppt.
Tests, page 20.</td><td rowspan="2">Solution
Cr.
Add $HC_2H_3O_2$ and $AgNO_3$ in excess.
Red Ppt.
Or boil with H_2SO_4 and spirit.
Green solution.
Tests, pages 32, 33.</td><td colspan="2">Precipitate
Co, Ni.
Dissolve in excess of HCl and add KCy and excess of KHO.</td><td rowspan="2">Filtrate
Zn.
Add NH_4HS
White Ppt.
Tests, page 23.</td></tr>
<tr><td>Ppt.
Ni.
Pale Apple-green.
Tests, page 31.</td><td>Filtrate
Co.
Evaporate to dryness and test residue with borax bead, red-brown in outer flame, grey in inner.
Tests, page 31.</td></tr>
</table>

* Mn may be tested for by adding dil. HNO_3, and either PbO_2 or Pb_3O_4 to the solution and then boiling; a red tint is due to permanganic acid.

GROUP IV.

To the filtrate from Group III. add $(NH_4)_2CO_3$.

Warm and filter.

<table>
<tr><td colspan="3">Precipitate [Preserve filtrate for Group V.]
Ba, Sr, Ca (as Carbonates).
Collect, wash, dissolve in $HC_2H_3O_2$, add excess of K_2CrO_4 and filter.</td></tr>
<tr><td rowspan="2">Precipitate
Ba.
Yellow.
Tests, page 18.</td><td colspan="2">Filtrate
Sr, Ca.
Add very diluted H_2SO_4 ; let stand and filter.</td></tr>
<tr><td>Ppt.
Sr.
White.
Tests, page 16.</td><td>Filtrate
Ca.
Add $(NH_4)_2C_2O_4$.
White Ppt.
Tests, pages 15, 16.</td></tr>
</table>

GROUP V.

To the filtrate from Group IV. add $(NH_4)_2HAsO_4$ or Na_2HPO_4.

Stir and filter.

<table>
<tr>
<td rowspan="2">Precipitate
Mg, (as ammonio-magnesian-arseniate (NH_4MgAsO_4) or sodio-magnesian-phosphate ($NaMgPO_4$)).
White.
Heated before blow pipe with $Co(NO_3)_2$ acquires a pink tinge.
Tests, page 22.</td>
<td colspan="2">Filtrate
L, K, Na, NH_3.
Evaporate to a small bulk and add NH_4HO.</td>
</tr>
<tr>
<td>Precipitate
L.
Scarlet on platinum, in inner flame, gives to outer flame a purple colour.</td>
<td>Filtrate
K, Na, NH_3.
Evaporate, ignite, and dissolve in water.
Na by the yellow flame; and by the white ppt. with $K_2H_2Sb_2O_7$ (page 9);
K by yellow ppt. with $PtCl_4$ (page 7);
NH_3 must be sought for in the original solution.
Tests, page 10, and Part I., page 16.</td>
</tr>
</table>

TABLES OF ANALYSIS FOR THE COMMONER ACIDS.

Precipitated by $AgNO_3$.	Precipitated by Fe_2Cl_6.	Precipitated by $BaCl_2$,	Precipitated by $CaCl_2$.	Decomposed by H_2SO_4.	Not precipitated.
Chlorides, white Bromides ,, Cyanides ,, Borates ,, Sulphites ,, Carbonates ,, Hyposulphites ,, Oxalates ,, Tartrates ,, Citrates ,, Chromates, crimson Iodides, yellow Phosphates ,, Sulphides, black Iodates, white The Silver Chloride, Bromide, Iodide, Cyanide and Sulphide are insoluble in dil. HNO_3. The others are soluble.	Borates, yellowish. Carbonates, reddish. Oxalates, yellow. Phosphates, yellowish-white. Sulphides, black. Acetates in neutral solution, cherry-red colour.	Borates, white Carbonates ,, Citrates ,, Oxalates ,, Phosphates ,, Sulphites ,, Sulphates ,, Tartrates ,, All soluble in HCl, except the Sulphate of Barium. The Citrate and Tartrate of Barium char when heated on platinum foil. The Sulphite and Carbonate of Barium are decomposed by acids with effervescence.	Borates. Phosphates. Carbonates. Sulphates. Citrates. Sulphites. Oxalates. Tartrates. The Borate, Carbonate and Citrate are dissolved by solution of NH_4Cl; the Sulphate alone is soluble in much H_2O. All are soluble in HCl, except much sulphate. All are soluble in $HC_2H_3O_2$, except oxalate and some tartrate and sulphate. The dry Citrate and Tartrate char when heated. With acids, the Carbonate and Sulphite effervesce.	Acetates, the odour of $HC_2H_3O_2$ being produced on warming the solution. Carbonates, with effervescence from the evolution of H_2S, SO_2 and CO_2 gases, known by their odour. Cyanides, the odour of HCy being produced. Sulphides. Sulphites.	Chlorates. Nitrates. All Chlorates are soluble, and deflagrate on charcoal; heated on platinum they are converted into chlorides; with HCl they are changed in colour to a yellowish-green, evolving Cl. The Nitrates are all soluble, deflagrate on charcoal, and are changed by red heat into Nitrites.

ACETATES.

These are usually colourless and soluble. The acetates of the fixed alkalies and alkaline earths are converted by heat into carbonates without blackening.

$AgNO_3$, in strong solution, produces a white precipitate of Acetate of Silver ($AgC_2H_3O_2$), soluble in NH_3 and HNO_3.

Fe_2Cl_6 gives a cherry-red colour.

H_2SO_4 and Alcohol (C_2H_6O), by heat, give off Acetic Ether ($C_2H_5,C_2H_3O_2$).

Free Acetic Acid, $HC_2H_3O_2$, has an odour of vinegar.

BROMIDES.

Very like Chlorides ; they are decomposed by Chlorine with the orange colour of Bromine.

$AgNO_3$ gives a yellowish-white precipitate of Bromide of Silver ($AgBr$), soluble in excess of NH_3, but insoluble in HNO_3.

BORATES.

The alkaline Borates are soluble and fusible. The insoluble Borates are dissolved by ammoniacal salts and by acids.

Chief salt is Borax ($Na_2B_4O_7$). $BaCl_2$ gives a white precipitate of Meta-Borate of Barium ($Ba(BO_2)_2$).

$AgNO_3$ gives a white Meta-Borate of Silver ($AgBO_2$).

Borates also give a green colour to flame.

CARBONATES.

The alkaline Carbonates are soluble. Heat converts the bicarbonates of the alkaline earths into carbonates with evolution of CO_2.

HCl causes effervescence. Liquor Calcis (CaH_2O_2) gives a white precipitate of Carbonate of Lime ($CaCO_3$).

$BaCl_2$ gives a white precipitate of Carbonate of Barium ($BaCO_3$).

$AgNO_3$ gives a white precipitate of Carbonate of Silver (Ag_2CO_3).

CHLORATES.

All soluble. Chief salt is Chlorate of Potash ($KClO_3$). They deflagrate on charcoal. Heated on platinum they are converted into Chlorides, and tested for as such.

HCl, on heating, changes the colour of chlorates to yellowish-green, yielding Cl and Chlorine Trioxide (Cl_2O_3).

CHLORIDES.

Most are colourless, soluble salts. The insoluble salts are Calomel (HgCl), Chloride of Silver (AgCl), and Chloride of Lead ($PbCl_2$).

$AgNO_3$ gives a white precipitate of AgCl, soluble in NH_3 and reprecipitated by HNO_3.

Manganese Dioxide (MnO_2) with H_2SO_4 yields Chlorine gas (Cl), known by its odour and colour, and by its turning starch paper blue when soaked in Iodide of Potassium (Kl).

HNO_3 gives fumes of Cl and Nitroxyl Chloride ($NOCl_2$).

CITRATES.

Are alkaline, colourless and soluble. Are converted by heat into carbonates, giving out pungent fumes and liberating Carbon (C).

$AgNO_3$ gives a white precipitate of Citrate of Silver ($Ag_3C_6H_5O_7$).

$CaCl_2$ gives a white precipitate of Citrate of Lime ($Ca_32C_6H_5O_7$), insoluble in KHO, but readily soluble in NH_4Cl.

HYPOSULPHITES.

The chief salt is the Sodium Hyposulphite ($Na_2S_2O_3$), soluble and alkaline.

HCl precipitates Sulphur (S), the solution becoming yellowish-white, and liberating SO_2.

$BaCl_2$ gives a white precipitate of Hyposulphite of Barium (BaS_2O_3).

$AgNO_3$ gives a white precipitate of Hyposulphite of Silver ($Ag_2S_2O_3$), which rapidly decomposes into H_2SO_4 and black Sulphide of Silver (Ag_2S).

IODIDES.

Resemble chlorides; but many are coloured. They are decomposed by Cl.

$AgNO_3$ gives a yellowish precipitate of Iodide of Silver (AgI).

Mercurous Nitrate ($HgNO_3$) gives a green precipitate of Mercurous Iodide (HgI).

Mercuric Chloride ($HgCl_2$) gives a scarlet Mercuric Iodide (HgI_2), soluble in excess.

HNO_3, sets free solid Iodine (I), by which a solution of starch is rendered blue.

By heat a violet vapour is given off.

Acetate of Lead ($Pb2C_2H_3O_2$) gives a yellow Iodide of Lead (PbI_2), soluble in excess of hot water.

NITRATES.

Colourless salts, deflagrating on charcoal. Chief salt is Nitrate of Potash (KNO_3), changed by red heat into Nitrite of Potash (KNO_2), which, with Sulphate of Copper ($CuSO_4$), forms green Nitrite of Copper ($Cu2NO_2$), and when heated with H_2SO_4 gives off fumes of Nitrogen Trioxide (N_2O_3).

H_2SO_4 liberates HNO_3 from a nitrate; with Metallic Copper (Cu) and H_2SO_4 orange vapours of Nitrogen Tetroxide (N_2O_4) are given off.

A green crystal of Sulphate of Iron ($FeSO_4$) and a drop or two of H_2SO_4 form reddish-brown pernitrate of iron (Fe_26NO_3).

OXALATES.

Decompose when heated upon platinum into carbonates with blackening, or they are reduced.

$AgNO_3$ gives a white precipitate of Oxalate of Silver ($Ag_2C_2O_4$), soluble in cold HNO_3.

$CaCl_2$ gives a white Oxalate of Lime (CaC_2O_4), insoluble in Acetic Acid ($HC_2H_3O_2$).

A dry oxalate with H_2SO_4 evolves Carbonic Oxide (CO) and CO_2.

PHOSPHATES.

The alkaline orthophosphates are soluble.

$BaCl_2$ gives a white Orthophosphate of Barium ($BaHPO_4$), soluble in HNO_3.

$AgNO_3$ gives a yellow tribasic Phosphate of Silver (Ag_3PO_4), soluble in HNO_3 and NH_3.

Sulphate of Magnesia ($MgSO_4$) with NH_4Cl and NH_3 gives a white crystalline Ammonio-Magnesian Phosphate ($NH_4MgPO_4, 6H_2O$).

For Pyrophosphates and Metaphosphates, see Part I., pages 52, 53.

SULPHATES.

All soluble except the Sulphates of Barium ($BaSO_4$), Strontium ($SrSO_4$), and Lead ($PbSO_4$). Sulphate of Lime ($CaSO_4$) is sparingly soluble.

$BaCl_2$ or Nitrate of Barium ($Ba2NO_3$) gives a white precipitate of Sulphate of Barium ($BaSO_4$), insoluble in all alkalies and acids, except boiling Sulphuric Acid.

Acetate of Lead ($Pb2C_2H_3O_2$) gives a white precipitate of Sulphate of Lead ($PbSO_4$).

By fusion with Na_2CO_3 on charcoal the Sulphide is formed.

SULPHIDES.

The alkaline Sulphides are soluble, and smell of Sulphuretted Hydrogen (H_2S).

With HCl, H_2S is evolved ; known by its odour of rotten eggs, and by blackening lead paper.

SULPHITES.

By heat HCl evolves SO_2, with odour of burning sulphur.

$AgNO_3$ gives a white Sulphite of Silver (Ag_2SO_3), reduced by heat to H_2SO_4 and Metallic Silver (Ag).

TARTRATES.

Fuse and carbonise, giving odour of burnt sugar. Chief salt, the Acid Tartrate of Potash ($KHC_4H_4O_6$). HCl precipitates the neutral Tartrate of Potash ($K_2C_4H_4O_6$) from a solution of the acid tartrate.

$AgNO_3$ gives white Tartrate of Silver ($Ag_2C_4H_4O_6$).

$CaCl_2$ gives white Tartrate of Lime ($CaC_4H_4O_6$).

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Cuprum.
Hydrargyrum.
Argentum.

Aurum.
Platinum.

MOLECULAR WEIGHT.
SPECIFIC GRAVITY OF A GAS.
FORMULÆ OF THE ELEMENTS.
ATOMICITY OR QUANTIVALENCE.
VARIATION OF QUANTIVALENCE.
BASYLOUS AND ACIDULOUS RADICALS.
ACIDS.
LATENT AND SPECIFIC HEAT.
THE AIR PUMP.
ELECTRICITY.
ELECTRICAL MACHINES.
ELECTRIC CURRENT. ELECTRIC BATTERIES.
RULES AND EXAMPLES FOR THE DETERMINATION OF THE CHEMICAL FORMULÆ AND PERCENTAGE COMPOSITION OF CHEMICAL SUBSTANCES.
TABLES OF ANALYSIS FOR THE COMMONER METALS AND ACIDS.

AIDS
TO
MATERIA MEDICA
AND
THERAPEUTICS.

SPECIALLY DESIGNED FOR
STUDENTS PREPARING FOR EXAMINATIONS.

PART I.
THE NON-METALLIC AND METALLIC ELEMENTS,
ALCOHOLIC & ETHEREAL PREPARATIONS, ETC.

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PREFACE.

The present volume is intended as a companion to my "Aids to Chemistry." The subjects have been arranged in the same order as in that work, and the modes of preparation of many of the substances having there been made a special feature, they have been omitted from this volume in some instances.

The doses given in the "British Pharmacopœia" have been followed closely, and the exact wording adopted in that work is frequently employed.

In preparing this, the Second Edition, the whole work has been very carefully revised, and a few pages of addenda have been supplied in order that no officinal substance shall be absent which was inadvertently omitted in the previous edition; it has also been considered advisable to introduce a table of officinal substances with their preparations at the commencement of the work, so that Part I. may resemble as much as possible Part II., which treats of the vegetable and animal substances.

For a more comprehensive knowledge of this extensive subject, I would draw attention to the works of the following authors, viz.: Drs. Pereira, Garrod, Milne, Attwood, Farquharson and Ringer.

In conclusion, I can only hope that the contents of the following pages may be useful to the student as an introduction to the study and in acquiring some elementary knowledge of Materia Medica and Therapeutics.

C. E. A. S.

8, Torrington Square, W.C.
January, 1881.

THE NON-METALLIC AND METALLIC ELEMENTS.

Oxygen. | Hydrogen. | Nitrogen. | Carbon.
Chlorine. | Bromine. | Iodine.
Sulphur. | Phosphorus. | Arsenicum. | Boron.
Potassium. | Sodium. | Lithium. | Ammonium.
Calcium. | Barium.
Aluminium.
Magnesium. | Zincum. | Cadmium.
Manganesium. | Ferrum.
Antimonium. | Bismuthum. | Plumbum.
Cuprum. | Hydrargyrum. | Argentum.
Aurum. | Cerium.

ALCOHOLIC AND ETHEREAL PREPARATIONS, ETC.

Alcohol. Cerevisiæ Fermentum. Æther. Æther Purus. Chloroformum. Alcohol Amylicum. Amyl Nitris. Chloral Hydras. Creasotum. Nitrous Oxide.

Acidum Carbolicum. Acidum Aceticum. Acidum Citricum Acidum Oxalicum. Acidum Tartaricum. Acidum Benzoicum. Acidum Tannicum. Acidum Gallicum. Acetum.

TABLE OF OFFICINAL SUBSTANCES WITH THEIR PREPARATIONS.

ACETUM.

Emplastrum Cerati Saponis.

ACIDUM ACETICUM.

Preparations containing free Acetic Acid.

Acetum	4·6 per cent. anhydrous acetic acid.
,, *Cantharidis.*	
,, *Scillæ.*	
Acidum Aceticum Glaciale	84 per cent. anhydrous acid.
,, *Aceticum*	28 per cent. ditto.
,, ,, *Dilutum*	3·6 per cent. ditto.
Extractum Colchici Aceticum.	
Linimentum Terebinthinæ Aceticum	1 volume acetic acid in 3.
Liquor Epispasticus	1 volume acetic acid in 5.
Mistura Creasoti.	
Oxymel.	
,, *Scillæ.*	
Syrupus Scillæ.	

Officinal Acetates.

Ammoniæ Acetatis, Liquor.
Ferri Acetatis, Tinctura.
Morphiæ Acetas.
,, *Acetatis, Liquor.*
Plumbi, Acetas.
,, *Subacetatis, Liquor.*
Plumbi Subacetatis Dilutus, Liquor.
Potassæ Acetas.
Sodæ Acetas.
Zinci Acetas.

ACIDUM ACETICUM GLACIALE.

Acetum Cantharidis.
Mistura Creasoti.

ACIDUM ARSENIOSUM.

Preparations in which Arsenious Anhydride is used.

Liquor Arsenicalis	4 grains in 1 fluid ounce.
,, *Arsenici Hydrochloricus*	4 grains in 1 fluid ounce.

Preparations of Arsenic Acid.

Ferri Arsenias.
Sodæ Arsenias.
,, *Arseniatis, Liquor.*

ACIDUM BENZOICUM.
Ammoniæ Benzoas.
Tinctura Camphoræ Composita ... 2 grains in 1 fluid ounce.
,, *Opii Ammoniata* ... 9 grains in 1 fluid ounce.

ACIDUM CARBOLICUM.
Glycerinum Acidi Carbolici.
Suppositoria Acidi Carbolici cum Sapone.

ACIDUM CITRICUM.

Preparations containing free Citric Acid.

Succus Limonis.
Syrupus Limonis.
Vinum Quiniæ.

Officinal Citrates.

Ammoniæ Citratis, Liquor.
Bismuthi et Ammoniæ Citratis, Liquor.
Ferri et Ammoniæ Citras.
Ferri et Quiniæ Citras.
Lithiæ Citras.
Potassæ Citras.
Sodæ Citro-Tartras Effervescens

ACIDUM GALLICUM.
Glycerinum Acidi Gallici ... ... 1 part in 6 by weight.

ACIDUM HYDROCHLORICUM.

Preparations containing free Hydrochloric Acid.

Acidum Hydrochloricum Dilutum.
,, *Nitro-Hydrochloricum Dilutum.*
Liquor Antimonii Chloridi.
,, *Arsenici Hydrochloricus.*
,, *Morphiæ Hydrochloratis.*

Officinal Chlorides.

Ammonii Chloridum.
Antimonii Chloridi, Liquor.
Arsenici Hydrochloricus, Liquor.
Calcii Chloridum.
Ferri Perchloridi, Liquor.
,, ,, *, Liquor Fortior.*
Hydrargyri Perchloridum.
Hydrargyri Perchloridi Liquor,
,, *Subchloridum.*
Morphiæ Hydrochloras.
,, *Hydrochloratis, Liquor.*
Sodii Chloridum.
Tinctura Ferri Perchloridi.
Zinci Chloridum.
,, *Chloridi, Liquor.*

Acidum Hydrochloricum Dilutum.
Liquor Morphiæ Hydrochloratis.
,, *Strychniæ.*
Acidum Hydrocyanicum Dilutum.
Vapor Acidi Hydrocyanici.
Acidum Nitricum.

Preparations containing free Nitric Acid.

Acidum Nitricum Dilutum.
,, *Nitro-Hydrochloricum Dilutum.*
Liquor Ferri Pernitratis.
,, *Hydrargyri Nitratis Acidus.*
Unguentum Hydrargyri Nitratis.

Officinal Nitrates.

Argenti Nitras.
Bismuthi Subnitras.
Ferri Pernitratis, Liquor.
Hydrargyri Nitratis Acidus, Liquor.
Plumbi Nitras.
Potassæ Nitras.
Sodæ Nitras.

Acidum Oxalicum.
Acidum Phosphoricum Dilutum.

Preparation containing free Phosphoric Acid.

Syrupus Ferri Phosphatis.

Officinal Phosphates.

Ammoniæ Phosphas.
Calcis Phosphas.
Ferri Phosphas.
Os Ustum.
Sodæ Phosphas.

Acidum Sulphuricum.

Preparations containing free Sulphuric Acid.

Acidum Sulphuricum Aromaticum.
,, *Sulphuricum Dilutum.*
Infusum Rosæ Acidum.

Officinal Sulphates.

Alumen.
,, *Exsiccatum.*
Atropiæ Sulphas.
Beberiæ Sulphas.
Cupri Sulphas.
Ferri Persulphatis, Liquor.
Ferri Sulphas.
Ferri Sulphas Exsiccata.
,, ,, *Granulata.*
Hydrargyri Sulphas.
Magnesiæ Sulphas.
Potassæ Sulphas.
Quiniæ Sulphas.
Sodæ Sulphas.
Zinci Sulphas.

ACIDUM SULPHURICUM DILUTUM.
Infusum Rosæ Acidum ... 1 fluid drachm in 10 fluid ounces.
ACIDUM SULPHUROSUM.
ACIDUM TANNICUM.
Glycerinum Acidi Tannici ... 1 part in 6 by weight.
Suppositoria Acidi Tannici ... ... 3 grains in each.
Suppositoria Acidi Tannici cum Sapone 1 grain in each.
Trochisci Acidi Tannici ... ... ½ grain in each lozenge.
ACIDUM TARTARICUM.

Officinal Tartrates.

Antimonium Tartaratum.
Ferrum Tartaratum.
Potassæ Tartras.
Potassæ Tartras Acida.
Sodæ Citro-Tartras Effervescens.
Soda Tartarata.

ÆTHER.
Æther Purus.
Collodion ... ... 6 volumes in 8 nearly.
,, *Flexile* ... ... 6 volumes in 8 ,,
Liquor Epispasticus ... ... 4 volumes in 5 ,,
Spiritus Ætheris ... ... 1 volume in 3 ,,
ÆTHER ACETICUS.
ÆTHER PURUS.
Spiritus Ætheris Nitrosi.
ALCOHOL.
Spiritus Rectificatus.
,, *Tenuior.*
,, *Vini Gallici.*
Vinum Aurantii.
,, *Xericum.*
ALCOHOL AMYLICUM ; used in preparing
Sodæ Valerianas.
ALUMEN.
Alumen Exsiccatum.
AMMONIÆ BENZOAS.
AMMONIÆ CARBONAS.
Liquor Ammoniæ Acetatis.
Spiritus Ammoniæ Aromaticus.
AMMONIÆ LIQUOR.
Ferri et Ammoniæ Citras.
,, *Quiniæ Citras.*
Hydrargyrum Ammoniatum.
Linimentum Ammoniæ.

Solution of Ammonio-Sulphate of Copper
,, ,, ,, *of Magnesia* } Test Solutions.
,, ,, *Ammonio-Nitrate of Silver*
Tinctura Quiniæ Ammoniata.

AMMONIÆ LIQUOR FORTIOR.
Ammoniæ Phosphas.
Linimentum Camphoræ Compositum.
Liquor Ammoniæ.
,, ,, *Citratis.*
Spiritus Ammoniæ Aromaticus.
,, ,, *Fœtidus.*
Tinctura Opii Ammoniata.

AMMONIÆ NITRAS.
AMMONIÆ OXALAS.
AMMONIÆ PHOSPHAS.
AMMONII BROMIDUM.
AMMONII CHLORIDUM.
Liquor Hydrargyri Perchloridi, ½ grain in 1 fluid ounce.
Liquor Ammoniæ Fortior.

AMYL NITRIS.
ANTIMONII OXIDUM.

Preparations in which Oxide of Antimony is used.

Antimonium Tartaratum.
Pulvis Antimonialis ... ... 1 part in 3.

Preparations containing Antimony.

Antimonii Oxidum.
Antimonium Nigrum.
,, *Sulphuratum.*
,, *Tartaratum.*
Liquor Antimonii Chloridi.
Pilula Hydrargyri Subchloridi Composita.
Pulvis Antimonialis.
Unguentum Antimonii Tartarati.
Vinum Antimoniale.

ANTIMONIUM NIGRUM.

Preparations in which Black Antimony is used.

Antimonium Sulphuratum.
Liquor Antimonii Chloridi.

ANTIMONIUM SULPHURATUM.
Pilula Hydrargyri Subchloridi Composita ... 1 part in 5.

Antimonium Tartaratum.
Unguentum Antimonii Tartarati ... ... 1 part in 5.
Vinum Antimoniale ... ... 2 grains in 1 fluid ounce.
Argenti Nitras.
Argenti Oxidum.
Argentum Purificatum.
Bismuthi Carbonas.
Bismuthi Oxidum.
Bismuthi Subnitras.
Trochisci Bismuthi ... ... 2 grains in each lozenge.
Bismuthum.
Bismuthum Purificatum.
Liquor Bismuthi et Ammoniæ Citratis.
Borax.
Glycerinum Boracis ... ... 1 part in 6 by weight.
Mel Boracis ... ... 56 grains in 1 ounce.
Bromum.
Ammonii Bromidum. | *Potassii Bromidum.*
Cadmii Iodidum.
Unguentum Cadmii Iodidi. ... ... 1 part in 8.
Calcii Chloridum.
Calcis Carbonas Præcipitata.
Trochisci Bismuthi ... 4 grains in each lozenge, nearly.
Calcis Hydras.
Liquor Calcis. | *Liquor Calcis Saccharatus.*
Calcis Hypophosphis.
Calcis Phosphas.
Pulvis Antimonialis. ... ... 2 parts in 3.
Calx.
Calcis Hydras.
Calx Chlorata.
Liquor Calcis Chloratæ ... ... 2 ounces to 1 pint.
Vapor Chlori; also used in preparing chloroform.
Carbo Animalis.
Carbo Animalis Purificatus.
Carbo Ligni.
Cataplasma Carbonis.
Cerii Oxalas.
Chloral Hydras.
Syrupus Chloral ... ... 10 grains in 1 fluid drachm.
Chloroformum.
Aqua Chloroformi. ... ... 1 part in 200.
Linimentum Chloroformi ... ... 1 volume in 2.
Spiritus Chloroformi ... ... 1 volume in 20.
Tinctura Chloroformi Composita ... 1 volume in 10.

CHLORUM.	
Liquor Chlori.	
Vapor Chlori.	
CREASOTUM.	
Mistura Creasoti ...	... 1 minim in 1 fluid ounce.
Unguentum Creasoti	... ... 1 part in 9.
Vapor Creasoti.	
CUPRUM.	
Cupri Sulphas.	
Spiritus Ætheris Nitrosi.	
FERRI ARSENIAS.	
FERRI CARBONAS SACCHARATA.	
Pilula Ferri Carbonatis ...	... ... 1 part in 1¼
FERRI ET AMMONIÆ CITRAS.	
Vinum Ferri Citratis	... 8 grains in 1 fluid ounce.
FERRI ET QUINIÆ CITRAS.	
FERRI IODIDUM.	
Pilula Ferri Iodidi ...	... ... 1 part in 3·6.
Syrupus Ferri Iodidi	... 4·3 grains in 1 fluid drachm.
FERRI OXIDUM MAGNETICUM.	
FERRI PEROXIDUM HUMIDUM.	
FERRI PEROXIDUM HYDRATUM.	
Emplastrum Ferri	... ... 1 part in 11.
FERRI PHOSPHAS.	
Syrupus Ferri Phosphatis	... 1 grain in 1 fluid drachm.
FERRI SULPHAS.	
Ferri Sulphas Exsiccata.	
Pilula Aloes et Ferri	... ... 1 part in 7.
FERRI SULPHAS EXSICCATA.	
FERRI SULPHAS GRANULATA.	
FERRUM.	

Preparations of Iron.

Emplastrum Ferri.
Ferri Arsenias.
  ,, *Carbonas Saccharata.*
  ,, *et Ammoniæ Citras.*
  ,, *et Quiniæ Citras.*
  ,, *Iodidum.*
  ,, *Oxidum Magneticum*
  ,, *Peroxidum Humidum.*
Ferri Peroxidum Hydratum.
  ,, *Phosphas.*
  ,, *Sulphas.*
  ,, *Sulphas Exsiccata.*
  ,, *Sulphas Granulata.*
Ferrum Redactum.
  ,, *Tartaratum.*
Liquor Ferri Perchloridi.
  ,, *Ferri Perchloridi Fortior.*

Liquor Ferri Pernitratis.
,, ,, Persulphatis.
Mistura Ferri Aromatica.
,, ,, Composita.
Pilula Ferri Carbonatis.
,, ,, Iodidi.
Syrupus Ferri Iodidi.
,, ,, Phosphatis.
Tinctura Ferri Acetatis.
,, ,, Perchloridi.
Trochisci Ferri Redacti.
Vinum Ferri.
Vinum Ferri Citratis.

FERRUM REDACTUM.
FERRUM TARTARATUM.
HYDRARGYRI IODIDUM RUBRUM.
Unguentum Hydrargyri Iodidi Rubri ... 1 part in 28.
HYDRARGYRI IODIDUM VIRIDE.
HYDRARGYRI OXIDUM FLAVUM.
HYDRARGYRI OXIDUM RUBRUM.
Unguentum Hydrargyri Oxidi Rubri ... 1 part in 8.
HYDRARGYRI PERCHLORIDUM.
Hydrargyrum Ammoniatum.
Liquor Hydrargyri Perchloridi... ½ grain in 1 fluid ounce.
Lotio Hydrargyri Flava ... 18 grains to 10 fluid ounces.
HYDRARGYRI SUBCHLORIDUM.
Lotio Hydrargyri Nigra ... 3 grains to 1 fluid ounce.
Pilula Hydrargyri Subchloridi Composita ... 1 part in 5.
Unguentum Hydrargyri Subchloridi, 1 part in 6½ nearly.
HYDRARGYRI SULPHAS.
Hydrargyri Perchloridum. | *Hydrargyri Subchloridum.*
HYDRARGYRUM.

Preparations containing Mercury, chiefly uncombined.

Hydrargyrum cum Creta	1 part in 3.
Emplastrum Ammoniaci cum Hydrargyro	1 ,, in 5.
,, Hydrargyri	1 ,, in 3.
Linimentum Hydrargyri	1 ,, in 6.
Pilula Hydrargyri	1 ,, in 3.
Suppositoria Hydrargyri	1 ,, in 6.
Unguentum Hydrargyri	1 ,, in 2.
,, ,, Composita ...	1 ,, in 4½.

Preparations containing combined Mercury.

Hydrargyri Iodidum Rubrum.
,, ,, Viride.
,, Oxidum Rubrum.
,, Perchloridum.
,, Subchloridum.
,, Sulphas.

Hydrargyrum Ammoniatum.
Liquor Hydrargyri Nitratis Acidus.
„ „ *Perchloridi.*
Lotio Hydrargyri Flava.
„ „ *Nigra.*
Pilula Hydrargyri Subchloridi Composita.
Unguentum Hydrargyri Ammoniati.
„ „ *Iodidi Rubri.*
„ „ *Nitratis.*
„ „ *Oxidi Rubri.*

HYDRARGYRUM AMMONIATUM.
Unguentum Hydrargyri Ammoniati ... ... 1 part in 8.

HYDRARGYRUM CUM CRETA.

IODUM.

Preparations of Iodine.

Cadmii Iodidum.
Ferri Iodidum.
Hydrargyri Iodidum Rubrum.
Hydrargyri Iodidum Viride.
Linimentum Iodi.
„ *Potassii Iodidi cum Sapone.*
Liquor Iodi.
Pilula Ferri Iodidi.
Potassii Iodidum.
Sulphuris Iodidum.
Syrupus Ferri Iodidi.
Tinctura Iodi.
Unguentum Cadmii Iodidi.
„ *Iodi.*
„ *Plumbi Iodidi.*
„ *Sulphuris Iodidi.*
Vapor Iodi.

LITHIÆ CARBONAS.
Liquor Lithiæ Effervescens.
Lithiæ Citras.

MAGNESIA.

Preparations of Magnesia and its Compounds.

Enema Magnesiæ Sulphatis ... 1 ounce Sulphate in 16 fluid ounces.
Liquor Magnesiæ Carbonatis ... 13 grains Carbonate in 1 fluid ounce.
Magnesia ; Magnesia Levis.
Magnesiæ Carbonas ; Magnesiæ Carbonas Levis.
„ *Sulphas.*
Mistura Sennæ Composita, 1 ounce Sulphate in 5 fluid ounces.
Pulvis Rhei Compositus ... ... 6 parts in 9.
Trochisci Bismuthi, 2½ grains Carbonate in each lozenge.

MAGNESIA LEVIS.
Pulvis Rhei Compositus. ... ... 6 parts in 9.

MAGNESIÆ CARBONAS.
Liquor Magnesiæ Carbonatis, 13 grains in 1 fluid ounce.
Liquor Magnesiæ Citratis.
Trochisci Bismuthi ... 2½ grains in each lozenge nearly.
MAGNESIÆ CARBONAS LEVIS.
MAGNESIÆ SULPHAS.
Enema Magnesiæ Sulphatis ... 1 ounce in 16 fluid ounces.
Mistura Sennæ Composita ... 1 ounce in 5 fluid ounces
MANGANESII OXIDUM NIGRUM.
MARMOR ALBUM.
PHOSPHORUS.
Acidum Phosphoricum Dilutum.
Oleum Phosphoratum.
Pilula Phosphori ... ... 2 grains in 3 drachms.
PLUMBI ACETAS; used in the preparation of
Liquor Plumbi Subacetatis ... ... 5 ounces in 1 pint.
Pilula Plumbi cum Opio ... ... 3 parts in 4.
Suppositoria Plumbi Composita ... 3 grains in each or 1 part in 5.
Unguentum Plumbi Acetatis ... ... 1 part in 38.
PLUMBI CARBONAS.
Unguentum Plumbi Carbonatis ... ... 1 part in 8.
PLUMBI IODIDUM.
Emplastrum Plumbi Iodidi ... ... 1 part in 9.
Unguentum Plumbi Iodidi ... ... 1 part in 8.
PLUMBI NITRAS.
Plumbi Iodidum.
PLUMBI OXIDUM; used in the preparation of
Emplastrum Cerati Saponis
,, *Plumbi.*
Liquor Plumbi Subacetatis.
Plumbi Acetas.

Preparations containing Lead.

Emplastrum Belladonnæ.
,, *Calefaciens.*
,, *Cerati Saponis.*
Emplastrum Ferri.
,, *Galbani.*
,, *Hydrargyri.*
,, *Opii.*
,, *Plumbi.*
,, *Resinæ.*
,, *Saponis.*
Liquor Plumbi Subacetatis.
Liquor Plumbi Subacetatis Dilutus.
Plumbi Acetas.
,, *Carbonas.*
,, *Iodidum.*
,, *Nitras.*
Suppositoria Plumbi Composita.
Unguentum Plumbi Acetatis.
,, ,, *Carbonatis.*
,, ,, *Iodidi.*
,, ,, *Subacetatis Compositum.*

POTASSA CAUSTICA.

Liquor Potassæ ... ... 27 grains in 1 fluid ounce
Potassæ Permanganas.

Preparations containing Potassium and its Compounds.

Antimonium Tartaratum.
Confectio Sulphuris.
Decoctum Aloes Compositum.
Enema Aloes.
Ferrum Tartaratum.
Linimentum Iodi.
  ,, *Potassii Iodidi cum Sapone.*
Linimentum Terebinthinæ.
Liquor Arsenicalis.
  ,, *Iodi.*
  ,, *Potassæ.*
  ,, ,, *Effervescens.*
Liquor Potassæ Permanganatis.
Mistura Ferri Composita.
Pilula Colocynthidis Composita.
Pilula Colocynthidis et Hyoscyami.
Pulvis Ipecacuanhæ Compositus.
Pulvis Jalapæ Compositus.
Potassa Caustica.
  ,, *Sulphurata.*
Potassæ Acetas.
  ,, *Bicarbonas.*
  ,, *Bichromas.*
  ,, *Carbonas.*
  ,, *Chloras.*
  ,, *Citras.*
  ,, *Nitras.*
  ,, *Permanganas.*
  ,, *Prussias Flava.*
  ,, *Sulphas.*
  ,, *Tartras.*
  ,, *Tartras Acida.*
Potassii Bromidum.
  ,, *Iodidum.*
Sapo Mollis.
Soda Tartarata.
Trochisci Potassæ Chloratis.
Unguentum Antimonii Tartarati.
Unguentum Iodi.
  ,, *Potassæ Sulphuratæ.*
Unguentum Potassii Iodidi.
Vinum Antimoniale.

POTASSA SULPHURATA.

Unguentum Potassæ Sulphuratæ.

POTASSÆ ACETAS.

Tinctura Ferri Acetatis.

POTASSÆ BICARBONAS.

Liquor Potassæ Effervescens... ... 30 grains to 1 pint.

POTASSÆ BICHROMAS.

Sodæ Valerianas.

POTASSÆ CARBONAS; used in preparing:—

Atropia.
Decoctum Aloes Compositum.
Enema Aloes.
Liquor Arsenicalis.
  ,, *Potassæ.*

Mistura Ferri Composita.
Potassa Sulphurata.
Potassæ Acetas.
Potassæ Bicarbonas.
,, *Chloras.*
,, *Citras.*
Potassæ Tartras.

Potassæ Chloras.
Potassæ Permanganas.
Trochisci Potassæ Chloratis ... 5 grains in each lozenge.

Potassæ Citras.

Potassæ Nitras.

Potassæ Permanganas.
Liquor Potassæ Permanganatis, 4 grains in 1 fluid ounce.

Potassæ Prussias Flava.
Acidum Hydrocyanicum Dilutum.

Potassæ Sulphas.
Pilula Colocynthidis Composita ... 1 part in 24, nearly.
,, ,, *et Hyoscyami* ... 1 ,, in 36, ,,
,, *Ipecacuanhæ cum Scilla* ... 1 ,, in 3, ,,
Pulvis Ipecacuanhæ Compositus ... 4 parts in 5.

Potassæ Tartras.

Potassæ Tartras Acida.
Acidum Tartaricum.
Antimonium Tartaratum.
Confectio Sulphuris.
Ferrum Tartaratum.
Potassæ Tartras.
Pulvis Jalapæ Compositus.
Soda Tartarata.

Potassii Bromidum.

Potassii Iodidum.
Linimentum Iodi ... 22 grains in 1 fluid ounce, nearly.
,, *Potassii Iodidi cum Sapone* 54½ grains in 1 fluid ounce, nearly.
Liquor Iodi ... ... 30 grains in 1 fluid ounce.
Tinctura Iodi ... ... 5½ grains in 1 fluid ounce, nearly.
Unguentum Iodi ... 16 grains in 1 fluid ounce, nearly.
,, *Potassii Iodidi* ... ... 1 part in 8¾, nearly.

Soda Caustica.
Liquor Sodæ ... ... 18·8 grains in 1 fluid ounce.

Preparations containing Sodium and its Compounds.

Borax.
Cataplasma Sodæ Chloratæ.
Emplastrum Belladonnæ.
,, *Calefaciens.*
,, *Cerati Saponis.*
Emplastrum Opii.
,, *Resinæ.*
,, *Saponis.*
Extractum Colocynthidis Compositum.
Fel Bovinum Purificatum.
Linimentum Opii.

Linimentum Potassii Iodidi cum Sapone.
Linimentum Saponis.
Liquor Sodæ.
,, ,, *Arseniatis.*
,, ,, *Chloratæ.*
,, ,, *Effervescens.*
Pilula Aloes Barbadensis.
,, ,, *et Assafœtidæ*
,, ,, *Socotrinæ.*
,, *Cambogiæ Composita.*
Pilula Rhei Composita.
,, *Saponis Composita.*
,, *Scillæ Composita.*
Sapo Animalis.
Sapo Durus.
Soda Caustica.
,, *Tartarata.*
Sodæ Acetas.
,, *Arsenias.*
,, *Bicarbonas.*
,, *Carbonas.*
,, ,, *Exsiccata.*
,, *Citro-Tartras Effervescens.*
,, *Nitras.*
,, *Phosphas.*
,, *Sulphas.*
,, *Valerianas.*
Sodii Chloridum.
Trochisci Sodæ Bicarbonatis.

Sodæ Acetas.
Ferri Arsenias.
Ferri Phosphas.
Syrupus Ferri Phosphatis.

Sodæ Arsenias.

Liquor Sodæ Arseniatis ...	6·6 grains or 4 grains dried	in 1 fluid ounce.

Sodæ Bicarbonas.

Liquor Sodæ Effervescens	30 grains in 1 pint.
Sodæ Citro-Tartras Effervescens	17 parts in 31.
Trochisci Sodæ Bicarbonatis ...	5 grains in each lozenge.

Sodæ Carbonas.
Liquor Sodæ.
,, ,, *Chloratæ.*
Soda Tartarata.
Sodæ Arsenias.
,, *Bicarbonas.*
,, *Carbonas Exsiccata.*
Sodæ Phosphas.

Sodæ Hypophosphis.

Sodæ Nitras.
Sodæ Arsenias.

Sodæ Phosphas.
Ferri Phosphas.
Syrupus Ferri Phosphatis.

Sodæ Sulphas.

Sodæ Valerianas.
Zinci Valerianas.

Sodii Chloridum; used in Preparations of
Acidum Hydrochloricum.
Hydrargyri Perchloridum.
Hydrargyri Subchloridum.

Spiritus Ætheris.

Tinctura Lobeliæ Ætherea.

Spiritus Rectificatus.

Tinctures made with Rectified Spirit.

Tinctura Aconiti.
,, *Arnicæ.*
,, *Assafœtidæ.*
,, *Aurantii Recentis.*
,, *Benzoini Composita.*
,, *Cannabis Indicæ.*
,, *Capsici.*
,, *Castorei.*
,, *Cubebæ.*
,, *Ferri Perchloridi.*
,, *Ferri Acetatis.*

Tinctura Iodi.
,, *Kino.*
,, *Laricis.*
,, *Lavandulæ Composita.*
,, *Myrrhæ.*
,, *Nucis Vomicæ.*
,, *Opii Ammoniata.*
,, *Pyrethri.*
,, *Tolutana.*
,, *Veratri Viridis.*
,, *Zingiberis.*
,, ,, *Fortior.*

Spiritus Tenuior.

Tinctures made with Proof Spirit.

Tinctura Aloes.
,, *Aurantii.*
,, *Belladonnæ.*
,, *Buchu.*
,, *Calumbæ.*
,, *Camphoræ Composita.*
,, *Cantharidis.*
,, *Cardamomi Composita*
,, *Cascarillæ.*
,, *Catechu.*
,, *Chiratæ.*
,, *Cinchonæ Composita.*
,, *Cinchonæ Flavæ.*
,, *Cinnamomi.*
,, *Cocci.*
,, *Colchici Seminis.*
,, *Conii.*
,, *Croci.*
,, *Digitalis.*

Tinctura Ergotæ.
,, *Gallæ.*
,, *Gentianæ Composita.*
,, *Hyoscyami.*
,, *Jalapæ.*
,, *Krameriæ.*
,, *Limonis.*
,, *Lobeliæ.*
,, *Lupuli.*
,, *Opii.*
,, *Quassiæ.*
,, *Quiniæ Ammoniata.*
,, *Rhei.*
,, *Sabinæ.*
,, *Scillæ.*
,, *Senegæ.*
,, *Sennæ.*
,, *Serpentariæ.*
,, *Stramonii.*
,, *Sumbul.*
,, *Valerianæ.*

Sulphur Præcipitatum.

SULPHUR SUBLIMATUM.
Confectio Sulphuris ... ... 4 parts in 10, nearly.
Emplastrum Ammoniaci cum Hydrargyro.
,, *Hydrargyri.*
Sulphur Præcipitatum.
Sulphuris Iodidum.
Unguentum Sulphuris ... ... 1 part in 5.

SULPHURIS IODIDUM.
Unguentum Sulphuris Iodidi ... 30 grains to 1 ounce.

ZINCI ACETAS.

ZINCI CARBONAS; used in preparation of
Zinci Acetas.
,, *Chloridum.*
Zinci Oxidum.
,, *Sulphas.*

ZINCI CHLORIDUM; contained in
Liquor Zinci Chloridi ... 366 grains in 1 fluid ounce.

ZINCI OXIDUM.
Unguentum Zinci ... ... 1 part in 6½, nearly.

ZINCI SULPHAS; used in preparation of
Zinci Carbonas; Zinci Valerianas.

ZINCUM.

Preparations containing Zinc.
Liquor Zinci Chloridi.
Unguentum Zinci.
Zinci Acetas.
,, *Carbonas.*
Zinci Chloridum.
,, *Oxidum.*
,, *Sulphas.*
,, *Valerianas.*

ZINCUM GRANULATUM.

AIDS TO MATERIA MEDICA

AND

THERAPEUTICS.

OXYGEN. O = 16.

THIS gas is obtained by heating the red oxide of mercury, and by various other methods.

Therapeutics.—A solution of oxygen in water has been used as a slight stimulant and excitant. Although great advantages were anticipated from its introduction as a remedial agent, these anticipations have not been confirmed by clinical experience. Inhalation of the gas has been tried in certain conditions of the system associated with deficient aëration of the blood, but this measure has not been attended with much success.

HYDROGEN. H = 1.

This gas is obtained by the action of sulphuric acid upon certain metals, as zinc, iron, etc.

Therapeutics.—Is of little value as a remedial agent; when mixed with a certain quantity of oxygen and breathed, a peculiar shrill and sharp tone is imparted to the voice. A *flame of hydrogen* has been used as a cautery to form issues, but it is not otherwise employed therapeutically.

WATER. H_2O = 18.

This substance should be free from taste, odour, or visible impurity.

The water in common use is derived from springs, rivers, and rain-fall. Rain-water, if collected before it touches the earth, is very pure and soft; but should it fall upon limestone or chalky districts it becomes impregnated with sulphate and carbonate of lime, and occasionally with the salts of magnesia.

The purity of spring and river waters entirely depends upon the soil out of which they rise, or through which they pass. Spring-water is often rendered "*hard*" from its containing compounds of lime.

Purification.—The chief methods for purifying common water are the following:

(a) *Subsidence.*—The water is left at complete rest, so that the suspended impurities may gradually subside.

(b) *Ebullition.*—By this means vegetable or animal vitality is destroyed, air and carbonic anhydride are expelled, and carbonate of lime is precipitated.

(c) *Distillation.*—This is the most effectual method, when properly conducted; but distilled water frequently contains traces of organic matter.

(d) *Filtration.*—This process renders water clear and transparent. The substances used for the filtration of water are charcoal (both vegetable and animal; the latter is the more effective), perforated plates of metal, flannel, cloth, sponge, porous stone, and beds of sand. Paper is made use of only in operations on a small scale. There are two kinds of filtering-paper—the *coarse*, for the separation of the grosser particles; the *fine*, for removing finely-divided matter.

MINERAL WATERS.

These are divided into four classes:—(1) *Chalybeate or Ferruginous* waters. These contain iron in the form of carbonate and sulphate. Carbonate of iron occurs in the waters of Pyrmont, Spa, Schwalbach, Tunbridge Wells, and Harrogate. Sulphate of iron exists in the waters of Sand Rock, Isle of Wight, Brighton, etc. *Therapeutically*, these chalybeate waters are useful in conditions of anæmia and debility; they should be avoided by plethoric persons. (2) *Acidulous or Carbonated waters.* These contain much carbonic acid, giving slight acidity and causing sparkling. Their chief salts are carbonate of lime, carbonate of soda, and carbonate of magnesia, with excess of carbonic acid. The chief of these waters are those of Carlsbad, Seltzer, and Ilkestone, near Nottingham. *Therapeutically*, they are useful in atonic dyspepsia; they increase the secretion of the kidneys and skin, and are of value in gout, rheumatism, and some calculous affections. (3) *Saline waters.* These may be subdivided into (*a*) *Purging Saline waters*, as those of Cheltenham, Leamington, Purton, Seidlitz, Püllna, and Friedrichshall bitter waters. They chiefly contain sulphates of magnesia and soda. (*b*) *Calcareous waters*, as those of Buxton, Bath, and Bristol, principally containing carbonate and sulphate of lime. (*c*) *Salt waters*, as those of Wiesbaden, Baden-Baden, and Kreutznach, containing chiefly chlorides, the last, considerable quantities of iodine and bromine. (*d*) *Alkaline waters*, as of Vichy and Ems, notable for the large amount of alkaline carbonates contained. *Therapeutically*, these are useful in congestion of the portal system. They are powerfully stimulant and alterative, and (*d*) are indicated in an acid condition of the urine. (4) *Sulphuretted or Hepatic waters*, contain sulphuretted hydrogen in solution, and are known by their odour. These are found principally at Harrogate, Moffat, Cheltenham, Aix-la-Chapelle, Borcel, and Aix in Savoy. *Therapeutically*, they are stimulants, especially to the skin and uterine system, and are much used in skin diseases of a chronic character.

Therapeutics.—Water is used both hot and cold; as ice, and as aqueous vapour.

Cold drinks were given by the ancients in *ardent fever*, and in modern times have been thus used. The affusion of cold water has been found of benefit in epilepsy, hysteria, and fainting, and its internal administration will sometimes alleviate gastric pain, spasm, and hiccough. Large draughts of this fluid have caused the expulsion of intestinal worms.

Injections of cold water are thrown into the *rectum* to arrest hæmorrhage, expel worms, and relieve pain in hæmorrhoids; and into the *vagina* to arrest uterine hæmorrhage.

The *cold bath* is employed to obtain a nervous impression, *shock*, and subsequent glow, with the object of increasing the tone and vigour of the body. In pregnancy and in diseases of the heart it is a dangerous remedy, as also in persons disposed to apoplexy, and in those in whom it is succeeded for a long period by coldness of surface, blueness of lips, feeble pulse, and headache. The *temperature* of this bath ranges from 1°C to about 23·8°C (33°F to about 75°F); when below 10°C (50°F) it is deemed very cold.

Perfusio, or cold affusion, has been recommended in some affections of the head. This term implies the pouring of cold water from a greater or lesser height upon the head of the patient.

The *temperature* should be between 0°C and 13·3°C (32°F and 60°F). This form of application is advantageous in syncope; in prussic acid, alcohol, or opium poisoning; in asphyxia from inhalation of carbonic acid, sulphuretted hydrogen, etc., and in the *convulsive fits* of children.

The *Impluvium*, or shower-bath, is similar to, though milder than, affusion. In insanity, it is of the greatest benefit in allaying mental excitement. Cold or tepid *washes* may be used in febrile diseases with the best effect, and what is called *water-dressing* may be said to be an improved form of poultice. This is used in the form of two or three layers of lint dipped in water and applied to inflamed parts, wounds or ulcers, the whole being covered with oiled silk. *Ice* is used externally to check hæmorrhage, especially in operations for piles and fistula; it has also been found of service in restraining sanguineous discharges from the uterus. The *ice-cap* (made by placing pounded ice in a bladder) is applied to the head in inflammation of the brain; in acute hydrocephalus, apoplexy, and mania with much mental excitement. Friction with ice and snow has been applied to *frost-bitten* parts. Internally we make use of ice to relieve cardialgia and vomiting, and to check gastric, nasal, bronchial, or uterine hæmorrhages; the constriction of the vessels being effected through the sympathetic relations of the stomach with other organs.

Tepid, Warm, or Hot Water Baths.—The temperature of the *tepid bath* ranges from 29·4°C to 33·3°C (85°F to 92°F); that of the *warm bath* from 33·3°C to 36·6°C (92°F to 98°F). The latter is of service in the anasarca of scarlatina, and of chronic renal disease, and has been employed as a relaxant for the reduction of dislocations, and in herniæ. It is of the greatest advantage in promoting the passage of urinary or biliary calculi. The temperature of the *hot bath* is from 36·6°C to 44·4°C (98°F to 112°F). This is principally employed in paralysis, rheumatism, and some other chronic diseases. *Warm fomentations* are frequently made use of to allay inflammation, and to relieve pain, tension, and spasm. *Internally*, tepid or warm water is taken into the stomach to promote vomiting; to induce diaphoresis in rheumatism, gout, etc. It is injected into *the rectum* to excite evacuation; into *the vagina* to allay uterine pain and irritation, and to promote the lochia; into the *bladder* to relieve vesical irritation, and for distension of the organ previous to lithotrity.

The *vapour bath* is powerfully stimulant and sudorific. It is very useful for the production of profuse sweating, and is employed in chronic rheumatism, gout, anasarca from Bright's disease, and in chronic skin diseases. It is also of service in uterine affections, as chlorosis and amenorrhœa.

The inhalation of *warm aqueous vapour* is of great benefit in inflammation of the tonsils, in the sore-throat of scarlatina, and in laryngitis.

Officinal Preparation.—AQUA DESTILLATA. Ten gallons of water are distilled from a copper still, connected with a block-tin worm. The first half-gallon is rejected, and the next 8 gallons are preserved.

AQUÆ, *Waters*, are saturated aqueous solutions of essential oils, obtained by distilling fresh or dried vegetables, or their essential oils, with water.

INFUSA, *Infusions*, are aqueous solutions of certain constituents of vegetable substances, obtained *without* the aid of ebullition. The substance, sliced, bruised, or coarsely powdered, is digested with distilled water, either hot or cold. Cold water is used if the active principle be very volatile, and when it is desirable to avoid the solution of a substance soluble in hot water. In making the infusions of quassia or calumba, cold water is preferred, because this does not take up the starchy matter. Infusions are preferred to decoctions when the active principle is volatilized by a boiling heat, as in the case of orange-peel and buchu, or when ebullition produces some chemical change, as in the case of senna.

DECOCTA, *Decoctions*, are aqueous solutions of certain constituents of organic substances obtained *with* the aid of ebullition.

LIQUORES, *Solutions*, consist of substances dissolved in water.

MUCILAGINES, *Mucilages*, consist in the suspension in water of amylaceous or gummy substances.

MISTURÆ, *Mixtures*, are chiefly aqueous preparations having earthy salts or other substances suspended by sugar or gum. In the scammony mixture, the resin is suspended by *milk*.

SYRUPI, *Syrups*, are infusions of organic or inorganic bodies saturated with sugar.

NITROGEN. $N = 14$.

This gas is prepared by burning phosphorus in a jar of air, etc.

Therapeutically.—Nitrogen has rarely if ever been used in the free state.

AMMONIA. NH_3.

Ammoniacal gas is prepared from gas liquor, hydrochloric acid and slaked lime.

Therapeutics.—Strong liquor ammoniæ is used in the following modes :

(1) As *a stimulant and sudorific* in typhoid fever, and the exanthemata ; or *expectorant* in pneumonia, and in chronic bronchitis.

(2) As *a nervine stimulant and antispasmodic ;* in poisoning by digitalis, tobacco or hydrocyanic acid. The *vapour of ammonia* may be inhaled in syncope, or to ward off an attack of epilepsy.

(3) As *a remedy for the bites of poisonous animals.*

(4) As *an antacid* in dyspepsia, and in poisoning by the mineral acids.

(5) As *a local irritant ;* employed as a rubefacient, vesicant, and occasionally as a caustic.

Administration.—The dose of the strong solution of ammonia is from 3 to 10 minims, well diluted, but the weaker solution is in more general use, and is given in doses from 5 to 30 minims, properly diluted.

The chief compounds of ammonia *used in medicine* are the following :

(1) *Ammoniæ Liquor Fortior*, ammoniacal gas (NH_3) dissolved in H_2O and constituting 32·5 per cent. of the solution.

The ordinary liquor ammoniæ consists of ammoniacal gas (NH_3) dissolved in water in the following proportions, viz. : 1 pint of strong solution of ammonia to 2 pints of distilled water.

The preparations in which liquor ammoniæ fortior is used are : *Ammoniæ phosphas ; Linimentum camphoræ compositum ; Liquor ammoniæ ; Liquor ammoniæ citratis ; Spiritus ammoniæ aromaticus ; Spiritus ammoniæ fœtidus ; Tinctura opii ammoniata, and Linimentum ammoniæ.*

(2) *Ammoniæ Carbonas* ($(NH_4)_2CO_3$), carbonate of ammonia, prepared by submitting chloride of ammonium (NH_4Cl) and chalk ($CaCO_3$) to sublimation. Thus—

$$2NH_4Cl + CaCO_3 = CaCl_2 + (NH_4)_2CO_3.$$

This salt is used in doses of from 5 to 10 grains, as a stimulant and diaphoretic. In doses of 30 grains as an emetic. It is often employed for preparing *effervescing draughts*, of which the following is a formula :

20 grains of carbonate of ammonia require	6 fluid drachms of lemon juice, or
	23½ grains of crystallised citric acid, or
	25½ grains of crystallised tartaric acid.

The preparations in which ammoniæ carbonas is used are : *Liquor ammoniæ acetatis*, and *Spiritus ammoniæ aromaticus.*

(3) *Ammonii Chloridum* (NH_4Cl), chloride of ammonium,

A B C, Pons

is obtained from gas liquor, or by neutralising hydrochloric acid with ammonia and evaporating to dryness. It is sometimes used in this country, and in Germany is regarded as a powerful alterative, stimulant to the absorbents, and resolvent of indurations. It is said to be a sedative in neuralgia. The dose is 5 to 20 grains every two or three hours. A mixture of 5 parts of this salt with an equal quantity of nitrate of potash and 16 parts of water forms a *freezing mixture*, which has been used as an *ice-poultice* for hernial tumours.

The preparations in which ammonii chloridum is used are : *Liquor hydrargyri perchloridi* and *Liquor ammoniæ fortior.*

(4) *Ammoniæ Phosphas* ($(NH_4)_2HPO_4$), phosphate of ammonia, is made by adding a strong solution of ammonia (NH_4HO) to diluted phosphoric acid (H_3PO_4). Thus—

$$2NH_4HO + H_3PO_4 = 2H_2O + (NH_4)_2HPO_4.$$

This salt is said to be capable of dissolving urate of soda, and to be valuable in the treatment of urinary diseases in which there is a tendency to the uric acid calculus. It is given in doses of 5 to 20 grains.

(5) *Ammoniæ Benzoas* ($NH_4C_7H_5O_2$), benzoate of ammonia, is prepared by adding together a solution of ammonia (NH_4HO), benzoic acid ($HC_7H_5O_2$) and distilled water. Thus—

$$NH_4HO + H_2O + HC_7H_5O_2 = 2H_2O + NH_4C_7H_5O_2.$$

This drug is converted in the body into hippuric acid, and as such is found in the urine. It is employed in chronic inflammation of the bladder, and in an alkaline condition of the urine, or when there is a deposit of phosphates. The dose is 10 to 20 grains.

(6) *Ammoniæ Acetas* ($NH_4C_2H_3O_2$), acetate of ammonia, given in the form of liquor ammoniæ acetatis, is prepared by acting upon carbonate of ammonia ($(NH_4)_2CO_3$) by acetic acid ($HC_2H_3O_2$). Thus—

$$(NH_4)_2CO_3 + 2HC_2H_3O_2 = H_2O + CO_2 + 2NH_4C_2H_3O_2.$$

Water, carbonic acid, and acetate of ammonia are formed.

It increases the secretions, especially of the skin, and is largely used in febrile conditions as a diaphoretic and refrigerant. In large doses it is also stated to relieve dysmenorrhœa. The dose of the liquor is 2 fluid drachms to 6 fluid drachms freely diluted.

(7) *Ammonii Bromidum* (NH_4Br), bromide of ammonium, is obtained by the addition of a solution of ammonia (NH_4HO) to a solution of bromide of iron (Fe_2Br_6). Thus—

$$Fe_2Br_6 + 6NH_4HO = Fe_2O_3 + 3H_2O + 6NH_4Br.$$

Ferric oxide, water, and bromide of ammonium are formed. This salt has been given in the same cases for which bromide of potassium has been used. It possesses all the powers of bromine. The dose is 2 to 20 grains.

NITROUS OXIDE. N_2O.

Laughing Gas.

This gas is prepared by heating the nitrate of ammonia.

Therapeutics.—Is much employed as an anæsthetic, especially for minor operations, as teeth extraction, etc.

Respiration of this gas is not usually followed by depression, or other unpleasant symptom. It occasionally excites violent muscular action, and care must be taken that the gas is pure, especially that the ammonium nitrate be free from chloride ; the salt should not be heated too strongly, in case the nitrous oxide be rendered irritating from fumes of ammonium nitrate and the irrespirable products of decomposition. The gas is inhaled from a waterproof cloth bag, which should contain four or five litres, and is furnished with a wooden nozzle. It is safer than chloroform, but its action is not so prolonged.

NITRIC ACID. HNO_3.

This acid is prepared by the action of sulphuric acid upon nitrate of potash or nitrate of soda.

In medicine nitric acid is used as follows :

(1) *Acidum Nitricum* (*aqua fortis*).—This contains 70 per cent. by weight of nitric acid (HNO_3) corresponding to 60 per cent. of nitric anhydride (N_2O_5).

(2) *Acidum Nitricum Dilutum*, diluted nitric acid, contains of nitric acid 6 fluid ounces, of water 24 fluid ounces, or 1 part of HNO_3 in 5 of the diluted acid.

(3) *Acidum Nitro-Hydrochloricum Dilutum*, diluted nitro-hydrochloric acid. Nitric acid 3 fluid ounces, hydrochloric acid 4 fluid ounces, distilled water 25 fluid ounces.

Therapeutics.—*Externally*, the strong acid is applied to phagedenic sores, to warts, and to hæmorrhoids. Diluted, it has been used as an application to ulcers, and in cancrum oris. It has proved efficacious in dissolving *phosphatic calculi* when injected in a diluted state into the bladder.

Internally, the diluted acid is refrigerant and tonic. It is very useful in some forms of dyspepsia by giving tone to the stomach, and in liver affections it appears to have considerable influence. It is also given as an alterative in some cutaneous affections.

Diluted nitro-hydrochloric acid is similar in its action to solution of chlorine. It is used as a stomachic in dyspepsia, and also as a solvent of phosphatic deposits in the urine. For chronic hepatitis it has much repute; it is often used externally as a *foot-bath*.

Dose.—Of strong nitric acid, 1 minim to 3 minims freely diluted; of the diluted, 10 minims to 30 minims; of diluted nitro-hydrochloric acid, 5 minims to 20 minims well diluted. As a bath, 6 fluid ounces to the gallon of water (in a wooden vessel).

Adulterations.—Chiefly sulphuric and hydrochloric acids, which may be detected by the tests for these substances.

CARBON. C = 12.

Officinal Preparation.—CATAPLASMA CARBONIS, charcoal poultice; prepared from wood charcoal in powder, crumb of bread, linseed meal and boiling water.

Therapeutics.—Wood charcoal is employed internally as an antiseptic and corrector of acidity and flatus. Externally it is used as a dentifrice, and as a poultice for fœtid ulcers. Internally it is given, recently prepared, in doses from one teaspoonful to one tablespoonful. It is sometimes made into biscuits, and has occasionally been given in the form of lozenges; also called Carbo Ligni.

CARBO ANIMALIS, animal charcoal, or bone-black, is the powdered residue of sheep and ox-bones after exposure to a red heat in the absence of air.

CARBO ANIMALIS PURIFICATUS, is prepared by submitting bone-black to the action of hydrochloric acid for two days at a moderate heat, in order to remove the salts, and subsequently heating to redness. It is a black inodorous pulverulent substance, almost tasteless, possessing the power of absorbing odours and gases, and therefore much employed for the purification of water.

Therapeutics.—Used in a similar manner to the vegetable variety. It has been shown to have considerable antidotal power against vegetable poisons, as opium, nux vomica, aconite, and nearly all active organic poisons.

The *dose* as an antacid is a teaspoonful to a tablespoonful; as an antidote, half an ounce to two ounces or more.

CARBONIC ACID. H_2CO_3.

Carbonic anhydride (CO_2) + H_2O = Carbonic acid (H_2CO_3).

Therapeutics.—Carbonic acid is useful in checking vomiting and gastric irritation. It may be taken advantageously in that form of lithiasis which is attended by phosphatic deposits in the urine.

Administration.—It is best given as carbonic acid water, or in the form of effervescing draughts composed of citric acid and bicarbonate of potash.

HYDROCYANIC ACID. Prussic acid. HCN.

Pharmacopœial Preparation.—By the addition of diluted sulphuric acid to ferrocyanide of potassium.

The *Acidum Hydrocyanicum Dilutum* of the British Pharmacopœia consists of hydrocyanic acid dissolved in water and constituting 2 per cent. by weight of the solution.

Scheele's prussic acid contains 4 per cent. of anhydrous acid. The anhydrous acid is very volatile, and speedily decomposes into a carbonaceous mass. The diluted acid can be much longer preserved if a trace of a mineral acid be present.

Officinal Preparation.—VAPOR ACIDI HYDROCYANICI, inhalation of hydrocyanic acid. This consists of 10 to 15 min. of HCN to 1 fluid drachm of cold water, mixed in a suitable apparatus, the rising vapour being inhaled.

Therapeutics.—The anhydrous acid is an active poison, arresting the functions of the whole body, but not specially affecting any particular organ. If the dose be large, death is almost instantaneous. The poisonous effects are the same when the acid is applied to the mucous membranes, or when inhaled in vapour, as when it is received into the stomach. In *medicinal doses,* and much diluted, it is employed to relieve spasm and pain, and is given in gastrodynia, pyrosis, enterodynia, and vomiting. It is also useful in nervous cough, and is given in pertussis, asthma, etc.; chorea, epilepsy, neuralgia, hysteria and tetanus are reported to derive benefit from its exhibition. Externally it is applied to cutaneous affections accompanied by much itching, great care being taken that there is no abrasion of the skin. The *dose* of acidum hydrocyanicum dilutum is 2 minims to 8 minims.

In the form of a lotion 1 fluid drachm may be added to 10 ounces of water, etc. To this lotion *glycerine* is a very useful adjunct, since by it evaporation is retarded.

Upon distilling the leaves of the cherry laurel (Prunus Laurocerasus) with water, some volatile oil and *prussic acid* are yielded. This fact is due to the decomposition of the *Amygdaline* ($C_{20}H_{27}NO_{11}$) contained in the leaves. *Aqua Lauro-Cerasi* is considered by some to be an elegant method of administering prussic acid. The dose is 5 to 30 minims.

The bitter almond (Amygdala amara) also contains *amygdaline,* together with an albuminous principle termed *emulsine.* Upon moistening this almond a species of fermentation is set up, and *prussic acid* and *volatile oil of bitter almonds* or *hydride of Benzol* (C_7H_5O,H) together with *glucose* ($C_6H_{12}O_6$) and *formic acid* (CH_2O_2) are formed.

CHLORINE. Chlorum. $Cl = 35{\cdot}5$.

This gas is prepared by the action of hydrochloric acid upon the black oxide of manganese.

Officinal Preparations.—(1) Liquor Chlori, solution of chlorine (the gas dissolved in water). (Hydrochloric acid, black oxide of manganese, and distilled water.)

Dose, 10 to 20 minims properly diluted.

(2) Vapor Chlori, inhalation of chlorine (prepared from chlorinated lime and cold water); employed when local action upon the mouth, fauces and bronchial tubes is desired.

Therapeutics.—Chlorine is used as a fumigating, disinfectant, and antiseptic agent, and is a valuable antidote in poisoning by sulphuretted hydrogen, sulphide of ammonium, and prussic acid. When free in vapour, it is powerfully irritant and stimulant, and is sometimes employed in a diluted form in chronic bronchitis and phthisis, and those forms of pulmonary abscess which are accompanied by fœtid expectoration. In chronic affections of the larynx it is sometimes useful. The solution, much diluted, may be used as a gargle in ptyalism, aphthæ, and cancrum oris, or in ulceration of the tonsils, in scarlatina and diphtheria. Liquor chlori is sometimes applied to foul ulcers and cancers, and to some forms of skin disease.

From its antiseptic properties it is supposed to have an especial influence upon the functions of the liver; and thus it is employed as a vapour bath, or the body is sponged with the liquor or a solution.

Hydrochloric Acid. HCl.

Hydrochloric acid-gas dissolved in water, and forming 31·8 per cent. by weight of the solution. It may be obtained by the addition of sulphuric acid to chloride of sodium and distilled water.

The Acidum Hydrochloricum Dilutum (diluted hydrochloric acid) is prepared by taking 8 fluid ounces of the strong acid, adding 16 ounces of water, and then adding more water, so that at a temperature of 60°F it shall measure 26½ fluid ounces. *Dose,* 10 to 30 minims.

The preparations in which the diluted acid are used are: Liquor morphiæ hydrochloratis, and Liquor strychniæ.

Therapeutics.—The strong acid is powerfully caustic, producing a white stain, which afterwards ulcerates. The diluted acid is refrigerant, tonic and astringent, and is used as a gargle in throat ulceration and in diphtheria.

Adulterations.—Sulphuric acid, chlorine, and iron.

BROMINE. Bromum. Br = 80.

A liquid, non-metallic element, obtained from sea-water and from some saline springs.

Therapeutics.—Seldom employed free. The chief preparations are the Ammonii bromidum and Potassii bromidum. It has some repute in diminishing hypertrophy of the liver and spleen. Bromide of potassium may be given in cases of syphilis, in which the iodide is not well borne. It possesses the alterative powers of the iodide, but is far less powerful. It is employed in diseases of the nervous system, in sleeplessness, and epilepsy, and is of much value in priapism, and nymphomania, and also in menorrhagia.

Begbie says it is of great use in checking the formation of sugar in diabetes mellitus.

Dose of ammonii bromidum, grains 2 to 20.
,, of potassii ,, grains 5 to 30.

Adulterations.—Sometimes contains iodine.

IODINE. Iodum. I = 127.

A non-metallic element, obtained principally from the ashes of sea-weeds.

Officinal Preparations.—Linimentum Iodi (iodine, iodide of potassium, camphor and rectified spirit); Liquor Iodi (iodine, iodide of potassium and water); Tinctura Iodi (iodine, iodide of potassium and rectified spirit); Unguentum Iodi (iodine, iodide of potassium, proof spirit and prepared lard); Vapor Iodi (tinctura iodi and water, 1 drachm to 1 ounce), heat slightly, and inhale the rising vapour.

Dose of free iodine, ½ grain, gradually increased.
,, of tinctura iodi, 5 to 20 minims.
,, of potassii iodidi, 3 to 10 grains or more.

Therapeutics.—Applied *externally*, free iodine may act as an irritant or vesicant. When rubbed upon the skin for some time, absorption may take place, and the system at large be affected. By inhaling the diluted vapour, the mucous membrane of the respiratory passages is topically acted upon.

Internally, irritation of the intestinal mucous membrane is occasioned. Iodine is very rapidly absorbed into the blood, and may be detected in the urine and other secretions. The activity of the kidneys, mucous membranes and skin is increased, and the glandular and absorbent systems are powerfully influenced. It is also a powerful alterative, in large doses inducing catarrhal symptoms. Iodine and its salts are indicated in scrofula, bronchocele and glandular enlargements, in hypertrophy of the spleen, liver and uterus; in chronic skin affections, syphilitic or otherwise; in chronic rheumatism, gout, tertiary syphilis and leucorrhœa; it may also be employed as a diuretic in dropsies. + and poisoning

Adulterations.—These may be water, iodide of cyanogen, plumbago, black oxide of manganese, charcoal or iron.

SULPHUR. S = 32.

Varieties.—(1) SULPHUR PRÆCIPITATUM, precipitated sulphur (sublimed sulphur, slaked lime, hydrochloric acid, distilled water), a greyish-yellow powder. *Dose*, 20 to 60 grains.

(2) SULPHUR SUBLIMATUM, sublimed sulphur (from the crude or rough sulphur by sublimation); a fine greenish-yellow powder, slightly gritty. *Dose*, 20 to 60 grains.

Officinal Preparations of the sublimed variety.—CONFECTIO SULPHURIS (sublimed sulphur, acid tartrate of potash and syrup of orange-peel). *Dose*, 1 to 2 drachms.

EMPLASTRUM AMMONIACI CUM HYDRARGYRO.
,, HYDRARGYRI.
SULPHUR PRECIPITATUM. UNGUENTUM SULPHURIS.

(3) SULPHURIS IODIDUM, iodide of sulphur (iodine and sublimed sulphur).

Officinal Preparation.—UNGUENTUM SULPHURIS IODIDI. (Iodide of sulphur, 30 grains; prepared lard, 1 ounce.)

Therapeutics.—In small doses sulphur acts as a stimulant to the skin and mucous membranes, part passing from the skin as sulphuretted hydrogen, and part from the kidneys as sulphuric acid. In larger doses it is a laxative or mild purgative. Externally applied, it is slightly stimulant, destroying the itch insect (acarus scabiei), and may be employed in chronic cutaneous diseases, as scabies, impetigo and prurigo. It is given in chronic bronchitis as a stimulating expectorant, and is useful in piles as a mild laxative.

Adulterations.—Sulphurous acid produced in the process of sublimation. Sulphur precipitatum may contain from 50 to 70 per cent. of sulphate of lime.

ACIDUM SULPHURICUM. H_2SO_4.

An acid produced by the combustion of sulphur and the oxidation of the resulting sulphurous anhydride by means of nitrous vapours. Contains 96·8 per cent. by weight of the sulphuric acid (H_2SO_4), and corresponds to 79 per cent. of sulphuric anhydride (SO_3). Specific gravity, 1·843.

Officinal Preparations.—(1) ACIDUM SULPHURICUM DILUTUM, diluted sulphuric acid; 7 fluid ounces of the strong acid are taken, and 77 fluid ounces of water added; and when the mixture has cooled to 60°F more water is added, so that it shall measure 83½ fluid ounces. Specific gravity, 1·094. *Dose*, 5 to 30 minims. It is used in the preparation of infusum rosæ acidum (1 fluid drachm to 10 fluid ounces).

(2) ACIDUM SULPHURICUM AROMATICUM, aromatic sulphuric acid (sulphuric acid, rectified spirit, cinnamon-bark, ginger).

Dose, 5 to 30 minims.

Therapeutics.—The strong acid is caustic, and chars the skin. The diluted acid is tonic, refrigerant, and astringent, and may be given to allay thirst in hectic fever, for the night-sweats of phthisis, and to check diarrhœa.

The strong acid rubbed up with lard is occasionally applied to some obstinate forms of skin disease.

Adulterations.—Water, known by the low specific gravity. Lead, detected by dilution with water, a white precipitate falling. Arsenic, from the use of impure sulphur during manufacture. Sulphuric acid sometimes becomes discoloured from traces of organic matter.

ACIDUM SULPHUROSUM. H_2SO_3.

This consists of sulphurous anhydride (SO_2) dissolved in water, and constituting 9·2 per cent. by weight of the solution. It is prepared from sulphuric acid, wood charcoal, water and distilled water. *Dose*, ½ to 1 fluid drachm.

Therapeutics.—Externally applied, redness and irritation are set up. It is seldom given internally, but is employed in the form of sulphite and hyposulphite of soda. It may be used as a spray for some kinds of sore throat.

PHOSPHORUS. $P = 31$.

A non-metallic element obtained from bones.

Officinal Preparations.—(1) OLEUM PHOSPHORATUM, phosphorated oil (phosphorus, oil of sweet almonds).

Dose, 5 to 10 minims.

(2) PILULA PHOSPHORI, pill of phosphorus (phosphorus,

balsam of tolu, and yellow wax). *Dose*, 3 to 6 grains. About $\frac{1}{18}$ grain of phosphorus is contained in 5 grains of the pill mass.

Therapeutics.—Is supposed to be powerfully stimulant and aphrodisiac, and a nervine tonic. It is used in nervous diseases and in phthisis.

ACIDUM PHOSPHORICUM DILUTUM.

Diluted phosphoric acid consists of tribasic phosphoric acid (H_3PO_4) dissolved in water, and corresponding to 10 per cent. by weight of phosphoric anhydride (P_2O_5). It is prepared from phosphorus, nitric acid, and distilled water.

Dose, 10 to 30 minims.

Therapeutics.—Somewhat like diluted sulphuric acid, but less astringent. It allays thirst in diabetes mellitus, is said to influence the growth of bony tumours, and is well adapted to the treatment of affections connected with alkalinity of the urine.

Adulterations. — Sulphuric acid, hydrochloric acid, and metallic impurities.

ARSENICUM. Arsenic. As = 75.

ARSENIOUS ANHYDRIDE (As_2O_3).* Prepared by roasting arsenical ores, and purifying by sublimation.

Dose, $\frac{1}{60}$ to $\frac{1}{12}$ of a grain, in solution.

Officinal Preparations.—(1) LIQUOR ARSENICALIS, arsenical solution (arsenious anhydride, carbonate of potash, compound tincture of lavender, and distilled water; arsenite of potash is formed. 4 grains of As_2O_3 to the ounce.

Dose, 2 to 8 minims.

(2) LIQUOR ARSENICI HYDROCHLORICUS, hydrochloric solution of arsenic (hydrochloric acid added to arsenious anhydride and distilled water). 4 grains of As_2O_3 to the ounce.

Dose, 2 to 8 minims.

The preparations containing arsenic anhydride (As_2O_5) are: (1) SODÆ ARSENIAS, arseniate of soda ($Na_2HAsO_4 + 7H_2O$), (arsenious anhydride, nitrate of soda, dried carbonate of soda, and boiling water.) *Dose*, $\frac{1}{12}$ to $\frac{1}{8}$ of a grain.

LIQUOR SODÆ ARSENIATIS (arseniate of soda, rendered anhydrous by a heat not exceeding 300°F). 4 grains of the salt in 1 ounce of distilled water. *Dose*, 5 to 10 minims.

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* This substance is termed *arsenious acid* in the British Pharmacopœia, but since, in my "Aids to Chemistry," I have carefully avoided calling any substance an acid which does not contain hydrogen, I have thought it expedient to apply to it the term *anhydride*.

(2) Ferri Arsenias ($Fe_3As_2O_8$), arseniate of iron partially oxidised (sulphate of iron, arseniate of soda dried at 300°F, acetate of soda and boiling distilled water).

Dose, $\frac{1}{16}$ to $\frac{1}{2}$ of a grain.

Therapeutics. —Arsenical preparations are employed in small doses in the treatment of skin diseases of a non-syphilitic origin, as nervine tonics in chorea and epilepsy, and for their antiperiodic effects in ague; they should be given after a meal. In large doses arsenic produces irritation of the alimentary canal and mucous membrane of the eyes; pain in the epigastrium, nausea, and irritation of the eyelids, are therefore indications for discontinuing its administration.

BORON. B = 11.

Borax.—Biborate of Soda ($Na_2B_4O_7 + 10H_2O$) is found native, but is also prepared by neutralising boracic acid with carbonate of soda. *Dose*, 5 to 40 grains.

Officinal Preparations.—Mel Boracis (borax in fine powder and clarified honey). (64 grains in 1 ounce.)

Glycerinum Boracis (borax in powder and glycerine). (1 in 4.)

Therapeutics.—Borax acts like a mild alkali: it tends to produce diuresis. It is used in combination with ergot to produce expulsion of the placenta. It exercises a peculiar topical, soothing influence when applied to mucous membranes, and may be used as a gargle with glycerine or honey in aphthæ of the throat or tongue, and in mercurial salivation; it is also employed as a lotion in irritable conditions of the vagina and uterus.

POTASSIUM. Kalium. K = 39.

Liquor Potassæ.—Solution of potash (KHO) is prepared from carbonate of potash, slaked lime, and distilled water. A colourless liquid, kept in green glass bottles, the white glass containing lead.* *Dose*, 10 minims to 1 drachm.

Therapeutics.—In large doses and undiluted, KHO is an irritant caustic poison; when administered internally, in a diluted form, it is very useful for certain forms of dyspepsia, acting as a direct antacid, and neutralising any free acid in the stomach. It is also alterative to the glandular system, increasing the activity of the secreting and excreting organs. It may be given in skin diseases dependent upon a morbid condition of the stomach, as in erythema; as a blood alterant in pericarditis, pleuritis, and periostitis; and in chronic bronchitis, scrofula, syphilis, and chronic rheumatism. It is

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* The potash acts as a solvent upon the lead.

3/13P. Saints, C. T.

occasionally used externally, as a wash, in some chronic skin diseases.

Adulterations.—Carbonate and sulphate of potash, chloride of potassium, lime.

POTASSA CAUSTICA.—Caustic potash (KHO) is prepared by boiling down liquor potassæ to a syrupy consistence, in a silver or iron vessel, until a drop removed upon a glass rod solidifies on cooling: it is then poured into moulds.

Therapeutics.—For touching ulcers and making issues; and is made into a paste, with spirit, for destroying cancers, etc.

Adulterations.—The same as of liquor potassæ, but in addition the oxides of iron and aluminium.

POTASSÆ CARBONAS. — Carbonate of potash ($K_2CO_3 + 16H_2O$) is prepared from pearl-ashes (obtained by the lixiviation of wood-ashes). *Dose*, 10 grains to 30 grains.

Therapeutics.—Almost the same as liquor potassæ, but much less caustic.

It is contained in *Decoctum aloes compositum* and *Mistura ferri composita.*

Adulterations.—Sulphates and chlorides of potassium.

POTASSÆ BICARBONAS.—Bicarbonate of potash ($KHCO_3$) is prepared by passing a stream of carbonic anhydride through a solution of potassæ carbonas to saturation, and subsequent crystallisation. *Dose*, 10 grains to 40 grains.

20 grains of this salt neutralise 14 grains of citric acid, or 15 of tartaric acid.

Therapeutics. —A direct antacid, rendering the urine strongly alkaline, and probably influencing the composition of the blood. It is chiefly used in dyspepsia, the uric acid diathesis, and acute rheumatism.

Adulterations.—Carbonate of potash.

Liquor potassæ effervescens is prepared by introducing carbonic anhydride into bicarbonate of potash and water, under a pressure of 7 atmospheres. *Dose*, 5 to 10 ounces.

POTASSÆ ACETAS.—Acetate of potash ($KC_2H_3O_2$) (acetic acid, 2 pints, and carbonate of potash, 20 ounces).

Dose, 10 grains to 1 drachm, as a *diuretic*; as a *purgative*, 2 drachms upwards.

Therapeutics.—Often appears in the urine in the form of the carbonate; renders that fluid alkaline, and increases its secretion. In large and concentrated doses, a slight purgative effect is produced. It is, perhaps, the most powerful of all saline diuretics, and is very useful in various forms of dropsy, in acute rheumatism, skin diseases, chronic enlargements of glands and other organs; it is occasionally used as an anthelmintic.

Adulterations.—Traces of sulphates and chlorides.

POTASSÆ CITRAS.—Citrate of potash ($K_3C_6H_5O_7$) (citric acid, carbonate of potash, and water). *Dose*, 20 grains to 1 drachm.

Therapeutics.—Is more agreeable, more readily absorbed, and less likely to purge than the other vegetable salts of potash: valuable as a saline febrifuge, increasing the secretion from the kidneys, and appearing as the carbonate in the urine. May be employed in the uric acid diathesis, and in chronic diseases for which the acetate has been prescribed. It possesses powerful antiscorbutic properties.

POTASSÆ TARTRAS.—Tartrate, or neutral tartrate of potash ($K_2C_4H_4O_6$) (boiling the acid tartrate of potash with carbonate of potash and distilled water).

Dose, 10 grains to 1 drachm as a *diuretic* and *alterative;* 2 drachms to 200 grains as a *purgative.*

Therapeutics.—Diuretic in small doses, and eliminated from the urine as carbonate. In larger doses, a hydragogue purgative, generally combined with, and increasing the action of, such vegetable purgatives as rhubarb, senna, etc.

Adulterations.—Sulphates.

POTASSÆ TARTRAS ACIDA.—Acid tartrate of potash ($KHC_4H_4O_6$), sometimes called cream of tartar (obtained from *argol*, the crude tartar deposited during the fermentation of grape-juice). This substance is contained in *Pulvis jalapæ compositus* and *Confectio sulphuris.*

Dose, as a *refrigerant* and *diuretic*, 20 grains to 1 drachm.
,, as a *purgative* ,, ,, 120 grains to 300 grains.

Therapeutics.—In small doses, refrigerant and diuretic; in large doses, a powerful hydragogue purgative. It is given as an acid drink in febrile affections, and as a purge in dropsy dependent upon cardiac or renal disease, and is best combined with jalap, gamboge, or scammony. Belladonna is said to assist its action.

Adulteration.—Tartrate of lime.

POTASSÆ SULPHAS.—Sulphate of potash (neutral), K_2SO_4. Prepared from the residuum (an impure acid sulphate of potash) of the distillation of nitric acid, when this acid is made by treating nitrate of potash with sulphuric acid, the excess of acid being got rid of. Slaked lime is added, which is again got rid of by means of carbonate of potash. Diluted sulphuric acid is then added to the filtered liquid, the sulphate of potash being subsequently submitted to evaporation and crystallisation.

Dover's Powd.

K_2SO_4 is contained in *Pulvis ipecacuanhæ compositus*, *Pilula colocynthidis composita*, *Pilula colocynthidis et hyoscyami*, and *Pilula ipecacuanhæ c scilla*.

Dose, as a *purgative*, 20 grains to 2 drachms; in smaller doses it is *alterative*.

Therapeutics.—A mild purgative, generally given with rhubarb and other vegetable aperients. Evidence has been lately given of its acting as a poison in large doses; but it is often employed on account of its mechanical properties, since it intimately divides vegetable substances, as in Dover's powder.

POTASSÆ NITRAS.—Nitrate of potash, Nitre (KNO_3); found native as an efflorescence on the soil of India, and prepared artificially by "nitrification."

Dose, as a *refrigerant* and *diuretic*, 5 to 20 grains.
,, ,, *vascular sedative* ... 20 grains to ½ drachm.

Therapeutics.—Refrigerant and diuretic; and in large doses powerfully sedative to the heart and vascular system. Is given in febrile affections, and to allay irritation of the mucous membrane of the stomach in dyspepsia. It is said to be especially useful in acute rheumatism.

Adulterations.—Traces of sulphate or chloride of calcium.

POTASSÆ CHLORAS.—Chlorate of potash ($KClO_3$); prepared by passing chlorine gas through carbonate of potash and slaked lime. Contained in *Trochisci potassæ chloratis*. *Dose*, 10 to 30 grains.

Therapeutics.—Refrigerant and diuretic, similar to nitre; almost a specific in severe tonsillitis, and stomatitis, and useful in mercurial ptyalism, salivation, in scarlatina, typhoid fever, etc.

Adulteration.—Chloride of potassium.

POTASSÆ PERMANGANAS.—Permanganate of potash ($KMnO_4$). Prepared from chlorate of potash, black oxide of manganese, caustic potash, diluted sulphuric acid and distilled water. Contained in *Liquor potassæ permanganatis*, of which the dose internally is 2 to 4 drachms; and when used externally, 1 drachm to 5 or 10 ounces of water.

Therapeutics.—A powerful oxydising agent; antiseptic and a deodoriser; said to be changed in the stomach into black oxide of manganese, giving off oxygen. It is applied to foul ulcers and gangrenous parts; also used as a gargle, injection, etc., in fœtid discharges, and occasionally in diphtheria. The importance of its internal administration is doubtful.

Condy's fluid

POTASSII BROMIDUM.—Bromide of potassium (KBr). Bromine is added to a solution of potash; bromate of potash is

$6Br + 6KHO = 5KBr + 3H_2O + KB$

formed, and this is reduced by finely-powdered wood charcoal; boiling distilled water is then added.

Dose, 5 to 30 grains, or more.

Therapeutics.—It is used to produce the constitutional effects of bromine.

Adulterations.—Iodide of potassium and bromate of potassium.

Potassii Iodidum.—Iodide of potassium (KI); iodine is added to a solution of potash. Iodate of potassium is first formed, which is reduced by finely-powdered wood charcoal. It is contained in *Unguentum potassii iodidi*, and *Linimentum potassii iodidi cum sapone*. *Dose*, 2 to 10 grains or more.

Therapeutics. —Is better adapted for internal use than iodine, since it produces no local irritation. It possesses the power of eliminating metallic substances, as mercury and lead, from the system.

Adulterations.—It may be damp, or contain carbonate of potash, chloride of sodium or potassium, iodate of potassium and free iodine.

Potassa Sulphurata.—Sulphurated potash (carbonate of potash and sublimed sulphur.) Contained in *Unguentum potassæ sulphuratæ*, and employed in chronic rheumatism and skin affections.

Potassæ Prussias Flava.—Ferrocyanide of potassium, or yellow prussiate of potash ($K_4FeCy_6, 3H_2O$). Prepared by boiling horns and hoofs and clippings of hides in an iron pot with carbonate of potash. Is not used medicinally. Does not appear to be poisonous, and is used for the preparation of prussic acid.

Potassæ Prussias Rubra.--Ferricyanide of potassium, or red prussiate of potash (K_3FeCy_6) is merely used as a test for the protosalts of iron, with which it strikes *dark-blue*.

SODIUM. Natrium. Na = 23.

Liquor Sodæ.—Solution of soda (NaHO) (carbonate of soda, slaked lime and distilled water). It is used in the preparation of sulphurated antimony. $= Sb_2O_3 + H_2SO_4 + NaHO$

Dose, 10 minims to 1 drachm, freely diluted.

Therapeutics.—Probably similar to liquor potassæ, but it is seldom used.

Soda Caustica.—Caustic soda (NaHO) is prepared from liquor sodæ in a similar manner to caustic potash.

Therapeutics.—Used externally as a caustic.

Sodæ Carbonas.—Carbonate of soda ($Na_2CO_3 + 10H_2O$) (from the ashes of marine plants, or by the chemical decomposition of chloride of sodium). *Dose*, 5 to 30 grains.

Salt cake = $2NaCl + H_2SO_4 = 2HCl + Na_2SO$

Sodæ Carbonas Exsiccata.—Dried carbonate of soda; an amorphous powder, prepared by driving off the water of crystallisation by heat from the carbonate of soda.

Dose, 3 to 10 grains.

Therapeutics.—Analogous to carbonate of potash, but less caustic.

Adulterations.—A little sulphate of soda.

Sodæ Bicarbonas.*—Bicarbonate of soda ($NaHCO_3$)—by passing a stream of carbonic anhydride through the *dry* carbonate. *Dose*, 10 grains to 1 drachm.

Officinal Preparations.—(1) Liquor Sodæ Effervescens (bicarbonate of soda and water, and as much carbonic anhydride as can be introduced under a pressure of 7 atmospheres).†

(2) Trochisci Sodæ Bicarbonatis (bicarbonate of soda, refined sugar, gum acacia, mucilage of gum acacia and distilled water). Each lozenge contains 5 grains of bicarbonate of soda. *Dose*, 1 to 6 lozenges.

Therapeutics.—Very like bicarbonate of potash, but not applicable to the uric acid diathesis.

Adulterations.—Carbonate and sulphate of soda in an efflorescent state.

Sodæ Sulphas.—Sulphate of soda ($Na_2SO_4 + 10H_2O$), called Glauber's salts (chloride of sodium and sulphuric acid, and subsequent neutralisation with carbonate of soda). *Dose*, ½ ounce to 1 ounce; smaller when effloresced.

Therapeutics.—A saline purgative, and in small doses a diuretic.

Sodæ Acetas.—Acetate of soda ($NaC_2H_3O_2 + 3H_2O$), prepared from carbonate of soda and acetate of potash; is used in the preparation of phosphate and arseniate of iron. *Dose*, 20 grains to 1 drachm.

Therapeutics.—A mild diuretic, but seldom used.

Sodæ Hypophosphis.—Hypophosphite of soda ($NaPH_2O_2$). Prepared by adding carbonate of soda to a solution of hypophosphite of lime so long as any precipitate of carbonate of lime is formed, then filtering and evaporating to dryness, stirring constantly until the commencement of solidification; sometimes used in phthisis. *Dose*, 5 to 10 grains.

Sodæ Hyposulphis.—Is given for chronic vomiting, to destroy the sarcinæ ventriculi, sulphurous anhydride being set free by the gastric juice. *Dose* 5 to 10 grains.

Sodæ Nitras.—Nitrate of soda ($NaNO_3$), is a native salt and is used for the production of arseniate of soda, but not employed medicinally.

Chili saltpetre

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* 20 grains neutralise 16·7 grains of citric acid, or
17·8 ,, of tartaric acid.

† Each half-pint bottle contains 15 grains of bicarbonate of soda.

$4SO_2 + 2NaS + 2NaHO = H_2O$ [illegible] isodic orthophosphate

Sodæ Phosphas.—Phosphate of soda ($Na_2HPO_4 + 12H_2O$) (by digesting bone-ash with sulphuric acid, sulphate of lime and free phosphoric acid being formed; carbonate of soda is then added until a precipitate no longer falls, and the solution is slightly alkaline. It is then filtered and crystallised). *Dose*, as a *purgative*, ½ drachm to 1 ounce; as a *diuretic*, 1 to 2 drachms.

Therapeutics.—In large doses, a mild saline purgative; in smaller ones, a diuretic, rendering the urine alkaline. It is sometimes employed as a mild purge for children.

Adulterations. — Phosphate of lime, which renders the solution milky.

Liquor Sodæ Chloratæ.—Solution of chlorinated soda. Prepared by passing chlorine gas through a solution of carbonate of soda until the solution attains the specific gravity of 10·6. *Dose*, 10 to 20 minims in 1 ounce of water; as a gargle, ½ ounce to 1 ounce in a pint of water.

Officinal Preparation. — Cataplasma Sodæ Chloratæ.

Therapeutics.—Internally antiseptic and stimulant, sometimes employed, much diluted, in fevers of a low malignant type, as scarlatina, etc. Externally, it is applied to unhealthy gangrenous parts; as a gargle for ulcerated sore throat, and in ulcerated mouths due to the abuse of mercury.

Sodii Chloridum. — Chloride of sodium, common salt ($NaCl$), occurs native as rock salt, in brine springs and in sea-water. *Dose*, a tablespoonful or more as an emetic.

Therapeutics.—A necessary article of food. Is contained in blood and in other animal fluids. Its deficiency may cause disease, the production of worms, etc. In large doses it is emetic and purgative, in smaller doses a slight stimulant and alterative. Externally it is stimulant and rubefacient. Sponging or bathing with salt water is valuable in chronic rheumatism, joint affections, etc. Sea-water is used as an emetic, purgative, and anthelmintic.

Soda Tartarata.—Tartarated soda ($NaKC_4H_4O_6 + 4H_2O$), called Rochelle salt; obtained from acid tartrate of potash, carbonate of soda and boiling distilled water.

Dose, as a *purge*, 2 drachms to ½ ounce; as a *diuretic*, ½ drachm to 1 drachm.

Therapeutics.—A mild saline purgative; in smaller doses diuretic.

Soda Citro-Tartras Effervescens.—Effervescing citro-tartrate of soda (bicarbonate of soda, tartaric acid, and citric acid in powder). *Dose*, 60 grains to ¼ ounce.

Therapeutics.—The same as tartarated soda, but more plea-

Vast 2 HBC (Pan)

sant to the taste; it sits more easily on the stomach on account of the carbonic anhydride evolved.

reddish

LITHIUM. L = 7.

3 preparati

LITHIÆ-CARBONAS.—Carbonate of lithia (L_2CO_3).
Dose, 3 to 6 grains.

Is used in the preparation of LIQUOR LITHIÆ EFFERVESCENS (carbonate of lithia, 10 grains to 1 pint of water). *Dose*, 5 to 10 ounces.

Therapeutics.—Very useful in the uric acid diathesis, since a very small amount of lithia will form a soluble salt with uric acid, and be eliminated by the urine. It is more powerful than the corresponding potash salt, and is employed with success in gout and calculous affections.

LITHIÆ CITRAS.—Citrate of lithia ($L_3C_6H_5O_7$). Prepared from carbonate of lithia, citric acid, and warm distilled water. *Dose*, 5 to 10 grains.

Therapeutics.—Resembles the carbonate in its remote antacid properties, but has no direct influence in neutralising acid. It is a neutral salt.

CALCIUM. Ca = 40.

light yellow

CALX.—Lime (CaO); an alkaline earth with some impurities, obtained by calcining chalk or limestone, to expel the carbonic anhydride.

Officinal Preparations.—(1) CALCIS HYDRAS, Slaked Lime (CaH_2O_2), lime slaked with water; should be recently prepared.

(2) LIQUOR CALCIS.—Lime water. (Slaked lime, 2 ounces, and distilled water, 1 gallon).

Dose, ½ to 2 ounces or more in milk.

(3) LIQUOR CALCIS SACCHARATUS.—Saccharated solution of lime. (Slaked lime, 1 ounce; refined sugar, in powder, 2 ounces; distilled water, 1 pint.) *Dose*, 15 to 60 minims.

(4) LINIMENTUM CALCIS.—(Lime-water and olive oil; equal parts of each.) carron oil

Therapeutics.—Only used internally, as liquor calcis; acts as a direct antacid upon the intestinal canal, and when absorbed upon the blood and secretions. It is astringent, diminishing secretion; and is useful in dyspepsia and diarrhœa associated with acidity. Has proved serviceable in rickets, etc. Linimentum calcis is applied to burns.

Adulterations of Lime.—Carbonic acid and metallic impurities.

Calcis Carbonas Præcipitata.—Precipitated carbonate of lime ($CaCO_3$) (chloride of calcium, carbonate of soda, and boiling distilled water). *Dose*, 10 to 60 grains.

Is contained in the *Trochisci Bismuthi.* 4 grains in each lozenge, nearly.

Therapeutics.—Not often used medicinally, but the same as creta præparata.

Creta Præparata.—Prepared chalk (chalk freed from most of its impurities by elutriation, and afterwards dried in small masses, which are usually of a conical form).

Dose, 10 to 60 grains.

Officinal Preparations.—(1) Hydrargyrum cum Creta (mercury, by weight, 1 ounce; prepared chalk, 2 ounces, rubbed together in a porcelain mortar until metallic globules are no longer visible, and the whole assumes a grey colour).

Dose, 3 to 8 grains.

(2) Mistura Cretæ (prepared chalk, gum acacia, syrup and cinnamon water). *Dose*, 1 to 2 fluid ounces.

(3) Pulvis Cretæ Aromaticus (cinnamon-bark, nutmeg, saffron, cloves, cardamom seeds, refined sugar, and prepared chalk; all in powder). *Dose*, 10 to 60 grains.

(4) Pulvis Cretæ Aromaticus cum Opio (pulvis cretæ aromaticus, with the addition of pulvis opii, 1 gr. in 40 grains of the entire powder).

Dose, depends upon the amount of opium which it is desirable to administer.

Therapeutics.—Prepared chalk is antacid and astringent. It is used in diarrhœa, either alone or combined; but should not be continued for any length of time, as it may lead to the formation of inconvenient concretions.

Calcii Chloridum.—Chloride of calcium ($CaCl_2$), prepared by the addition of hydrochloric acid to carbonate of lime. *Dose*, 10 grains and upwards.

Therapeutics.—Introduced into chemistry and pharmacy on account of its great power of absorbing water. Is used in the preparation of chloroform, ether, etc.; and in the rectification of spirit. Medicinally it acts upon the glandular system, and was formerly used in scrofula. It is said to allay certain forms of vomiting.

Calx Chlorata.—Chlorinated lime ($CaOCl_2$), a product obtained by exposing slaked lime to the action of chlorine gas, as long as the latter is absorbed. Possesses bleaching and disinfectant properties, and is used in the preparation of liquor calcis chloratæ, vapor chlori and chloroform. Used with water as a disinfectant, since it evolves chlorine; but

C H P

chlorinated soda is preferable.* It is not employed either internally or externally.

Calcis Phosphas.—Phosphate of lime ($Ca_3P_2O_8$), bone-ash dissolved in hydrochloric acid and precipitated by liquor ammoniæ. Is contained in pulvis antimonialis (2 parts in 3), but is seldom used in medicine in the present day. Has been employed with advantage for promoting the formation of bone in scrofula and rickets.

Dose, 10 to 20 grains.

Calcis Hypophosphis.—Hypophosphite of lime ($Ca2PH_2O_2$) is obtained by heating phosphorus with hydrate of lime and water until phosphuretted hydrogen gas ceases to be evolved; the liquid is then filtered, uncombined lime is separated by carbonic anhydride, and the remaining solution evaporated until the salt crystallises. This salt, like the hypophosphite of soda, is said to be useful in the treatment of phthisis.

Dose, 5 to 10 grains.

BARIUM. Ba = 137.

Barii Chloridum.—Chloride of barium ($BaCl_2 + 2H_2O$). Is prepared by acting upon the carbonate of barium with hydrochloric acid. Is used as a precipitant of sulphuric acid.

Therapeutics.—This salt has been used in small doses as an alterative, influencing the glandular system especially, and it is supposed to act upon the nerve centres; but, being an irritant poison, is seldom employed in medicine.

ALUMINIUM. Al = 27·4.

Officinal Preparations:

(1) **Alumen.**—Alum ($NH_4Al(SO_4)_2 + 12H_2O$), a double sulphate of alumina and ammonia crystallised from solution in water; prepared from Alum-schist.

(2) **Alumen Exsiccatum**, Dried Alum; prepared by depriving alum of its water by heat.

Dose, as an *astringent,* 10 to 20 grains.

,, as a *purgative,* ½ drachm to 1 drachm.

Therapeutics.—Astringent in small doses, and in large doses purgative. Used locally as a gargle, etc., and internally for whooping cough.

Incompatibles.—Alkalies and their carbonates; infusions and decoctions containing tannin, tartrates, salts of lead, baryta and lime.

MAGNESIUM. Mg = 24.

Magnesia (MgO).—Heavy magnesia. The heavy carbonate of magnesia is exposed to a low red heat in a Hessian crucible,

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* Because when chlorinated lime is used, after the chlorine has escaped the lime is left in a caustic state, and acts corrosively on carpets, etc.

until a small quantity, taken from the centre when it has cooled, causes no effervescence when dropped into diluted sulphuric acid. *Dose*, 10 grains to 1 drachm.

MAGNESIA LEVIS (MgO).—Light magnesia (prepared from the light carbonate of magnesia in the same manner as the foregoing). Contained in Pulvis Rhei Compositus (powdered rhubarb, light magnesia and ginger); the relative weight of the light to the heavy magnesia is 1 to 3½.

Dose, as an *antacid*, 10 to 20 grains; as an *adjunct* and *purgative*, 20 grains to 1 drachm.

Therapeutics.—A direct antacid, neutralising acid in the stomach. It is liable to cause concretions if given for a length of time. All the salts of magnesia have an aperient tendency, and after absorption into the blood the urine is rendered alkaline, uric acid and the urates being held in solution. It is given in acidity of the stomach and heartburn, and in an acid condition of the intestines. It is very useful combined with rhubarb in the early stages of diarrhœa. Is most suitable for children, and for the treatment of gouty affections. It is considered by some authors to be a lithontriptic, dissolving concretions or calculi composed of uric acid.

Adulterations.—May contain a little sulphate or carbonate of magnesia, or lime.

MAGNESIÆ CARBONAS.*—Heavy carbonate of magnesia ($(MgCO_3)_3MgO + 5H_2O$). (Sulphate of magnesia, carbonate of soda and boiling water.)

MAGNESIÆ CARBONAS LEVIS.*—Light carbonate of magnesia ($(MgCO_3)_3MgO + 5H_2O$). This is prepared in the same manner as the preceding compound, the difference depending upon the amount of heat employed, and the amount of dilution. *Dose*, of either carbonate, 10 grains to 1 drachm.

Officinal Preparations.—Carbonate of Magnesia is contained in the Trochisci Bismuthi (3 grains in each lozenge).

LIQUOR MAGNESIÆ CARBONATIS (sulphate of magnesia, carbonate of soda and water, pure carbonic anhydride being passed through) contains 13 grains of magnesia, in the form of bicarbonate, to 1 ounce of the solution. *Dose*, 1 to 2 ounces.

Therapeutics.—The same as magnesia, both as antacid and purgative; but when it encounters any acidity in the stomach it gives off carbonic anhydride.

Adulterations.—Lime and some sulphates.

MAGNESIÆ SULPHAS.—Sulphate of magnesia, Epsom salts ($MgSO_4 + 7H_2O$), (from dolomite, a carbonate of lime and magnesia, by the addition of sulphuric acid); formerly made from "bittern."

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* See Addenda.

Officinal Preparation.—ENEMA MAGNESIÆ SULPHATIS (sulphate of magnesia, 1 ounce; olive-oil, 1 ounce; and mucilage of starch, 15 ounces). Sulphate of magnesia is contained in Mistura Sennæ Composita.

Dose, as an *enema*, 1 ounce or more; as a *purge*, 2 to 4 drachms; in combination, 60 grains and upwards; as a *diuretic*, 20 grains to 1 drachm.

Therapeutics.—In ordinary doses a saline purgative, inducing free watery discharge; in small doses causes diuresis. Is employed in febrile affections, and in congestion of the portal system. With the infusion of senna it forms the ordinary black draught. It is generally given in combination, since when administered alone it frequently causes uncomfortable distension of the abdomen.

Adulterations.—When made from "bittern" it may contain chloride of sodium and magnesium.

ZINCUM. Zinc. $Zn = 65$.

ZINCI OXIDUM.—Oxide of zinc (ZnO), (carbonate of zinc exposed to a dull red heat).

Dose, 2 to 10 grains in pill or powder.

Officinal Preparation. — UNGUENTUM ZINCI (80 grains of oxide of zinc to 1 ounce of benzoated lard).

Therapeutics.—In large doses causes vomiting; in small doses is tonic and astringent, acting upon the nervous system, and is given to check excessive perspiration. Used in chorea, epilepsy, hysteria, neuralgia, and whooping cough. Externally it is applied to ulcerations and excoriated surfaces.

Adulterations.—Chalk and carbonate of magnesia.

ZINCI CHLORIDUM.—Chloride of zinc ($ZnCl_2$), (granulated zinc, hydrochloric acid, solution of chlorine, carbonate of zinc and distilled water). *Dose*, internally, ½ to 2 grains.

Officinal Preparation. — LIQUOR ZINCI CHLORIDI (366 grains to 1 fluid ounce).

Therapeutics.—Externally a powerful escharotic; when in solution, irritant and astringent, and employed in cancer, malignant ulcers, and for the removal of nævi; generally made into a paste with flour or gypsum. It is given internally, though seldom, in chorea and epilepsy.

ZINCI SULPHAS.—Sulphate of zinc ($ZnSO_4 + 7H_2O$), (granulated zinc, sulphuric acid, distilled water, solution of chlorine, and carbonate of zinc). *Dose*, as a *tonic* or *astringent*, 1 to 3 grains; as an *emetic*, 10 to 30 grains.

Therapeutics.—In *large* doses a direct and speedy emetic; useful in opium and other poisoning. Is given in phthisis and those forms of dyspepsia in which free emptying of the stomach is desirable, without producing much depression. In *small* doses an astringent and nervine tonic, given in chorea, epilepsy and hysteria ; also employed as an injection in leucorrhœa and gleet.

ZINCI CARBONAS.—Carbonate of zinc ($ZnCO_3(ZnO)_2 + 3H_2O$), (sulphate of zinc, carbonate of soda, and boiling distilled water). Used in the preparation of the acetate, chloride, oxide and sulphate of zinc.

Dose, 1 to 10 grains in pill or powder.

Therapeutics.—May be used in the same cases as the oxide, but it is rarely used medicinally.

ZINCI ACETAS. —Acetate of zinc ($Zn(C_2H_3O_2)_2 + 2H_2O$) (carbonate of zinc, acetic acid, and distilled water).

Dose, as a *tonic*, 1 to 2 grains ; as an *emetic*, 10 to 20 grains.

Therapeutics.—Similar to the sulphate.

ZINCI VALERIANAS.—Valerianate of zinc ($Zn(C_5H_9O_2)_2$), (sulphate of zinc, valerianate of soda, and distilled water). *Dose*, 1 to 3 grains ; increased until some nausea is occasioned.

Therapeutics.—A nervine tonic and antispasmodic, given in hysteria, chorea, epilepsy and neuralgic affections, in which the combined effect of valerian and the metal appears desirable.

CADMIUM. Cd = 112.

CADMII IODIDUM.—Iodide of cadmium (CdI_2). Prepared by direct combination of cadmium and iodine in the presence of water.

Officinal Preparation.—UNGUENTUM CADMII IODIDI (62 grains of iodide of cadmium to 1 ounce of simple ointment).

Therapeutics.—Not given internally, but used in the same manner as the iodide of lead ; does not produce any staining of the skin or any unpleasant effects after absorption. It sometimes causes irritation of the skin, and should be diluted with lard or some other bland substance.

MANGANESIUM. Manganese. Mn = 55.

MANGANESII OXIDUM NIGRUM. — Black oxide of manganese (MnO_2). Found native ; chiefly used for the production of chlorine.

Therapeutics.—Only occasionally employed. The protosulphate in doses of 1 to 2 drachms induces purging. In small doses this salt and the carbonate have been given with the idea of improving the blood in anæmia ; it somewhat resembles iron in its action.

Topsiqarcans.

FERRUM. Iron. Fe = 56.

Wrought Iron.—In the form of wire or nails, free from oxide; used in the preparation of: (1) Mistura Ferri Aromatica (pale cinchona bark, calumba root, cloves, fine iron wire, compound tincture of cardamoms, tincture of orange-peel and peppermint-water). *Dose*, 1 to 2 ounces.

(2) Vinum Ferri (fine iron wire, 1 ounce; sherry, 1 pint). *Dose*, 1 to 4 drachms.

Therapeutics of the iron preparations in general:

Iron forms an essential part of the red globules of the blood, 6½ per cent. of iron being contained in the pure colouring matter or hæmatin. It appears to be intimately united with the organic element hæmatin, and not to exist in the condition of proto- or per- oxide. When this metal is absent from the blood, the anæmic condition is produced. All the salts of iron exert the same influence, and it cannot be asserted that any one is superior to another. Independently of their hæmatinic property, they exercise a direct influence upon the nervous system, as in chorea, epilepsy, neuralgia, and hysteria. Most of the preparations are astringent and therefore apt to cause constipation, and it is consequently expedient to combine them with some mild aperient, such as aloes. The persalts are the most astringent. All iron preparations communicate a black colour to the fæces, owing to the formation of the black sulphide, and probably of some little tannate of iron.

Ferrum Redactum, reduced iron. Metallic iron, with a variable amount of magnetic oxide of iron (hydrate of peroxide of iron, granulated zinc, sulphuric acid, and chloride of calcium).

Officinal Preparation.—Trochisci Ferri Redacti (reduced iron, refined sugar, gum acacia, mucilage of gum acacia and distilled water). Each lozenge contains 1 grain of reduced iron. *Dose*, 1 to 6 lozenges with a meal.

Therapeutics.—Given when it is desirable to obtain the effect of iron without its astringency. It sometimes causes eructations of sulphuretted hydrogen.

Adulterations.—May contain some sulphide, or the magnetic oxide.

Ferri Carbonas Saccharata, saccharated carbonate of iron (carbonate of iron ($FeCO_3$) mixed with the per-oxide (Fe_2O_3) and sugar (the carbonate forming at least 37 per cent. of the mixture), sulphate of iron, carbonate of ammonia, refined sugar and boiling distilled water). *Dose*, 5 to 20 grains.

Officinal Preparation. — PILULA FERRI CARBONATIS (saccharated carbonate of iron and confection of roses).

Dose, 5 to 20 grains.

Carbonate of iron is also contained in Mistura Ferri Composita or Griffith's mixture.

Therapeutics.—Possesses the hæmatinic properties of iron; is not astringent, and scarcely affects the mucous membrane of the alimentary canal.

FERRI IODIDUM, iodide of iron (FeI_2, with 18 per cent. of water of crystallisation, and a little oxide of iron). (Fine iron wire, iodine and distilled water.) *Dose,* 1 to 5 grains.

Officinal Preparations. — SYRUPUS FERRI IODIDI (iodine, fine iron wire, refined sugar, and distilled water); 4½ grains of the iodide of iron to 1 drachm of the syrup.

Dose, ½ to 1 fluid drachm.

PILULA FERRI IODIDI (iodine, fine iron wire, refined sugar, liquorice root and distilled water); 1 grain of the iodide of iron in 2½ of the pill mass. *Dose,* 3 to 8 grains.

Therapeutics.—Peculiarly applicable to scrofulous disease. Is given in phthisis in combination with cod-liver oil; occasionally in rheumatic arthritis, especially when the pain is increased by the heat of the bed; and in certain forms of syphilis. The proportion of iron in FeI_2 is only 1 to 4½.

FERRI SULPHAS, sulphate of iron, $FeSO_4 + 7H_2O$ (iron wire, sulphuric acid and distilled water). *Dose,* 1 to 5 grains. Is contained in Ferri Sulphas Exsiccata and Pilula Aloës et Ferri; also used in the Mistura Ferri Composita.

FERRI SULPHAS EXSICCATA, dried sulphate of iron, $FeSO_4, H_2O$ (the preceding salt exposed to 400°F.) *Dose,* ½ to 3 grains.

FERRI SULPHAS GRANULATA, granulated sulphate of iron. (A hot solution of sulphate of iron in rectified spirit, and stirred until the salt separates in minute granular crystals). *Dose,* 1 to 5 grains.

Therapeutics.—The same as the other iron salts, but very astringent. Useful in passive hæmorrhage and mucous discharges; in anæmia and relaxation.

Incompatibles.—Forms inks with any preparations containing tannin or gallic acid; these do not destroy the medicinal properties, but form unsightly mixtures.

FERRI ARSENIAS, arseniate of iron ($Fe_3(AsO_4)_2$), partially oxidised (sulphate of iron, arseniate of soda dried at 300°F., acetate of soda and boiling distilled water). Thus—

$$3FeSO_4 + 2Na_2HAsO_4 + 2NaC_2H_3O_2 = Fe_3(AsO_4)_2 + 3Na_2SO_4 + 2HC_2H_3O_2.$$

Arseniate of iron, sulphate of soda, and free acetic acid are formed. The presence of the free acetic acid causes the precipitation of the $Fe_3(AsO_4)_2$, which is insoluble in it).

Dose, $\frac{1}{16}$ to $\frac{1}{2}$ of a grain.

Therapeutics.—Combines the properties of arsenic and iron. Is given in certain skin diseases associated with anæmia.

FERRI PHOSPHAS, phosphate of iron ($Fe_3(PO_4)_2$) partially oxidised (sulphate of iron, phosphate of soda, acetate of soda and boiling distilled water. Thus—

$$3FeSO_4 + 2Na_2HPO_4 + 2NaC_2H_3O_2 = Fe_3(PO_4)_2 + 3Na_2SO_4 + 2HC_2H_3O_2.$$

Phosphate of iron, sulphate of soda and free acetic acid are formed). *Dose*, 5 to 10 grains.

Officinal Preparation.—SYRUPUS FERRI PHOSPHATIS (granulated sulphate of iron, phosphate of soda, acetate of soda, diluted phosphoric acid, refined sugar and distilled water); contains 1 grain of $Fe_3(PO_4)_2$ in 1 fluid drachm.

Dose, 1 fluid drachm.

Therapeutics.— Used in diabetes, and has been recommended for rickets. It is apparently not astringent.

FERRI OXIDUM MAGNETICUM, magnetic oxide of iron (Fe_3O_4) combined with about 20 per cent. of water of hydration, and containing some per-oxide of iron (solution of persulphate of iron, sulphate of iron, solution of soda and distilled water). *Dose*, 5 to 10 grains.

Therapeutics.—The same as of reduced iron. It is cheaper, and probably less effectual.

FERRI PEROXIDUM HYDRATUM, hydrated peroxide of iron (Fe_2O_3,H_2O), (moist peroxide of iron dried at a temperature not exceeding 212°F., until it ceases to lose weight, and then reduced to fine powder). *Dose*, 5 to 30 grains.

Officinal Preparation.—EMPLASTRUM FERRI (hydrated peroxide of iron, Burgundy pitch, and lead plaster).

Therapeutics.—A non-irritant, and useful when it is desired to give large doses of iron, or to continue its use for a long period. Employed beneficially in neuralgia, etc.

FERRI PEROXIDUM HUMIDUM, moist peroxide of iron (hydrated peroxide of iron, with about 86 per cent. of uncombined water: solution of persulphate of iron, solution of soda and distilled water). *Dose*, $\frac{1}{4}$ to $\frac{1}{2}$ ounce.

Therapeutics.—Not administered internally to produce the effects of iron, but as an antidote in arsenic poisoning, in which it is said to be capable of forming in the stomach an insoluble arsenite or arseniate of iron. It is probable, however, that it merely acts mechanically by enveloping the poison, and so shielding the stomach from any further action.

FERRI PERCHLORIDI LIQUOR FORTIOR, strong solution of perchloride of iron (iron wire, hydrochloric acid, nitric acid and distilled water). *Dose*, 3 to 10 minims. Used in the preparation of the following:

(1) LIQUOR FERRI PERCHLORIDI, solution of perchloride of iron (strong solution of perchloride of iron, 5 ounces; distilled water, 15 ounces). This is of the same strength as the tincture following, viz.: 1 in 4. *Dose*, 10 to 30 minims.

(2) TINCTURA FERRI PERCHLORIDI, tincture of perchloride of iron (strong solution of perchloride of iron, 5 ounces; rectified spirit, 15 ounces).

Dose, 10 to 30 minims.

Therapeutics.—A very powerful preparation of iron, useful in passive hæmorrhages and other discharges, and in erysipelas. It is much employed as a blood-restorer.

FERRI PERNITRATIS LIQUOR, solution of pernitrate of iron (iron wire, free from rust, nitric acid and distilled water).

Dose, 10 to 40 minims.

Therapeutics.—Powerfully astringent and tonic, and used in the same cases for which the perchloride is prescribed.

FERRI PERSULPHATIS LIQUOR, solution of persulphate of iron (proto-sulphate of iron, sulphuric acid, nitric acid and distilled water, boiled until the persalt is formed). Is used in the preparation of other iron salts, but not given medicinally. Very astringent.

FERRI ET AMMONIÆ CITRAS, citrate of iron and ammonia (solution of persulphate of iron, solution of ammonia, citric acid and distilled water). Dose, 5 to 10 grains upwards.

Officinal Preparation.—VINUM FERRI CITRATIS, wine of citrate of iron (citrate of iron and ammonia, 160 grains; orange wine, 1 pint). *Dose*, 1 to 4 drachms.

Therapeutics.—Possesses but little astringency, and is very effectual as a blood-restorer. Is well adapted for children, and may be employed when more styptic ferruginous preparations are not well tolerated.

Incompatibles.—Tannin solutions, since these turn black, and caustic alkalies, which precipitate the oxide.

FERRUM TARTARATUM, tartarated iron (solution of persulphate of iron, solution of ammonia, acid tartrate of potash, and distilled water). *Dose*, 5 to 10 grains.

Therapeutics.—Exactly similar in action to the ammonio-citrate.

FERRI ET QUINIÆ CITRAS, citrate of iron and quinine (solution of persulphate of iron, sulphate of quinia, diluted sulphuric acid, citric acid, solution of ammonia, distilled water). *Dose*, 5 to 10 grains.

Therapeutics.—Combines the properties of iron and quinine; must not be given with alkalies, since by these the quinine is precipitated.

Adulterations.—Cinchona and deficiency of quinine.

STIBIUM. Antimony. Sb = 122.

orange with H_2

ANTIMONIUM NIGRUM. Black Antimony. The native sulphide (Sb_2S_3), purified from siliceous matter by fusion, and afterwards reduced to a fine crystalline powder, having a steel-grey colour.

ANTIMONIUM SULPHURATUM, sulphurated antimony (containing the sulphide of antimony, Sb_2S_3, with a small and variable amount of the oxide, Sb_2O_3). *Dose*, 1 to 5 grains. Contained in Pilula Hydrargyri Subchloridi Composita.

Sb_2
H_2S
Nat

Therapeutics.—This substance is rather uncertain in its action, from its slight solubility; but it is used for the same purposes as the other preparations of antimony.

ANTIMONIUM TARTARATUM, tartarated antimony, tartar emetic ($KSbC_4H_4O_7$). This is in reality a double tartrate of potash and antimony, and is prepared by the addition of the antimonious oxide (Sb_2O_3) to acid tartrate of potash ($KHC_4H_4O_6$). Thus—

$$Sb_2O_3 + 2KHC_4H_4O_6 = H_2O + 2KSbC_4H_4O_7.$$

Officinal Preparations:

(1) VINUM ANTIMONIALE (tartarated antimony in sherry). 2 grains of the salt to the ounce. *Dose*, 5 minims to 1 drachm.

(2) UNGUENTUM ANTIMONII TARTARATI (tartar emetic, 2 drachms, and simple ointment 1 ounce).

Therapeutics.—In small doses tartar emetic, when internally administered, acts upon the skin and mucous membranes. It is expectorant, diaphoretic, and possibly cholagogue. In larger doses it is at first emetic, then occasionally purgative; if continued for some time a powerful sedative effect is produced upon the vascular system and in all the muscles. *Externally* it is powerfully irritant, producing pustules resembling those of small-pox, and there is danger of its becoming absorbed, especially in young children. It is employed in febrile conditions to promote secretions, and as a vascular depressant in severe inflammations.

Dose, as a diaphoretic and expectorant, $\frac{1}{16}$ to $\frac{1}{6}$ of a grain.
" as a vascular depressant and sedative, $\frac{1}{6}$ to 1 grain.
" as an emetic, 1 to 3 grains.

Incompatibles.—Acids, alkalies and their carbonates, lime, lead and astringent vegetable infusions.

Adulterations.—Cream of tartar and iron.

ANTIMONII OXIDUM.—Antimonious oxide (Sb_2O_3) is prepared from the terchloride ($SbCl_3$) by the addition of carbonate of soda (Na_2CO_3) and water. *Dose,* 1 to 4 grains.

P *Officinal Preparation.*—PULVIS ANTIMONIALIS (oxide of antimony, 1 ounce ; and phosphate of lime, 2 ounces).

Dose, 3 to 10 grains.

Therapeutics.—Analogous to tartar emetic, but much less active in its operation ; dissolves slowly in the stomach, and is less likely on that account to cause irritation.

ANTIMONII CHLORIDI LIQUOR (sulphide of antimony dissolved slowly in hydrochloric acid ; 1 pound to 4 pints).

Therapeutics.—Powerfully caustic and escharotic ; sometimes applied to cancerous growths and poisoned wounds, bites of snakes, etc. It is never used internally.

BISMUTHUM. Bismuth. Bi = 210.

BISMUTHUM PURIFICATUM, purified bismuth (bismuth, 10 ounces ; nitrate of potash in powder, 2 ounces).

BISMUTHI SUBNITRAS, subnitrate of bismuth ($BiNO_4 + H_2O$) (purified bismuth, nitric acid and distilled water).

Dose, 5 to 20 grains in powder, or suspended by means of mucilage of tragacanth or gum arabic.

Officinal Preparation.—TROCHISCI BISMUTHI (subnitrate of bismuth, carbonate of magnesia, precipitated carbonate of lime, refined sugar, gum acacia, mucilage of gum acacia and rose water). Each lozenge contains 2 grains of the salt of bismuth. *Dose,* 1 to 6 lozenges.

Therapeutics.—When taken internally, acts as a direct sedative upon the mucous membrane of the stomach and intestines. It is largely used in the treatment of irritative dyspepsia, especially when pyrosis or water-brash is a prominent symptom. May be given in chronic vomiting. It has been stated to be valuable in checking the diarrhœa of phthisis. Externally it is used as a topical sedative in affections of the skin, and as an injection in gleet and leucorrhœa. Has been largely used as a cosmetic for giving the peculiar whiteness to the complexion termed enamelling.

Adulterations.—Carbonate of lead, and occasionally arsenic.

* LIQUOR BISMUTHI ET AMMONIÆ CITRATIS, solution of citrate of bismuth and ammonia (purified bismuth, nitric acid, citric acid, solution of ammonia and distilled water).

Dose, $\frac{1}{2}$ to 1 fluid drachm.

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* Each fluid drachm contains 3 grains of oxide of bismuth.

Therapeutics.—Appears to act like the subnitrate, and is considered by some authors to be more powerful on account of the more soluble condition of the metal.

Bismuthi Carbonas, carbonate of bismuth ($2(Bi_2CO_5) + H_2O$), (purified bismuth, nitric acid, carbonate of ammonia and distilled water). *Dose,* 5 to 20 grains.

Therapeutics.—Acts probably in the same manner as the subnitrate.

Bismuthi Oxidum, oxide of bismuth (Bi_2O_3), (subnitrate of bismuth and solution of soda). *Dose,* 5 to 15 grains.

Therapeutics.—Similar to the other preparations of bismuth.

PLUMBUM. Lead. Pb = 207.

Plumbi Oxidum, oxide of lead (PbO), (made during the cupellation of lead ores containing silver, the oxide becoming semi-vitrified or fused).

Officinal Preparation.—Emplastrum Plumbi, lead plaster (oxide of lead, olive-oil, and water).

Therapeutics.—Never given internally. The plaster, in which the lead is combined with oleic and margaric acid, is used as a mechanical support.

Plumbi Iodidum, iodide of lead (PbI_2) (nitrate of lead, iodide of potassium and distilled water).

Dose, ¼ to 1 grain or more.

Officinal Preparations.—(1) Emplastrum Plumbi Iodidi, iodide of lead plaster (iodide of lead, soap and resin plaster).

(2) Unguentum Plumbi Iodidi, iodide of lead ointment (iodide of lead 62 grains, and simple ointment 1 ounce).

Therapeutics.—Externally acts as a mild stimulant, and has been used as the plaster or ointment for scrofulous enlargement of joints. By long continued use the metal may become absorbed. It is occasionally used internally, but has no advantage over other iodides in the treatment of scrofulous tumours.

Plumbi Acetas, acetate of lead ($Pb(C_2H_3O_2)_2 3H_2O$) (oxide of lead, acetic acid and distilled water).

Dose, 1 to 4 grains.

Officinal Preparations.—(1) Pilula Plumbi cum Opio, pill of lead and opium (acetate of lead, opium, and confection of roses). 1 grain of opium is contained in 8 grains of the pill mass. *Dose,* 4 to 8 grains.

* (2) Suppositoria Plumbi Composita, compound lead suppositories (acetate of lead, opium, benzoated lard, white wax, and oil of theobroma).

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* 3 grains of acetate of lead and 1 grain of opium in each suppository.

(3) UNGUENTUM PLUMBI ACETATIS, ointment of acetate of lead (acetate of lead, 12 grains, and benzoated lard, 1 ounce).

Therapeutics of the Lead Salts.—In small doses acetate of lead is sedative and astringent, diminishing morbid mucous discharges and hæmorrhages, and even the natural secretions. It induces constipation, thirst, and the well-known painters' colic, accompanied by the blue line round the gums. When long continued, wasting of the body is induced, the nervous system is affected, neuralgic pains occur in the limbs, and eventually the extensors of the hand lose their power (dropped wrist). Apoplexy, and sometimes complete paralysis supervene. Anæmia is one of the marked effects of the use of acetate of lead and other lead preparations. From the prevalence of gout in painters and plumbers, it would appear that lead, when taken for any long period, causes impregnation of the blood with uric acid. The above serious symptoms are usually produced by contact with lead, either by the nature of the occupation or by drinking water containing the metal; but acetate of lead is employed medicinally to check hæmorrhages, for the treatment of diarrhœa and dysentery, and to lessen the expectoration and excessive sweatings of phthisis.

LIQUOR PLUMBI SUBACETATIS, solution of sub-acetate of lead ($Pb(C_2H_3O_2)_2PbO$), (acetate of lead, oxide of lead and distilled water).

Officinal Preparations.—(1) LIQUOR PLUMBI SUBACETATIS DILUTUS, diluted solution of subacetate of lead (solution of subacetate of lead, rectified spirit and distilled water). This is usually known as Goulard water.

(2) UNGUENTUM PLUMBI SUBACETATIS COMPOSITUM, compound ointment of subacetate of lead (solution of subacetate of lead, camphor, white wax and oil of almonds).

Therapeutics.—An astringent and sedative; only used externally. The diluted solution is generally used when the topical action of lead is required.

PLUMBI CARBONAS, carbonate of lead (Pb_2CO_3,PbO ?). (By the exposure of sheets of metallic lead to acetic and carbonic acid fumes from vinegar and spent tan.)

Officinal Preparation.—UNGUENTUM PLUMBI CARBONATIS, ointment of carbonate of lead (carbonate of lead, 62 grains, and simple ointment, 1 ounce).

Therapeutics.—Not used internally. Applied externally it acts as a local astringent and sedative, and is used in a similar manner to the subacetate. May be powdered upon diseased surfaces, either alone or mixed with starch.

PLUMBI NITRAS, nitrate of lead ($Pb(NO_3)_2$), (lead and nitric acid slightly diluted the result being crystallised out). This salt is employed in the preparation of the iodide of lead.

CUPRUM. Copper. Cu = 63·5.

FINE COPPER WIRE.—Used in the preparation of cupri sulphas and spiritus ætheris nitrosi.

CUPRI SULPHAS, sulphate of copper ($CuSO_4 + 5H_2O$). (By heating sulphuric acid and copper together, dissolving the soluble product in hot water and evaporating the solution until crystallisation takes place on cooling.)

Dose, as an *astringent*, ¼ to 2 grains; as an *emetic*, 5 to 10 grains; *externally*, 1 to 10 grains or more to an ounce of water.

Therapeutics.—In small doses internally an astringent to the alimentary canal; suitable for obstinate diarrhœa and dysentery; after absorption, a tonic to the nervous system, and employed in chorea and epilepsy.

In large doses a quick, powerful emetic, given in some cases of narcotic poisoning, but its use is open to objection. Externally it may be applied, in the form of powder or in strong solution, to extensive granulations and ulcers, or in weaker solution to diminish the excessive secretions from mucous membranes in gleet and ophthalmia.

Adulterations.—The commercial salt may contain sulphate of iron; sulphate of zinc is sometimes a fraudulent addition.

ANHYDROUS SULPHATE OF COPPER ($CuSO_4$), (the sulphate deprived of its water by a heat of 400°F). Used as a test.

SOLUTION OF AMMONIO-SULPHATE OF COPPER, sulphate of copper, solution of ammonia and distilled water. Merely introduced as a test for the qualitative analysis of liquor ammoniæ fortior.

The formula of the contained salt is as follows:

$$CuSO_4,4NH_3,H_2O.$$

SUBACETATE OF COPPER OF COMMERCE.—Verdigris (Ærugo) ($(C_2H_3O_2)_2Cu,CuO$), (copper plates exposed to the action of the fermenting marc of grapes, or pyroligneous acid, the salt forming on the surface).

Therapeutics.—Verdigris is occasionally applied externally as an escharotic, either in powder, mixed with vinegar or honey, or under the title of Linimentum Æruginis.

Adulteration.—Sometimes contains chalk and sulphate of copper.

HYDRARGYRUM. Mercury. Hg = 200.

Chiefly obtained from the native sulphide, cinnabar, by distillation with iron.

= Pappion

Officinal Preparations.—Liquid mercury is seldom used in medicine, but some of its preparations are valuable from the presence of mercury in a finely-divided condition.

(1) HYDRARGYRUM CUM CRETA, mercury with chalk (mercury, 1 ounce; prepared chalk, 2 ounces, rubbed together until metallic globules are no longer visible, and the mixture acquires a uniform grey colour). *Dose,* 3 to 8 grains.

(2) PILULA HYDRARGYRI, mercurial pill or blue pill (mercury, confection of roses, and powdered liquorice root). *Dose,* 3 to 8 grains.

(3) EMPLASTRUM HYDRARGYRI, mercurial plaster (mercury, olive-oil, sulphur and lead plaster).

(4) EMPLASTRUM AMMONIACI CUM HYDRARGYRO, ammoniac and mercury plaster (ammoniacum, mercury, olive-oil and sulphur.

(5) UNGUENTUM HYDRARGYRI, mercurial ointment; blue ointment (mercury, prepared lard, and prepared suet).

(6) UNGUENTUM HYDRARGYRI COMPOSITUM, compound mercury ointment (ointment of mercury, yellow wax, olive-oil and camphor).

(7) LINIMENTUM HYDRARGYRI, liniment of mercury (mercurial ointment, solution of ammonia and liniment of camphor).

(8) SUPPOSITORIA HYDRARGYRI, mercurial suppositories (ointment of mercury, benzoated lard, white wax and oil of theobroma).

Therapeutics of the MERCURIAL SALTS IN GENERAL:

Mercury, when taken into the stomach in a liquid form, appears to exert no influence upon the economy, and even pounds have been swallowed without inducing any particular symptoms; but occasionally, in consequence of partial oxidation and absorption, the full effects of the metal have ensued. Mercury, in vapour, acts very energetically, and when taken internally, or when rubbed upon the surface of the body, in a fine state of division, the same results are observed. In small doses mercurials increase the various secretions, and hence they are said to be sialagogue, cholagogue, diuretic and emmenagogue. They also promote the absorption of morbid fluids by increasing the activity of the absorbent system and preventing deposition. However administered, mercury becomes absorbed into the blood, and may be found in milk, saliva, sweat, urine, bile, pus from ulcers, and in various tissues, as bone, synovial and serous membranes, brain, lungs, and cellular tissue. If administered internally for some time, the red globules of the blood are diminished in quantity, and anæmia is produced. Internally mercurials are employed in the following diseases :

(1) In *internal congestions,* as of the liver and kidneys ; increasing their secretion and relieving their vessels.

(2) In *acute and chronic inflammations.* More useful in inflammation of serous than of mucous membranes, but mercurials are hurtful in scrofulous or erythematous inflammation, and in all inflammatory actions of a low type.

(3) In *acute rheumatism ;* their utility in this affection is doubtful.

(4) In *dropsies arising from inflammation of serous membranes and disease of the liver ;* but injurious when dependent upon chronic diseases of the kidney.

(5) In *syphilis.* (6) Externally, as the ointment and plaster, a topical stimulant action is produced, the metal becoming absorbed and affecting the system generally. These preparations are used over chronically inflamed and indurated parts, and occasionally to introduce the mineral into the system by "inunction."

The pulvis hydrargyri c̄ cretâ is one of the mildest forms of employing mercury. It exerts a very slight influence upon the mucous membrane, and may be used in such irritable conditions of the intestines as diarrhœa. The pilula hydrargyri is also comparatively unirritating. The external applications—the blue and compound ointments—cause but little local action, and their employment is useful in inducing the constitutional effects of mercury through the agency of the skin. The mercurial plaster and suppository also produce the local effect of the mineral.

Effects of excessive action, or over doses of mercurials :

Profuse ptyalism, swelling of the salivary glands and the tongue, redness and swelling of the gums, ulceration of the mucous membrane of the mouth, loosening of the teeth and necrosis of the jaw, excessive purging, with bilious stools, the eczema mercuriale, inflammation of the bone (ostitis) and periosteum (periostitis), mercurial erethism, *i.e.*, a low febrile condition, accompanied by intense prostration, neuralgic pains, the tremor mercurialis, partial and sometimes complete paralysis and death. These symptoms are usually observed in those who are exposed to the action of the vapour of mercury.

Circumstances which modify the action of mercurials :

Age ; children tolerate the drug much better than adults. Acute inflammation resists the action of mercurials, whereas in kidney disease, scrofula and scurvy, the constitution is very sensitive to mercury.

HYDRARGYRI SUBCHLORIDUM, subchloride of mercury, calomel ($HgCl$), (sulphate of mercury, mercury, chloride of sodium, dried, and boiling distilled water). *Dose,* ½ to 5 grains.

Officinal Preparations.—(1) LOTIO HYDRARGYRI NIGRA, black mercurial lotion (calomel and lime-water); 3 grains to the ounce.

(2) PILULA HYDRARGYRI SUBCHLORIDI COMPOSITA, compound pill of subchloride of mercury (calomel, sulphurated antimony, guaiacum resin, and castor oil). *Dose,* 5 to 10 grains.

(3) UNGUENTUM HYDRARGYRI SUBCHLORIDI, ointment of subchloride of mercury (calomel and prepared lard).

Therapeutics.—Calomel produces little local irritation. It increases the secretion of bile and other intestinal fluids, and hence may be given as an adjunct in liver diseases, and in cases of obstruction to the portal circulation. Produces in children the so-called "calomel-stools," or greenish-coloured fæces.

Dose, as a *purge,* 2 to 5 grains. To affect the system, ½ to 1 grain or more. It should not be given with alkaline carbonates, since there is a possibility of the formation of the perchloride of mercury.

Adulterations.—Perchloride of mercury, formed in its preparation, and intentional impurities, as sulphate and carbonate of baryta.

HYDRARGYRI PERCHLORIDUM, perchloride of mercury, corrosive sublimate ($HgCl_2$), (sulphate of mercury, chloride of sodium and black oxide of manganese, the last being added in order to generate with the excess of common salt some free chlorine, which prevents the formation of calomel from the subsulphate of mercury, which the sulphate of mercury sometimes contains).

Officinal Preparations.—(1) LIQUOR HYDRARGYRI PERCHLORIDI, solution of perchloride of mercury (perchloride of mercury, chloride of ammonium and distilled water). ½ grain of the mercurial salt to the ounce of the liquor.

Dose, ½ fluid drachm to 2 fluid drachms.

(2) LOTIO HYDRARGYRI FLAVA, yellow mercurial lotion (perchloride of mercury and solution of lime). 18 grains to 10 fluid ounces.

Therapeutics—A powerful irritant. In large doses causes burning pain at the epigastrium, with vomiting and purging. In very small doses it is an alterative, useful in chronic affections, syphilitic or otherwise, in the scaly skin affections (squameæ) and in periosteal affections. Externally, $HgCl_2$ is employed as a lotion, injection, gargle, or ointment, in chronic skin diseases, ulcerated sore throats, and chronic discharges from the mucous membranes.

Dose, $\frac{1}{16}$ to $\frac{1}{8}$ grain in solution, or in pill with crumb of bread.

Incompatibles.—Preparations containing albumen or tannin, It is also thrown down by alkalies, alkaline sulphides, iodides, and tartar emetic.

HYDRARGYRUM AMMONIATUM, ammoniated mercury (NH_2HgCl), (perchloride of mercury, solution of ammonia and distilled water).

Officinal Preparation.—(1) UNGUENTUM HYDRARGYRI AMMONIATI, ointment of ammoniated mercury (ammoniated mercury, 62 grains ; simple ointment, 1 ounce).

Therapeutics.—Never employed internally. Used externally for destroying pediculi, and as a stimulating application to chronic skin affections.

Adulterations.—Chalk, carbonate of lead, plaster of Paris, etc.

HYDRARGYRI IODIDUM VIRIDE, green iodide of mercury (HgI), (mercury and iodine rubbed together, rectified spirit being added to assist pulverisation and prevent detonation).

Therapeutics.—Similar to calomel, but less purgative, and more readily affecting the system. Externally alterative, and useful in chronic skin diseases. *Dose*, 1 to 3 grains.

Adulterations.—May contain a little red iodide.

HYDRARGYRI IODIDUM RUBRUM, red iodide of mercury (HgI_2), (perchloride of mercury, iodide of potassium and boiling distilled water). Thus—

$$HgCl_2 + 2KI = 2KCl + HgI_2.$$

Perchloride of mercury and iodide of potassium yield chloride of potassium and periodide of mercury.

Dose, $\frac{1}{16}$ to $\frac{1}{4}$ of a grain.

Officinal Preparations. — (1) UNGUENTUM HYDRARGYRI IODIDI RUBRI, ointment of red iodide of mercury. 16 grains of the red iodide to 1 ounce of simple ointment.

Therapeutics. — Closely resembles corrosive sublimate. Chiefly used externally for enlarged glands and syphilitic and periosteal nodes, and in goitre. Internally, in the same cases as corrosive sublimate.

HYDRARGYRI OXIDUM RUBRUM, red oxide of mercury (HgO), (mercury, nitric acid and water).

Officinal Preparation.—UNGUENTUM HYDRARGYRI OXIDI RUBRI (red oxide of mercury, yellow wax and oil of almonds). 1 grain in 8.

Therapeutics.—Only used externally. Applied to the eyes in ophthalmia, and to indolent ulcers in the form of ointment. In powder it is escharotic, and may be used alone, or mixed with sugar, to specks in the cornea, over chancres, excrescences, and fungoid ulcers.

Adulterations.—Brick-dust, red lead and other red powders.

HYDRARGYRI OXIDUM FLAVUM, yellow oxide of mercury (perchloride of mercury, solution of soda and distilled water). This, when dried, is really the same as the red oxide; it is inserted in the appendix of the "British Pharmacopœia."

HYDRARGYRI NITRATIS LIQUOR ACIDUS, acid solution of nitrate of mercury (mercury, nitric acid and distilled water).

Officinal Preparation.—UNGUENTUM HYDRARGYRI NITRATIS, ointment of nitrate of mercury (mercury, nitric acid, prepared lard and olive-oil).

Therapeutics.—Never used internally. It is powerfully caustic. The ointment is stimulant, and, when diluted, is exceedingly useful in eye affections, as tinea tarsi, and in some skin diseases.

HYDRARGYRI SULPHAS, sulphate of mercury ($HgSO_4$) (mercury, sulphuric acid and heat). Merely used for the preparation of calomel and corrosive sublimate. Is never used internally.

ARGENTUM. Silver. Ag = 108.

ARGENTUM PURIFICATUM.—Purified silver, used for coating pills.

ARGENTI NITRAS, nitrate of silver ($AgNO_3$), (refined silver, nitric acid and distilled water). Used in the preparation of oxide of silver. *Dose*, $\frac{1}{6}$ to $\frac{1}{3}$ of a grain in the form of a pill.

Incompatibles.—Distilled water must always be used with it, since water in the natural state will cause a white precipitate of the carbonate of silver. It decomposes almost all vegetable infusions.

Therapeutics.—Externally it is astringent, irritant, and vesicant, and is used with great advantage for poisoned wounds and ulcers, venereal or otherwise, pustules and erysipelas. It destroys warts, chancres, morbid growths, etc. Internally, in small doses, nitrate of silver is astringent, and alterative to the mucous membrane of the stomach and intestines. It is also tonic, and is sometimes administered in chronic gastric affections, gastrodynia, pyrosis and vomiting, or even in malignant and organic diseases of the stomach. It enjoys much repute on the Continent for the treatment of epilepsy and chorea; but its internal use must not be of long continuance, since it may communicate to the skin a permanent leaden hue.

Adulterations.—May contain copper or lead, or, in a fused form, nitrate of potash.

ARGENTI OXIDUM, oxide of silver (Ag_2O), (solution of lime, nitrate of silver and distilled water). An olive-brown powder. *Dose,* $\frac{1}{2}$ to 2 grains in a pill.

Incompatibles.—Decomposes many organic substances, and is particularly incompatible with creosote, with which it forms a substance prone to spontaneous combustion.

Therapeutics.—Similar to the nitrate, only that the topical action is slight. May be given as a nervine tonic, and in dyspepsia.

AURUM. Gold. Au = 197.

Fine gold, in mass or leaf.

Therapeutics.—Gold in very fine division as PULVIS AURI, and in the forms of the CHLORIDE and TRIOXIDE, has been sometimes employed medicinally. Its action is apparently similar to that of mercury. It has been chiefly used in the treatment of scrofulous and venereal affections. The most common preparation used is the DOUBLE CHLORIDE OF GOLD AND SODIUM ($NaCl, AuCl_3 + 2H_2O$). *Dose,* of powdered gold, $\frac{1}{4}$ to 1 grain; of the trioxide (Au_2O_3), $\frac{1}{10}$ of a grain upwards; of the trichloride ($AuCl_3$), or the auro-chloride of sodium, $\frac{1}{20}$ of a grain upwards. The chloride in large doses is excessively poisonous, acting in a similar manner to corrosive sublimate.

CERIUM. Ce = 92.

CERII OXALAS, oxalate of cerium ($CeC_2O_4 + 3H_2O$), (a salt which may be obtained as a precipitate by adding a solution of oxalate of ammonia to a solution of chloride of cerium).

Dose, 1 to 2 grains.

Therapeutics.—Appears to act as a local sedative, and subsequently upon the general system as a nervine tonic. It has been used in gastrodynia, pyrosis and vomiting, in the same way as subnitrate of bismuth and nitrate of silver. Has enjoyed much repute in the vomiting of early pregnancy and in sea-sickness, and is also given in epilepsy and chorea, in nervous palpitations and convulsive coughs.

[illegible]

·735 : do

·795 : C_2H_6O

·818 : $C_5H_{12}O$

·838 : $C_2H_6O+16H_2O$

·920 : proof spirit

APPENDIX.

ALCOHOLIC AND ETHEREAL PREPARATIONS, ETC.

ALCOHOL. Absolute Alcohol. C_2H_6O.

Obtained from rectified spirit, carbonate of potash and slaked lime. Specific gravity, 0·795.

Use.—Never administered as a medicine. Is used as a solvent, and as a test for the purity of some chemical substances.

Spiritus Rectificatus ($C_2H_6O + 16H_2O$) rectified spirit consists of alcohol, with 16 per cent. of water; obtained by the distillation of fermented saccharine fluids. Contains 84 per cent. of absolute alcohol. Specific gravity, 0·838.

Spiritus Tenuior, proof spirit; prepared by the addition of 3 pints of distilled water to 5 pints of rectified spirit. Contains 49 per cent. of alcohol. Specific gravity, 0·920.

Use.—Rectified spirit is employed in pharmacy, in the preparation of many tinctures and spirits, when the substances contain a large amount of resin or volatile oil. Proof spirit is used when these principles are not abundant.

Therapeutics.—Sometimes used as an application to sore nipples.

Spiritus Vini Gallici, brandy. Spirit distilled from French wine. Contains 53 per cent. of alcohol, volatile oil and œnanthic ether. It is white when first distilled, but in the cask it generally acquires a light sherry colour; burnt sugar is often added to produce the same effect.

Officinal Preparation.—Mistura Spiritus Vini Gallici (spirit of French wine, cinnamon water, of each 4 fluid ounces, yolk of two eggs, and refined sugar, ½ ounce).

Therapeutics.—A powerful diffusible stimulant, given in syncope, typhus and typhoid fever, etc.

Vinum Xericum, sherry, a Spanish wine. Contains usually from 17 to 18 per cent. of alcohol, colouring matters, œnanthic ether, bitartrate of potash, malates, and sugar.

Sherry is used in making most of the wines of the Pharmacopœia, as—

Vinum Aloes.
,, Antimoniale.
,, Colchici.
,, Ferri.
Vinum Ipecacuanhæ.
,, Opii.
,, Rhei.

Cape and other white wines are often substituted for sherry.

Therapeutics.—Much the same as brandy, but less powerful.

Vinum Aurantii.—Orange wine ; made in Britain by the fermentation of a saccharine solution, to which the fresh peel of the bitter orange has been added. Contains about 12 per cent. of alcohol.

Officinal Preparations.—Vinum Ferri Citratis and Vinum Quiniæ.

CEREVISIÆ FERMENTUM. Beer yeast.

The ferment obtained in the brewing of beer.

Dose, ½ to 1 ounce.

Officinal Preparation.—Cataplasma Fermenti, yeast poultice (beer yeast, wheaten flour, and water heated to 100°F.).

Therapeutics.—Externally applied, it is stimulant and antiseptic, and is used for indolent ulcers. Internally it has been given in low states of the system. It has been said to prevent the formation of boils and carbuncles.

ÆTHER ($(C_2H_5)_2O$). Sulphuric Ether.

A volatile liquid obtained from alcohol, and containing not less than 92 per cent. by volume of pure ether. It is prepared from the following ingredients, viz. : rectified spirit, sulphuric acid, chloride of calcium, slaked lime and distilled water. Specific gravity ·735. The preparation may, however, be represented in the following equations. Thus—

Alcohol.		Sulphuric Acid.		Water.		Sulphovinic Acid.
(*a*) C_2H_6O	+	H_2SO_4	=	H_2O	+	C_2H_6,SO_4.

Sulphovinic Acid.		Alcohol.		Sulphuric Acid		Ether.
(*b*) $C_2H_6SO_4$.	+	C_2H_6O	=	H_2SO_4	+	$(C_2H_5)_2O$

The above is called the *Continuous Etherification Process,* since during the operation the sulphovinic acid is being constantly formed and decomposed, and thus a continuous supply of ether is produced.

Dose, 20 minims to 1 drachm.

Spiritus Ætheris.—Ether, 10 ounces, and rectified spirit, 1 pint. Specific gravity, 0·809. *Dose*, ½ drachm to 1 drachm.

Use.—Ether is used for preparing the ether purus, and for making collodion and the epispastic solution. Spirit of ether is employed in making the ethereal tincture of lobelia.

Therapeutics.—A powerful diffusible stimulant, used to correct flatulency, and for allaying pain and cramp in the stomach, and to diminish spasm in spasmodic asthma, angina pectoris and hysteria. When applied externally it produces cold by its rapid evaporation, and is employed in the reduction of hernia. In the form of vapour its action is anæsthetic and not unlike chloroform.

ÆTHER PURUS. Pure Ether ($(C_2H_5)_2O$).

Ether, freed from alcohol and water, is prepared by washing ether with water, and digesting for 24 hours with recently-burnt lime and chloride of calcium, and distilling at a gentle heat. The specific gravity should not exceed 0·720. It is a powerful solvent of fixed and volatile oils, resins, some alkaloids, gun-cotton, iodine, bromine, perchloride of mercury, etc.

Adulterations.—May contain alcohol, which increases the specific gravity and causes it to coagulate the serum of the blood. It may also contain water and sulphurous anhydride, adding to its weight and giving it an acid reaction.

Spiritus Ætheris Nitrosi, spirit of nitrous ether. This contains nitrite of ethyl ($C_2H_5NO_2$). Prepared from nitric acid, sulphuric acid, copper in fine wire and rectified spirit. By the action of the nitric acid upon the copper wire nitrous acid is generated, and this, uniting with the ether given off by the action of the sulphuric acid upon the rectified spirit, produces the nitrite of ethyl. *Dose*, ½ drachm to 2 drachms.

Therapeutics.—A stimulant, diaphoretic and diuretic. Used in dropsies and in slight febrile affections.

Adulteration.—Excess of acid, from being kept too long or being improperly prepared.

Æther Aceticus, acetic ether ($C_2H_5,C_2H_3O_2$), (acetate of ethyl). Obtained by distilling the dry acetate of soda ($NaC_2H_3O_2$) with rectified spirit (C_2H_5HO) and sulphuric acid (H_2SO_4), then adding chloride of calcium, allowing the mixture to stand for 24 hours, and finally decanting the ethereal fluid. The equation may be represented thus—

$$NaC_2H_3O_2 + C_2H_5HO + H_2SO_4 = H_2O + NaHSO_4 + C_2H_5,C_2H_3O_2.$$

Water, bisulphate of soda and acetic ether are formed.

Therapeutics.—A stimulant and anti-spasmodic, like sulphuric ether, only less powerful. *Dose*, 20 to 60 minims.

+ $CaCl_2$ + $CaClO_2$

CHLOROFORMUM. Chloroform. $CHCl_3$.

$Cl + CH_4$

This has also been termed terchloride of formyl. It is prepared from chlorinated lime, rectified spirit, slaked lime, water, sulphuric acid, chloride of calcium and distilled water. During this process *two* strata are formed, the lower of which is crude chloroform, and this is purified by redistillation.

When exposed to air and light, $CHCl_3$ is apt to decompose into hydrochloric acid and free chlorine. It is also decomposed by fixed alkalies. Specific gravity, from 1·48 to 1·496. *Dose*, 1 minim to 10 minims.

Officinal Preparations.—(1) Aqua Chloroformi (1 drachm of $CHCl_3$ to 25 ounces of water). *Dose*, ½ drachm to 2 ounces.

(2) Linimentum Chloroformi, liniment of chloroform (chloroform and camphor liniment, of each 2 fluid ounces).

(3) Spiritus Chloroformi (chloroform, 1 fluid ounce; rectified spirit, 19 fluid ounces). Specific gravity, 0·871. *Dose*, 10 minims to 60 minims.

(4) Tinctura Chloroformi Composita, compound tincture of chloroform (chloroform, 2 fluid ounces; rectified spirit, 8 fluid ounces; and compound tincture of cardamoms, 10 fluid ounces). *Dose*, 20 to 60 minims.

Therapeutics.—Internally, in small doses, chloroform is sedative and antispasmodic. In large doses it produces great diminution of the power of sense, there being no exhilaration or acceleration of the pulse. It is employed in spasmodic cough, asthma, chorea, lead colic and hysteria. Externally it is applied to allay pain in neuralgia and itching in skin affections. Inhaled in small doses it is slightly inebriant, impairing vision and common sensibility, consciousness remaining. The sensations are often said to be pleasurable at first, but if inhalation be continued a dreamy condition is induced, and subsequently there is loss of voluntary motion, the eyes incline upwards, the mental faculties are suspended, the muscles are slightly contracted and the limbs rigid. At length there is complete relaxation of the voluntary muscles, the respiration continues with slight stertorous breathing. The iris is insensible to light, and moderately contracted. Inhalation of the vapour is made use of in tetanus, hydrophobia, colic, during the passage of gall stones and renal calculi. The dangerous indications are syncope and apnœa. Chloroform may be detected in the blood by passing the vapour from this fluid through a red-hot tube; it is then decomposed into hydrochloric acid and free chlorine, which may be allowed to act either upon nitrate of silver, forming the white chloride of silver soluble in liquor ammoniæ, or upon starch paper soaked in a solution of iodide of potassium, when the blue iodide of starch will be developed.

Adulterations.—Hydrochloric acid and free chlorine, and sometimes oily matters formed during the preparation.

ALCOHOL AMYLICUM. Amylic Alcohol. Fousel Oil. ($C_5H_{12}O$.)

This is also called hydroxide of amyl ($C_5H_{11}HO$). Specific gravity, 0·818. It is an oily liquid contained in the crude spirit produced by the fermentation of saccharine solutions with yeast, and is separated in the distillation of such crude spirit. By oxidation $C_5H_{12}O$ is converted into *Valerianic Acid* ($C_5H_{10}O_2$). It is employed in the preparation of SODÆ VALERIANAS, valerianate of soda.

AMYL NITRIS. Nitrite of Amyl. $C_5H_{11}NO_2$.

This is an ethereal liquid, with a peculiar odour and yellowish colour. It is produced by the action of nitrous vapours (N_2O_4) upon amylic alcohol ($C_5H_{11}HO$). Thus—

$$C_5H_{11}HO + N_2O_4 = HNO_3 + C_5H_{11}NO_2.$$

Nitric acid and amyl nitrite are formed.

Dose, by inhalation, 2 to 5 minims, on lint; internally, ½ to 5 minims, dissolved in rectified spirit.

Therapeutics.—When inhaled a great and rapid fall of blood-pressure is caused, the action of the heart being increased. If continued, suffocation, convulsions, and death may follow. Sugar is found in the urine several hours after the vapour has been administered. This substance has been inhaled with good effect in cases of angina pectoris, in spasmodic asthma, and several forms of neuralgia. It should be given cautiously, especially in those old persons whose vessels are rigid.

CHLORAL HYDRAS. Hydrate of Chloral. C_2HCl_3O,H_2O.

CHLORAL is produced by the action of dry chlorine gas (Cl) upon absolute alcohol (C_2H_6O). Thus—

$$C_2H_6O + 8Cl = 5HCl + C_2HCl_3O.$$

It is then purified by treatment, first with sulphuric acid, and afterwards with lime, and finally converted into the solid hydrate by the addition of water. *Dose,* 5 to 30 grains.

Officinal Preparation.—SYRUPUS CHLORAL (hydrate of chloral, 80 grains; distilled water, 4 fluid drachms; and simple syrup, 4 fluid drachms): 10 grains of chloral in 1 fluid drachm. *Dose,* ½ fluid drachm to 2 fluid drachms.

Therapeutics.—Chloral induces natural sleep; but it is far inferior as an anodyne to opium and morphia. It is very valuable in the treatment of delirium tremens, acute mania, and severe chorea; and it may be beneficially employed to relax the spasms in tetanus and strychnia poisoning. In young children, anæmic patients, and in some stages of continued fever, where opium is inadmissible, chloral has been found of great service; and much relief has been obtained from its administration in cases of asthma and whooping cough, and in the sweating and nocturnal sleeplessness of phthisis. Dangerous symptoms of cardiac depression are at times occasioned by a full dose of this drug. Syncope and death may follow giddiness, sickness and delirium, with a weak and irregular pulse. Considerable excitement may be caused if sleep has not been produced, and an eruption of urticaria is sometimes observed. Profound melancholy, feebleness of the will, with langour and debility, are some of the evils ensuing from the habitual use of chloral. The nauseous taste may be disguised by syrup of tolu, or syrup of orange-peel. Alkalies decompose hydrate of chloral into chloroform and a formiate of the base. Thus—

$$2C_2Cl_3HO,H_2O + 2KHO = K_2C_2H_2O_4 + 2H_2O + 2CHCl_3.$$

Hydrate of chloral and liquor potassæ yield formiate of potash, water, and chloroform.

CREASOTUM. Creasote or Kreasote.

A product of the distillation of wood tar. *Dose*, 1 to 3 minims in a pill; as a gargle, ½ drachm to 1 ounce of water.

Officinal Preparations.—MISTURA CREASOTI, creasote mixture (creasote, glacial acetic acid, spirit of juniper, syrup and distilled water; 1 minim in 1 ounce of the mixture). *Dose*, ½ to 3 fluid ounces.

UNGUENTUM CREASOTI (creasote and simple ointment).

VAPOR CREASOTI, inhalation of creasote (creasote, 12 minims, and boiling water, 8 fluid ounces).

Therapeutics.—Internally, in small doses, creasote is a stimulant to the stomach. It has been used in certain forms of vomiting, and sometimes in diarrhœa; in toothache dependent upon caries; as a local application to ulcers and chronic skin disorders; as a topical styptic in hæmorrhages, and as a gargle in mercurial salivation. The vapour is useful in chronic bronchitis with excessive expectoration, and for correcting the fœtor of the sputa in dilatation of the bronchi, in pulmonary abscess and gangrene.

Incompatibles.—When mixed with the oxide of silver, heat is given off, and even flame is produced.

ACIDUM CARBOLICUM. Carbolic or Phenic Acid. HC_6H_5O.

This is obtained from coal-tar oil by fractional distillation and subsequent purification. It occurs in colourless acicular crystals, which readily absorb moisture on exposure to the air. It is but slightly soluble in water, but very soluble in alcohol, ether and glycerine. *Dose,* 1 to 3 grains.

Tests. (1) Coagulates albumen.
(2) Does not redden blue litmus paper.
(3) Gives a *violet* colour with a solution of the perchloride of iron, varying in intensity with the strength of the reagents.
(4) A slip of deal dipped into carbolic acid, and afterwards into nitric or hydrochloric acid, acquires (upon drying) a *greenish-blue* colour.

Officinal Preparations. — GLYCERINUM ACIDI CARBOLICI, glycerine of carbolic acid (4 ounces of glycerine to 1 ounce of carbolic acid).

SUPPOSITORIA ACIDI CARBOLICI c̄ SAPONE, carbolic acid suppositories (carbolic acid, curd soap and starch). 1 grain in each.

Therapeutics.—Carbolic acid acts upon the skin and other parts as a powerful stimulant, and even escharotic. It is also antiseptic. Is used to correct the fœtor of gangrenous and offensive sores, and to remove putrid odours. It is also useful in caries and necrosis; and may be applied to carbuncles, lupus, etc., or for the destruction of hæmorrhoids. Internally it may be given for the same objects as creasote. When incautiously inhaled, or applied to a large extent of surface, poisonous symptoms may arise, such as nausea, vomiting, feeble pulse, and even coma and convulsions. The best antidote is olive-oil. As an external application to ulcers, etc. 1 part of the acid should be mixed with 20 parts of water.

ACIDUM ACETICUM. Acetic Acid. $HC_2H_3O_2$.

This acid is prepared from wood by destructive distillation. It is a colourless liquid, with a very pungent odour and strong acid taste. Specific gravity, 1·044. It is volatile, and leaves no residue when evaporated. It gives a *cherry-red* colour with a solution of perchloride of iron.

Officinal Preparation. — OXYMEL (clarified honey, acetic acid and distilled water). *Dose,* 1 to 2 drachms.

Acetic acid is also contained in LIQUOR EPISPASTICUS.

ACIDUM ACETICUM DILUTUM, diluted acetic acid (acetic acid, 1 pint; and distilled water, 7 pints). *Dose,* 1 to 2 drachms. Used in the preparation of ACETUM SCILLÆ and LIQUOR MORPHIÆ ACETATIS.

P. 301. Roc:

Therapeutics.—Acts as a refrigerant when taken internally, but is seldom used for this purpose. Externally, in the strong form, it is used as a rubefacient, sometimes as a vesicant and escharotic; but the glacial acid is more effectual for such purposes. Much diluted, it may be employed for sponging the surface in fevers, to check excessive sweating, and also as a soothing lotion. It is more frequently used on account of its solvent powers.

Adulterations.—Metallic impurities, as copper and foreign acids.

Acidum Aceticum Glaciale, glacial acetic acid (concentrated acetic acid, corresponding to at least 84 per cent. of the anhydrous acid, $C_4H_6O_3$).*

Officinal Preparations.—Used in the preparation of Acetum Cantharidis and Mistura Creasoti.

Therapeutics.—A caustic, irritant, vesicant and escharotic. chiefly used for external application.

ACIDUM CITRICUM. Citric acid. $H_3C_6H_5O_7,H_2O$.

A crystalline acid, prepared from lemon-juice, or from the juice of the fruit of Citrus Limetta. Prepared chalk is added to the lemon-juice, forming citrate of lime; to this sulphuric acid is added, to precipitate sulphate of lime and set free the citric acid. *Dose*, 10 to 30 grains.

Therapeutics.—Appears to act internally as a refrigerant. Merely allays thirst and irritation of the skin.

The free acid is contained in Vinum Quiniæ, Succus Limonis and Syrupus Limonis.

Adulterations.—Traces of sulphuric and tartaric acids. P 313

ACIDUM OXALICUM. Oxalic acid. $H_2C_2O_4,2H_2O$.

This acid is prepared by the action of caustic potash upon sawdust (by which means oxalate of potash is formed), and the subsequent addition of lime and sulphuric acid with the production of sulphate of lime and oxalic acid. It is chiefly used as a test reagent.

Tests.—(1) Nitrate of silver gives a *white* precipitate of oxalate of silver, soluble in cold nitric acid. Oxalate of silver, when heated upon platinum foil, is decomposed with detonation, leaving metallic silver behind.

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* If we take $2HC_2H_3O_2$ we find this collectively equals $C_4H_8O_4$, and by abstracting a molecule of water (H_2O) from this we obtain $C_4H_6O_3$.

(2) Sulphate of lime gives a *white* precipitate of oxalate of lime.

ACIDUM TARTARICUM. Tartaric Acid. $H_2C_4H_4O_6$.

A crystalline acid, prepared from the acid tartrate of potash by the following processes :

(*a*) Carbonate of lime ($CaCO_3$) is added to the acid tartrate of potash ($KHC_4H_4O_6$). Thus—

$$2KHC_4H_4O_6 + CaCO_3 = H_2O + CO_2 + K_2C_4H_4O_6 + CaC_4H_4O_6.$$

Water, carbonic anhydride, neutral tartrate of potash, and tartrate of lime are formed.

(*b*) Chloride of calcium ($CaCl_2$) is added to the neutral tartrate of potash ($K_2C_4H_4O_6$). Thus—

$$K_2C_4H_4O_6 + CaCl_2 = 2KCl + CaC_4H_4O_6.$$

Chloride of potassium and a second portion of tartrate of lime resulting.

(*c*) Sulphuric acid (H_2SO_4) is added to the tartrate of lime ($CaC_4H_4O_6$). Thus—

$$CaC_4H_4O_6 + H_2SO_4 = CaSO_4 + H_2C_4H_4O_6.$$

Sulphate of lime and tartaric acid are produced.

Dose, 10 to 30 grains or more in water.

Test.—Gives a *white* crystalline precipitate with acetate of potash, tartrate of potash being formed slowly.

Therapeutics.—Acts in a similar manner to citric acid, allaying the thirst of fevers. It is generally administered in the form of cream of tartar (acid tartrate of potash), combined with bicarbonate of soda, in a state of effervescence.

Adulterations.—Acid tartrate of potash and alum have been sometimes added ; and sulphuric acid may be present from imperfect preparation.

ACIDUM BENZOICUM. Benzoic Acid. $HC_7H_5O_2$.

A crystalline acid obtained from benzoin, and prepared by sublimation. *Dose*, 10 to 15 grains. It is contained in AMMONIÆ BENZOAS, TINCTURA CAMPHORÆ COMPOSITA, and TINCTURA OPII AMMONIATA.

Therapeutics.—A stimulant to the mucous membrane of the bladder, acting as an alterative in chronic inflammation of this viscus, especially in those cases which are associated with alkalinity of the urine. It is also expectorant.

Excreted in Urine as Hippuric Acid.

ACIDUM TANNICUM. Tannic Acid. $C_{27}H_{22}O_{17}$.

An acid extracted from galls, occurring in dull yellow vesicular masses, or thin glistening scales. It is prepared as follows:

The powdered galls are exposed to a damp atmosphere for two or three days, sufficient ether being then added to form a paste. After standing for twenty-four hours, the paste is compressed in a linen bag, and the liquid part preserved. The pressed cake is reduced to powder and mixed with ether, one-sixteenth of its bulk of water being added to form again a soft paste. This is then pressed as before. The expressed liquids are mixed, and exposed to spontaneous evaporation until they have acquired the consistence of a soft extract, which is dried in a hot-air chamber at a temperature not exceeding 212°F. *Dose*, 2 to 10 grains.

* *Officinal Preparations.*—Glycerinum Acidi Tannici (tannic acid, 1 ounce, and glycerine, 4 fluid ounces).

Suppositoria Acidi Tannici (tannic acid, benzoated lard, white wax, oil of theobroma); 3 grains in each suppository.

Trochisci Acidi Tannici (tannic acid, tincture of tolu, sugar, gum arabic, mucilage of gum arabic and water); ½ grain in each lozenge.

Tests.—The aqueous solution of tannic acid gives—

(1) A *blueish-black* precipitate with persalts of iron; and

(2) A *yellowish-white* precipitate with a solution of gelatine.

ACIDUM GALLICUM. Gallic Acid. $H_3C_7H_3O_5,H_2O$.

A crystalline acid, occurring in white, or pale fawn-coloured silky needles; prepared from galls. The galls are powdered and made into a paste with water, being kept in this condition for six weeks, at a temperature of between 60°F. and 70°F. The paste is then boiled with distilled water and strained; when the solution cools, crystals are deposited, which are redissolved in boiling water; the liquid is then allowed to cool to 80°F. The crystals that are formed are washed with ice-cold water, and finally dried at a temperature not exceeding 100°F. The gallic acid is apparently formed during this process by a nitrogenous ferment (contained in the gall nuts) acting upon the tannic acid.

Dose, 2 to 10 grains.

Officinal Preparation.—Glycerinum Acidi Gallici (gallic acid, 1 ounce; glycerine, 4 fluid ounces).

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* Also Suppositoria Acidi Tannici cum Sapone (tannic acid, glycerine of starch, curd soap in powder, starch in powder). 3 grains in each.

Tests.—The aqueous solution of gallic acid gives—

(1) A *blueish-black* precipitate with the persalts of iron; but

(2) *No* precipitate with a solution of gelatine.

Therapeutics of Gallic and Tannic Acids.—Tannic acid is a powerful astringent when applied to a living part. Internally administered, dryness of the mouth and fauces, with thirst, and sometimes constipation, are occasioned after absorption by the blood; it is partly thrown out by the kidneys as gallic and pyrogallic acids. Gallic acid is less astringent than tannic acid, perhaps on account of its being comparatively less soluble. After absorption, its remote effects are the same as those of tannic acid. Both the above acids may be employed in hæmaturia, hæmoptysis and menorrhagia; in diarrhœa and dysentery, or wherever there is increased discharge of mucus, and to check excessive sweating. The compounds of gallic or tannic acids may be given to stay hæmorrhage from the nose, gums, etc.; or to diminish such discharges as gleet, hæmorrhoids and leucorrhœa.

ACETUM. Vinegar.

An acid liquid, of a brown colour and peculiar odour, prepared from malt and unmalted grain by the acetous fermentation. Specific gravity, 1·017 to 1·019.

The constituents of vinegar are acetic acid, acetic ether, colouring matter, gluten, and a trace of sulphuric acid; of this last substance $\frac{1}{1000}$ part only is legally allowed by the revenue.

Any liquid which is susceptible of vinous fermentation may be made to yield vinegar; the presence of some substance capable of producing sugar, such as diluted spirit, beer, and other liquids, is the essential ingredient; this is converted by the fermentative process first into alcohol and eventually into acetic acid.

In England commercial vinegar is procured from an infusion of malt, or of a mixture of raw barley and malt. In the wine countries it is obtained from inferior wines; either red or white wine, producing either the red or white vinegar. The white wine vinegar is usually preferred, since it keeps better. The alcohol (C_2H_6O) contained in the malt or wine under certain circumstances takes up oxygen (O), and becomes converted into acetic acid ($C_2H_4O_2$) and water (H_2O), which are contained in the vinegar. Thus—

$$C_2H_6O + O_2 = H_2O + C_2H_4O_2.$$

Dose, 1 to 2 fluid drachms.

Vinegar is used in the preparation of

Emplastrum Cerati Saponis, soap cerate plaster (hard soap in powder, 10 ounces; yellow wax, 12½ ounces; olive oil, 1 pint; oxide of lead, 15 ounces; vinegar, 1 gallon).

Adulterations.—Sulphuric acid may be added, and metallic impurities, as lead or copper, may be present from the vessel in which the vinegar is preserved.

Therapeutics.—The same action as that of acetic acid of equal strength.

ADDENDA.

AMMONIA.

Ammoniæ Citratis Liquor, solution of citrate of ammonia. Citrate of Ammonia, $(NH_4)_3C_6H_5O_7$, dissolved in water (citric acid, 3 ounces; strong solution of ammonia, 2¾ fluid ounces or a sufficiency; distilled water, 1 pint).

Dose, 2 to 6 drachms.

Therapeutics.—Refrigerant, febrifuge, and slightly diuretic.

Ammoniæ Aromaticus Spiritus, aromatic spirit of ammonia (carbonate of ammonia, 8 ounces; strong solution of ammonia, 4 fluid ounces; volatile oil of nutmeg, 4 fluid drachms; oil of lemon, 6 fluid drachms; rectified spirit, 6 pints; water, 3 pints). Contained in Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata.

Dose, ½ to 1 fluid drachm; for nervous headache, etc.

Ammoniæ Fœtidus Spiritus, fœtid spirit of ammonia (assafœtida, 1½ ounces; strong solution of ammonia, 2 fluid ounces; rectified spirit, a sufficiency).

Dose, ½ to 1 fluid drachm, as a stimulant and antispasmodic.

Ammoniæ Linimentum, liniment of ammonia (solution of ammonia, 1 fluid ounce; olive-oil, 3 fluid ounces).

Ammoniæ Nitras, nitrate of ammonia, NH_4NO_3, is prepared by neutralising diluted nitric acid with solution of ammonia, or carbonate of ammonia, evaporating the solution until crystals are obtained, and keeping these fused at a temperature not exceeding 320° Fah. until the vapour of water is no longer emitted.

Used in making nitrous oxide gas.

Ammoniæ Oxalas, oxalate of ammonia, $(NH_4)_2C_2O_4, H_2O$

(purified oxalic acid, 1 ounce; boiling distilled water, 8 fluid ounces; carbonate of ammonia, a sufficiency).

Used as a test for lime salts in neutral or alkaline solutions.

Ammonii Sulphidum, sulphide of ammonium, $(NH_4)_2S$, is prepared by passing sulphuretted hydrogen (H_2S) into solution of ammonia as long as the gas continues to be absorbed, then adding more ammonia, and finally transferring the solution to a well-stoppered green glass bottle. Thus—

(1) NH_3 ammonia + H_2S = NH_4HS or the hydrosulphate of ammonia; and

(2) $NH_4HS + NH_3 = (NH_4)_2S$ = the sulphide of ammonium.

The solution of sulphide of ammonium is only used as a test re-agent.

ARSENICUM.

Sodæ Arsenias, Na_2HAsO_4. In this preparation the nitrate of soda ($NaNO_3$) oxidises the arsenious anhydride (As_2O_3) and converts it into arsenic anhydride (As_2O_5), which expels the carbonic anhydride (CO_2) of the carbonate of soda (Na_2CO_3), and unites with all the soda present to form pyro-arseniate of soda ($Na_4As_2O_7$). Thus—

$$As_2O_3 + Na_2CO_3 + 2NaNO_3 = CO_2 + N_2O_3 + Na_4As_2O_7.$$

N_2O_3 (nitrous anhydride) is also given off.

By solution in water the pyro-arseniate is converted into the arseniate. Thus—

$$Na_4As_2O_7 + H_2O = 2Na_2HAsO_4.$$

Arsenicalis Liquor.—In this solution the compound tincture of lavender is merely added as a colouring agent.

POTASSIUM.

Potassæ Bichromas.—Bichromate of potash, $K_2Cr_2O_7$, is prepared by roasting chrome-iron ore (FeO,Cr_2O_3) with a mixture of carbonate of potash (K_2CO_3) and chalk (carbonate of lime, $CaCO_3$) in a furnace through which a current of air passes. Thus—

$$2FeO,Cr_2O_3 + 4K_2CO_3 + O_7 = Fe_2O_3 + 4CO_2 + 4K_2CrO_4.$$

Ferric oxide, carbonic anhydride, and *yellow* chromate of potash are formed. (The oxygen (O) is derived from the current of air.) The chalk is added to diminish the fusibility of the mixture, and thus keep it in a porous condition.

Sulphuric acid (H_2SO_4) is added to the *yellow* chromate (K_2CrO_4). Thus—

$$2K_2CrO_4 + H_2SO_4 = H_2O + K_2SO_4 + K_2Cr_2O_7.$$

Water, sulphate of potash, and the *red* bichromate of potash are formed.

This salt is used in the preparation of valerianate of soda; it is also employed as a test re-agent, its solution in water giving with chloride of barium a *yellowish-white* precipitate, and with nitrate of silver a *purplish-red* precipitate.

If an excess of H_2SO_4 be added to a cold saturated solution of $K_2Cr_2O_7$, water (H_2O) and sulphate of potash (K_2SO_4) are formed, chromic anhydride (Cr_2O_3) being deposited in *crimson* needles. Thus—

$$K_2Cr_2O_7 + H_2SO_4 = H_2O + K_2SO_4 + 2Cr_2O_3.$$

Potassæ Chloratis Trochisci, chlorate of potash lozenges (chlorate of potash, in powder, 3600 grains; refined sugar, in powder, 25 ounces; gum acacia, in powder, 1 ounce; mucilage of gum acacia, 2 fluid ounces; distilled water, 1 ounce or a sufficiency).

Each lozenge contains 5 grains of chlorate of potash.

Dose, 1 to 6 lozenges.

Potassæ Sulphuratæ Unguentum, ointment of sulphurated potash (sulphurated potash, 30 grains; prepared lard, 1 ounce).

Should be prepared at the time when required, as it quickly changes.

Potassii Iodidi cum Sapone Linimentum, liniment of iodide of potassium with soap (hard soap, 1½ ounce; iodide of potassium, 1½ ounce; glycerine, 1 fluid ounce; oil of lemon, 1 fluid drachm; distilled water, 10 fluid ounces).

Potassii Iodidi Unguentum, ointment of iodide of potassium (iodide of potassium, 64 grains; carbonate of potash, 4 grains; distilled water, 1 fluid drachm; prepared lard, 1 ounce).

The carbonate of potash is added to prevent the ointment turning yellow.

SODIUM.

Sodæ Chloratæ Cataplasma, chlorine poultice (solution of chlorinated soda, 2 fluid ounces; linseed meal, 4 ounces; boiling water, 8 fluid ounces).

Sodæ Hyposulphis, hyposulphite of soda, Na_2SO_2, is prepared by immersing clippings of zinc in a concentrated solution of acid-sodium-sulphite ($NaHSO_3$) in a closed vessel;

thus zinc-sodium-sulphite ($ZnNa_2 2SO_3$) and hyposulphite of soda (Na_2SO_2) are formed; the former crystallises out, and the hyposulphite is taken up by alcohol, from which it crystallises in slender colourless needles.

CALCIUM.

Calcis Chloratæ Liquor, solution of chlorinated lime (chlorinated lime, 1 pound; distilled water, 1 gallon).

Used as a disinfectant, and as a stimulating application to foul ulcers; also in fœtid discharges.

MAGNESIUM.

The *Heavy* Carbonate of Magnesia is made by dissolving 10 ounces of sulphate of magnesia and 12 ounces of carbonate of soda, each in 1 *pint of boiling distilled water;* then mixing the two solutions and evaporating to complete dryness. The residue is then digested with 2 pints of boiling water, the insoluble matter (carbonate of magnesia) being collected and washed, and finally dried at a temperature not exceeding 212° Fah., to avoid driving off the carbonic acid.

The *Light* Carbonate of Magnesia is prepared by taking the same proportions of the sulphate of magnesia and carbonate of soda as in the preparation of the heavy carbonate, but by adding to each ½ *gallon of cold distilled water;* the two solutions are then boiled, the precipitate being collected, and washed with boiling distilled water, and finally dried at a heat not exceeding 212° Fah.

Thus, in preparing the light carbonate, less heat and greater amount of dilution are employed than in the preparation of the heavy carbonate.

Magnesiæ Citratis Liquor (Magnesiæ Citras, $Mg_3 2C_6H_5O_7$), solution of citrate of magnesia (carbonate of magnesia, 100 grains; citric acid, 200 grains; syrup of lemons, ½ fluid ounce; bicarbonate of potash, in crystals, 40 grains; water, a sufficiency).

Dose, 5 to 10 fluid ounces as a mild saline cathartic.

FERRUM.

Ferri Acetatis Tinctura (Ferri Acetas, $Fe_2 6C_2H_3O_2$), tincture of acetate of iron (solution of persulphate of iron ($Fe_2 3SO_4$), 2½ fluid ounces; acetate of potash ($KC_2H_3O_2$)

2 ounces; rectified spirit, a sufficiency. The following reactions occur:

$$Fe_2 3SO_4 + 6KC_2H_3O_2 = 3K_2SO_4 + Fe_2 6C_2H_3O_2.$$

Sulphate of potash and acetate of iron are formed.

Dose, 5 to 30 minims; as a tonic.

Ferrum Redactum, reduced iron, is prepared as follows: Hydrated peroxide of iron is fixed in the centre of a gun-barrel by means of plugs of asbestos; the gun-barrel is passed through a furnace, and after being raised to a strong red heat is traversed by a stream of hydrogen gas developed by the action of some sulphuric acid upon metallic zinc; the gas is rendered quite dry by being first passed through a tube containing small pieces of chloride of calcium. The farther end of the gun-barrel is connected by a cork with a bent tube dipping under water, and when the hydrogen is observed to pass through the water at the same rate that it bubbles through the sulphuric acid, the furnace is allowed to cool down to the temperature of the atmosphere, the current of hydrogen being still continued, since the hot metal is very prone to oxidation while in a state of minute division.

Ferri Sulphidum.—Sulphide of Iron, FeS, is produced by applying the end of a rod of iron, heated to a white heat at a blacksmith's forge, to the end of a roll of sulphur, and allowing the sulphide of iron as it is formed to run into a vessel of water.

Used for the production of sulphuretted hydrogen.

Ferri Mistura Composita, compound mixture of iron (sulphate of iron, 25 grains; carbonate of potash, 30 grains; myrrh and refined sugar, of each 60 grains; spirit of nutmeg, 4 fluid drachms; rose-water, 9½ fluid ounces).

Carbonate of iron ($FeCO_3$) is here formed. Since this salt rapidly decomposes, the mixture should be recently prepared.

Dose, 1 to 2 fluid ounces; as a stimulating tonic.

LITHIUM.

Lithiæ Carbonas, carbonate of lithia, may be prepared by the action of carbonate of ammonia upon the sulphate or chloride of lithia.

ZINCUM.

Zinci Chloridum.—In the preparation of this substance the solution of chlorine is used to remove any iron which the zinc sometimes contains. Ferrous Chloride is converted into Ferric Chloride. Thus—

$$2FeCl_2 + Cl_2 = Fe_2Cl_6.$$

Upon the addition of the carbonate of zinc ($ZnCO_3$) ferric oxide is precipitated and chloride of zinc is formed. Thus—

$$Fe_2Cl_6 + 3ZnCO_3 = Fe_2O_3 + 3CO_2 + 3ZnCl_2.$$

ZINCI SULPHAS.—This substance is purified from any ferrous sulphate ($FeSO_4$) that may be present by the addition of solution of chlorine and carbonate of zinc. Thus—

$$2FeSO_4 + 2Cl + ZnCO_3,2ZnO = Fe_2O_3 + ZnCl_2 + CO_2 + 2ZnSO_4.$$

Ferric oxide, chloride of zinc, carbonic anhydride, and sulphate of zinc are formed.

SPIRITUS TENUIOR.—Proof Spirit. In the preparation of this substance 2½ per cent. decrease of bulk occurs. Thus—

$$\left.\begin{array}{l}\text{Rectified spirit, 5 pints (100 ounces)}\\ \text{Distilled water, 3 pints (60 ounces)}\end{array}\right\} = \begin{array}{c}\text{156 ounces of proof}\\ \text{spirit.}\end{array}$$

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AIDS
TO
MATERIA MEDICA
AND
THERAPEUTICS.

SPECIALLY DESIGNED FOR
STUDENTS PREPARING FOR EXAMINATIONS.

PART II.—(Double Part.)
THE VEGETABLE AND ANIMAL SUBSTANCES.

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PREFACE.

In the present work I have endeavoured, as much as possible, to arrange the contained substances in alphabetical order, thus departing from the plan usually adopted by writers on the subject, who have attempted some sort of botanical classification.

The officinal substances only have been retained, to the entire exclusion of those which are non-officinal.

The descriptions and doses of the "British Pharmacopœia" have been closely followed, and in many instances the text of that volume has been copied literally.

Although the various ingredients employed in each preparation have been specified throughout, the exact pharmaceutical operations have in most cases been omitted, a Third Part of these "Aids" being in contemplation in which it is proposed that these details shall be more fully discussed.

That the following pages may prove serviceable to the student in acquiring some preliminary knowledge of Materia Medica and Therapeutics is the sole object and sincere desire of

THE AUTHOR.

8, Torrington Square, W.C.
December, 1879.

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EXPLANATORY TABLE OF ABBREVIATIONS.

ABBREVIATION.	LATIN.		ENGLISH.	IN PRESCRIPTIONS.
	(Singular.)	(Plural.)		
gr.	granum	grana	a grain or grains	gr.
min.	minimum	minima	a minim or minims	♏
dr.	drachma	drachmæ	a drachm or drachms	ʒ
fl. dr.	fluid drachma	fluid drachmæ	a fluid drachm or fluid drachms	fl. ʒ
oz.	uncia	unciæ	an ounce or ounces	℥
fl. oz.	fluid uncia	fluid unciæ	a fluid ounce or fluid ounces	fl. ℥
oct.	octarius	octarii	a pint or pints	O.
cong.	congius	congii	a gallon or gallons	C.
lb.	libra	libræ	a pound or pounds	lb.

TABLE OF OFFICINAL SUBSTANCES WITH THEIR PREPARATIONS.

VEGETABLE KINGDOM.

CLASS I. EXOGENÆ.

Sub-Class I. Thalamifloræ.

Natural Order. Aurantiaceæ.

Aurantii Cortex.
Infusum Aurantii.
,, *Aurantii Compositum.*
,, *Gentianæ Compositum.*
Mistura Gentianæ.
Spiritus Armoraciæ Compositus.
Tinctura Aurantii. *Syrupus Aurantii.*
,, *Cinchonæ Composita.*
,, *Gentianæ Composita*
Vinum Aurantii.
Aurantii Floris Aqua.
Syrupus Aurantii Floris.
Aurantii Fructus.
Tinctura Aurantii Recentis.
Belæ Fructus.
Extractum Belæ Liquidum.
Limonis Cortex.
Infusum Aurantii Compositum.
,, *Gentianæ Compositum.*
Syrupus Limonis.
Tinctura Limonis.
Limonis Oleum.
Limonis Succus.
Syrupus Limonis.

Nat. Ord. Byttneriaceæ.

Theobromæ Oleum.

Nat. Ord. Canellaceæ.

Canellæ Albæ Cortex.
Vinum Rhei.

Nat. Ord. CRUCIFERÆ.

ARMORACIÆ RADIX.
    Spiritus Armoraciæ Compositus.
SINAPIS SEMINA.
    Cataplasma Sinapis.
    Charta Sinapis.
SINAPIS OLEUM.
    Linimentum Sinapis Compositum.

Nat. Ord. GUTTIFERÆ.

CAMBOGIA.
    Pilula Cambogiæ Composita.

Nat. Ord. LINACEÆ.

LINI FARINA.
    Cataplasma Lini.
LINI OLEUM.
LINI SEMINA.
    Infusum Lini.

Nat. Ord. MAGNOLIACEÆ.

ILLICIUM ANISATUM.

Nat. Ord. MALVACEÆ.

GOSSYPIUM.
    Pyroxylin.
    Collodium.
        ,, *Flexile.*

Nat. Ord. MENISPERMACEÆ.

CALUMBÆ RADIX.
    Extractum Calumbæ.
    Infusum Calumbæ.
    Mistura Ferri Aromatica.
    Tinctura Calumbæ.
PEREIRÆ RADIX.
    Decoctum Pereiræ.
    Extractum Pereiræ.
        ,, *Pereiræ Liquidum.*

Nat. Ord. PAPAVERACEÆ.

OPIUM.
    Confectio Opii.
    Emplastrum Opii.
    Enema Opii.
    Extractum Opii.
        ,, *Opii Liquidum.*
    Linimentum Opii.

Pilula Ipecacuanhæ cum Scilla.
,, *Plumbi cum Opio.*
,, *Saponis Composita.*
Pulvis Cretæ Aromaticus cum Opio.
,, *Ipecacuanhæ Compositus.*
,, *Kino Compositus.*
,, *Opii Compositus.*
Suppositoria Plumbi Composita.
Tinctura Camphoræ Composita.
,, *Opii.*
,, *Opii Ammoniata.*
Trochisci Opii.
Unguentum Gallæ cum Opio.
Vinum Opii.

MORPHIÆ ACETAS.
Liquor Morphiæ Acetatis.

MORPHIÆ HYDROCHLORAS.
Injectio Morphiæ Hypodermica.
Liquor Morphiæ Hydrochloratis.
Suppositoria Morphiæ.
,, *Morphiæ cum Sapone.*
Trochisci Morphiæ.
,, *Morphiæ et Ipecacuanhæ.*

PAPAVERIS CAPSULÆ.
Decoctum Papaveris.
Extractum Papaveris.
Syrupus Papaveris.

RHÆADOS PETALA.
Syrupus Rhœados.

Nat. Ord. POLYGALACEÆ.

KRAMERIÆ RADIX.
Extractum Krameriæ.
Infusum Krameriæ.
Pulvis Catechu Compositus.
Tinctura Krameriæ.

SENEGÆ RADIX.
Infusum Senegæ.
Tinctura Senegæ.

Nat. Ord. RANUNCULACEÆ.

ACONITI FOLIA.
Extractum Aconiti.

ACONITI RADIX.
Linimentum Aconiti.
Tinctura Aconiti.

ACONITIA.
Unguentum Aconitiæ.
PODOPHYLLI RADIX.
PODOPHYLLI RESINA.

Nat. Ord. RUTACEÆ.

BUCHU FOLIA.
Infusum Buchu.
Tinctura Buchu.
CUSPARIÆ CORTEX.
Infusum Cuspariæ.
RUTÆ OLEUM.

Nat. Ord. SIMARUBACEÆ.

QUASSIÆ LIGNUM.
Extractum Quassiæ.
Infusum Quassiæ.
Tinctura Quassiæ.

Nat. Ord. VITACEÆ.

UVÆ.
Tinctura Cardamomi Composita.
,, *Sennæ.*

Nat. Ord. ZYGOPHYLLACEÆ.

GUAIACI LIGNUM.
Decoctum Sarsæ Compositum.
GUAIACI RESINA.
Mistura Guaiaci.
Pilula Hydrargyri Subchloridi Composita.
Tinctura Guaiaci Ammoniata.

SUB-CLASS II.—CALYCIFLORÆ.

Nat. Ord. AMYRIDACEÆ.

ELEMI.
Unguentum Elemi.
MYRRHA.
Decoctum Aloes Compositum.
Mistura Ferri Composita.
Pilula Aloes et Myrrhæ.
,, *Assafœtidæ Composita.*
,, *Rhei Composita.*
Tinctura Myrrhæ.

Nat. Ord. ANACARDIACEÆ.

MASTICHE.

Nat. Ord. CUCURBITACEÆ.

- COLOCYNTHIDIS PULPA.
  - *Extractum Colocynthidis Compositum.*
  - *Pilula Colocynthidis Composita.*
  - ,, *Colocynthidis et Hyoscyami*
- ECBALII FRUCTUS.
- ELATERIUM.
  - *Pulvis Elaterii Compositus.*

Nat. Ord. LEGUMINOSÆ.

Sub. Ord. PAPILIONACEÆ.

- BALSAMUM PERUVIANUM.
- BALSAMUM TOLUTANUM.
  - *Syrupus Tolutanus.*
  - *Tinctura Benzoini Composita.*
  - ,, *Tolutana.*
- GLYCYRRHIZÆ RADIX.
  - *Confectio Terebinthinæ.*
  - *Decoctum Sarsæ Compositum.*
  - *Extractum Glycyrrhizæ.*
  - ,, *Glycyrrhizæ Liquidum.*
  - *Infusum Lini.*
  - *Pilula Hydrargyri.*
  - ,, *Ferri Iodidi.*
  - *Pulvis Glycyrrhizæ Compositus.*
- KINO.
  - *Pulvis Catechu Compositus.*
  - ,, *Kino Compositus.*
  - *Tinctura Kino.*
- PHYSOSTIGMATIS FABA.
  - *Extractum Physostigmatis.*
- PTEROCARPI LIGNUM.
  - *Tinctura Lavandulæ Composita.*
- SCOPARII CACUMINA.
  - *Decoctum Scoparii (dried).*
  - *Succus Scoparii (fresh).*
- TRAGACANTHA.
  - *Confectio Opii.*
  - *Mucilago Tragacanthæ.*
  - *Pulvis Opii Compositus.*
  - ,, *Tragacanthæ Compositus.*

Sub. Ord. CÆSALPINEÆ.

- CASSIÆ PULPA.
  - *Confectio Sennæ.*

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COPAIBÆ OLEUM.
HÆMATOXYLI LIGNUM.
    Decoctum Hæmatoxyli.
    Extractum Hæmatoxyli.
SENNA ALEXANDRINA.
    Confectio Sennæ.
    Infusum Sennæ.
    Mistura Sennæ Composita.
    Syrupus Sennæ.
    Tinctura Sennæ.
SENNA INDICA.
    May be used in the place of the Alexandrian variety.
TAMARINDUS.
    Confectio Sennæ.

Sub. Ord. MIMOSEÆ.

ACACIÆ GUMMI.
    Mistura Cretæ.
    ,, *Guaiaci.*
    Mucilago Acaciæ.
    Pulvis Amygdalæ Compositus.
    ,, *Tragacanthæ Compositus.*
    Trochisci, in all.
INDIGO.

Nat. Ord. MYRTACEÆ.

CARYOPHYLLUM.
    Infusum Aurantii Compositum.
    ,, *Caryophylli.*
    Mistura Ferri Aromatica.
    Vinum Opii.
CARYOPHYLLI OLEUM.
CAJUPUTI OLEUM.
    Linimentum Crotonis.
    Spiritus Cajuputi.
GRANATI RADICIS CORTEX.
    Decoctum Granati Radicis.
PIMENTA.
    Aqua Pimentæ.
    Syrupus Rhamni.
PIMENTÆ OLEUM.

Nat. Ord. RHAMNACEÆ.

RHAMNI SUCCUS.
    Syrupus Rhamni.

Nat. Ord. ROSACEÆ.

AMYGDALA AMARA.
AMYGDALA DULCIS.
    Mistura Amygdalæ.
    Pulvis Amygdalæ Compositus.
AMYGDALÆ OLEUM.
CUSSO.
    Infusum Cusso.
LAUROCERASI FOLIA.
    Aqua Laurocerasi.
PRUNUM.
    Confectio Sennæ.
ROSÆ CANINÆ FRUCTUS.
    Confectio Rosæ Caninæ.
ROSÆ CENTIFOLIÆ PETALA.
    Aqua Rosæ.
ROSÆ GALLICÆ PETALA.
    Confectio Rosæ Gallicæ.
    Infusum Rosæ Acidum.
    Syrupus Rosæ Gallicæ.

Nat. Ord UMBELLIFERÆ.

AMMONIACUM.
    Emplastrum Ammoniaci cum Hydrargyro.
        ,, *Galbani.*
    Mistura Ammoniaci.
    Pilula Scillæ Composita.
        ,, *Ipecacuanhæ cum Scilla.*
ANETHI FRUCTUS.
    Aqua Anethi.
ANETHI OLEUM.
ANISI OLEUM.
    Essentia Anisi.
    Tinctura Camphoræ Composita.
        ,, *Opii Ammoniata.*
ASSAFŒTIDA.
    Enema Assafœtidæ.
    Pilula Aloes et Assafœtidæ.
        ,, *Assafœtidæ Composita.*
    Spiritus Ammoniæ Fœtidus.
    Tinctura Assafœtidæ.
CARUI FRUCTUS.
    Aqua Carui.
    Confectio Opii.
        ,, *Piperis.*

Pulvis Opii Compositus.
Tinctura Cardamomi Composita.
,, *Sennæ.*
CARUI OLEUM.
CONII FOLIA.
Cataplasma Conii.
Extractum Conii. *Pilula Conii Composita.*
Vapor Coniæ.
Succus Conii.
CONII FRUCTUS.
Tinctura Conii.
CORIANDRI FRUCTUS.
Confectio Sennæ.
Mistura Gentianæ.
Syrupus Rhei.
Tinctura Rhei.
,, *Sennæ.*
CORIANDRI OLEUM.
FŒNICULI FRUCTUS.
Aqua Fœniculi.
GALBANUM.
Emplastrum Galbani.
Pilula Assafœtidæ Composita.
SUMBUL RADIX.
Tinctura Sumbul.

SUB-CLASS III. COROLLIFLORÆ.

Nat. Ord. ASCLEPIADACEÆ.

HEMIDESMI RADIX.
Syrupus Hemidesmi.

Nat. Ord. ATROPACEÆ.

BELLADONNÆ FOLIA.
Extractum Belladonnæ.
Emplastrum Belladonnæ.
Unguentum Belladonnæ.
Succus Belladonnæ.
Tinctura Belladonnæ.
BELLADONNÆ RADIX.
Linimentum Belladonnæ.
ATROPIA.
Liquor Atropiæ.
Unguentum Atropiæ.

ATROPIÆ SULPHAS.
  Liquor Atropiæ Sulphatis.
HYOSCYAMI FOLIA.
  Extractum Hyoscyami.
  Succus Hyoscyami.
  Tinctura Hyoscyami.
STRAMONII FOLIA.
STRAMONII SEMINA.
  Extractum Stramonii.
  Tinctura Stramonii.
TABACI FOLIA.
  Enema Tabaci.

Nat. Ord. CAPRIFOLIACEÆ.

SAMBUCI FLORES.
  Aqua Sambuci.

Nat. Ord. CINCHONACEÆ.

CATECHU PALLIDUM.
  Infusum Catechu.
  Pulvis Catechu Compositus.
  Tinctura Catechu.
  Trochisci Catechu.
CINCHONÆ FLAVÆ CORTEX.
  Decoctum Cinchonæ Flavæ.
  Extractum Cinchonæ Flavæ Liquidum.
  Infusum Cinchonæ Flavæ.
  Tinctura Cinchonæ Flavæ.
QUINIÆ SULPHAS.
  Ferri et Quiniæ Citras.
  Pilula Quiniæ.
  Tinctura Quiniæ.
    ,, *Quiniæ Ammoniata.*
  Vinum Quiniæ.
CINCHONÆ PALLIDÆ CORTEX.
  Mistura Ferri Aromatica.
  Tinctura Cinchonæ Composita.
CINCHONÆ RUBRÆ CORTEX.
IPECACUANHA.
  Pilula Conii Composita.
    ,, *Ipecacuanhæ cum Scilla.*
  Pulvis Ipecacuanhæ Compositus.
  Trochisci Ipecacuanhæ.
    ,, *Morphiæ et Ipecacuanhæ.*
  Vinum Ipecacuanhæ.

Nat. Ord. COMPOSITÆ.

ANTHEMIDIS FLORES.
    Extractum Anthemidis.
    Infusum Anthemidis.
ANTHEMIDIS OLEUM.
ARNICÆ RADIX.
    Tinctura Arnicæ.
LACTUCA.
    Extractum Lactucæ.
PYRETHRI RADIX.
    Tinctura Pyrethri.
SANTONICA.
SANTONINUM.
TARAXACI RADIX.
    Decoctum Taraxaci.
    Extractum Taraxaci.
    Succus Taraxaci.

Nat. Ord. CONVOLVULACEÆ.

JALAPA.
    Extractum Jalapæ.
    Pulvis Jalapæ Compositus.
        ,, *Scammonii Compositus.*
    Tinctura Jalapæ.
JALAPÆ RESINA.
SCAMMONIÆ RADIX.
SCAMMONIÆ RESINA.
    Extractum Colocynthidis Compositum.
    Mistura Scammonii.
    Pilula Scammonii Composita.
SCAMMONIUM.
    Confectio Scammonii.
    Pilula Colocynthidis Composita.
        ,, *Colocynthidis et Hyoscyami.*
    Pulvis Scammonii Compositus.

Nat. Ord. ERICACEÆ.

UVÆ URSI FOLIA.
    Infusum Uvæ Ursi.

Nat. Ord. GENTIANACEÆ.

CHIRATA.
    Infusum Chiratæ.
    Tinctura Chiratæ.

GENTIANÆ RADIX.
Extractum Gentianæ.
Infusum Gentianæ Compositum.
Mistura Gentianæ.
Tinctura Gentianæ Composita.

Nat. Ord. LABIATÆ.

LAVANDULÆ OLEUM.
Linimentum Camphoræ Compositum.
Spiritus Lavandulæ.
Tinctura Lavandulæ Composita.
MENTHÆ PIPERITÆ OLEUM.
Aqua Menthæ Piperitæ.
Essentia Menthæ Piperitæ.
Pilula Rhei Composita.
Spiritus Menthæ Piperitæ.
MENTHÆ VIRIDIS OLEUM.
Aqua Menthæ Viridis.
ROSMARINI OLEUM.
Linimentum Saponis.
Spiritus Rosmarini.
Tinctura Lavandulæ Composita.

Nat. Ord. LOGANIACEÆ.

NUX VOMICA.
Extractum Nucis Vomicæ.
Tinctura Nucis Vomicæ.
STRYCHNIA.
Liquor Strychniæ.

Nat. Ord. OLEACEÆ.

GLYCERINUM.
Glycerinum Acidi Carbolici.
,, *Acidi Gallici.*
,, *Acidi Tannici.*
,, *Amyli.*
,, *Boracis.*
Linimentum Potassii Iodidi cum Sapone.
MANNA.
OLIVÆ OLEUM.
Cataplasma Lini.
Charta Epispastica.
Emplastrum Ammoniaci cum Hydrargyro.
,, *Cerati Saponis.*
,, *Hydrargyri.*

Emplastrum Picis.
,, *Plumbi.*
Enema Magnesiæ Sulphatis.
Linimentum Ammoniæ.
,, *Calcis.*
,, *Camphoræ.*
Unguentum Cantharidis.
,, *Hydrargyri Compositum.*
,, *Hydrargyri Nitratis.*
,, *Veratriæ.*
SAPO ANIMALIS.
Pilula Scammonii Composita.
Suppositoria Acidi Carbolici cum Sapone.
,, *Acidi Tannici cum Sapone.*
,, *Morphiæ cum Sapone.*
SAPO DURUS.
Emplastrum Resinæ.
,, *Saponis.*
Extractum Colocynthidis Compositum.
Linimentum Potassii Iodidi cum Sapone.
,, *Saponis.*
Pilula Aloes Barbadensis.
,, *Aloes et Assafœtidæ.*
,, *Aloes Socotrinæ.*
,, *Cambogiæ Composita.*
,, *Saponis Composita.*
,, *Scillæ Composita.*
SAPO MOLLIS.
Linimentum Terebinthinæ.

Nat. Ord. SAPOTACEÆ.

GUTTA PERCHA.
Liquor Gutta Percha.

Nat. Ord. SCROPHULARIACEÆ.

DIGITALIS FOLIA.
Infusum Digitalis.
Tinctura Digitalis.
DIGITALINUM.

Nat. Ord. SOLANACEÆ.

CAPSICI FRUCTUS.
Tinctura Capsici.
DULCAMARA.
Infusum Dulcamaræ.

Nat. Ord. STYRACEÆ.

BENZOINUM.
Acidum Benzoicum.
Adeps Benzoatus.
Tinctura Benzoini Composita.

Nat. Ord. VALERIANACEÆ.

VALERIANÆ RADIX.
Infusum Valerianæ.
Tinctura Valerianæ.
,, *Valerianæ Ammoniata.*
VALERIANAS SODÆ.
VALERIANAS ZINCI.

SUB-CLASS IV. APETALÆ.

Nat. Ord. ARISTOLOCHIÆ.

SERPENTARIÆ RADIX.
Infusum Serpentariæ.
Tinctura Cinchonæ Composita.
,, *Serpentariæ.*

Nat. Ord. CANNABINACEÆ.

CANNABIS INDICA.
Extractum Cannabis Indicæ.
Tinctura Cannabis Indicæ.

Nat. Ord. CONIFERÆ or PINACEÆ.

JUNIPERI OLEUM.
Spiritus Juniperi.
LARICIS CORTEX.
Tinctura Laricis.
PIX BURGUNDICA.
Emplastrum Ferri.
,, *Picis.*
PIX LIQUIDA.
Unguentum Picis Liquidæ.
RESINA.
Charta Epispastica.
Emplastrum Calefaciens.
,, *Cantharidis.*
,, *Opii.*
,, *Picis.*
,, *Resinæ.*
,, *Saponis.*

Unguentum Resinæ.
,, *Terebinthinæ.*
SABINÆ CACUMINA.
Tinctura Sabinæ.
Unguentum Sabinæ.
SABINÆ OLEUM.
TEREBINTHINA CANADENSIS.
Charta Epispastica.
Collodium Flexile.
TEREBINTHINÆ OLEUM.
Confectio Terebinthinæ.
Enema Terebinthinæ.
Linimentum Terebinthinæ
,, *Terebinthinæ Aceticum.*
Unguentum Terebinthinæ.
THUS AMERICANUM.
Emplastrum Picis.

Nat. Ord. CUPULIFERÆ.

GALLA.
Acidum Gallicum.
,, *Tannicum.*
Tinctura Gallæ.
Unguentum Gallæ.
,, *Gallæ cum Opio.*
QUERCUS CORTEX.
Decoctum Quercus.

Nat. Ord. EUPHORBIACEÆ.

CASCARILLÆ CORTEX.
Infusum Cascarillæ.
Tinctura Cascarillæ.
CROTONIS OLEUM.
Linimentum Crotonis.
KAMALA.
RICINI OLEUM.
Collodium Flexile.
Linimentum Sinapis Compositum.
Pilula Hydrargyri Subchloridi Composita.

Nat. Ord. LAURACEÆ.

CAMPHORA.
Aqua Camphoræ.
Linimentum Aconiti.
,, *Belladonnæ.*

Linimentum Camphoræ.
,, *Camphoræ Compositum.*
,, *Chloroformi.*
,, *Hydrargyri.*
,, *Iodi.*
,, *Opii.*
,, *Saponis.*
,, *Sinapis Compositum.*
,, *Terebinthinæ.*
,, *Terebinthinæ Aceticum.*
Spiritus Camphoræ.
Tinctura Camphoræ Composita.
Unguentum Hydrargyri Compositum.
Unguentum Plumbi Subacetatis Compositum.

CINNAMOMI CORTEX.
Acidum Sulphuricum Aromaticum.
Aqua Cinnamomi.
Decoctum Hæmatoxyli.
Infusum Catechu.
Pulvis Catechu Compositus.
,, *Cinnamomi Compositus.*
,, *Cretæ Aromaticus.*
,, *Kino Compositus.*
Tinctura Cardamomi Composita.
,, *Catechu.*
,, *Cinnamomi.*
,, *Lavandulæ Composita.*
Vinum Opii.

CINNAMOMI OLEUM.

NECTANDRÆ CORTEX.
Beberiæ Sulphas.

SASSAFRAS.
Decoctum Sarsæ Compositum.

Nat. Ord. LIQUIDAMBARACEÆ.

STYRAX PRÆPARATUS.
Tinctura Benzoini Composita.

Nat. Ord. MORACEÆ.

FICUS.
Confectio Sennæ.

MORI SUCCUS.
Syrupus Mori.

Nat. Ord. MYRISTICACEÆ.

MYRISTICA.
Pulvis Catechu Compositus.

Pulvis Cretæ Aromaticus.
Spiritus Armoraciæ Compositus.
Tinctura Lavandulæ Composita.

MYRISTICÆ OLEUM.
Pilula Aloes Socotrinæ.
Spiritus Ammoniæ Aromaticus.
,, *Myristicæ.*

MYRISTICÆ OLEUM EXPRESSUM.
Emplastrum Calefaciens.
,, *Picis.*

Nat. Ord. PIPERACEÆ.

CUBEBA.
Tinctura Cubebæ.

CUBEBÆ OLEUM.

MATICÆ FOLIA.
Infusum Maticæ.

PIPER NIGRUM.
Confectio Opii.
,, *Piperis.*
Pulvis Opii Compositus.

Nat. Ord. POLYGONACEÆ.

RHEI RADIX.
Extractum Rhei.
Infusum Rhei.
Pilula Rhei Composita.
Pulvis Rhei Compositus.
Syrupus Rhei.
Tinctura Rhei.
Vinum Rhei.

Nat. Ord. THYMELACEÆ.

MEZEREI CORTEX.
Decoctum Sarsæ Compositum.
Extractum Mezerei Æthereum.

Nat. Ord. ULMACEÆ.

ULMI CORTEX.
Decoctum Ulmi.

CLASS II. ENDOGENÆ.

Nat. Ord. GRAMINACEÆ.

AMYLUM.
    Glycerinum Amyli.
    Mucilago Amyli.
    Pulvis Tragacanthæ Compositus.
ERGOTA.
    Extractum Ergotæ Liquidum.
    Infusum Ergotæ.
    Tinctura Ergotæ.
FARINA TRITICI.
    Cataplasma Fermenti.
HORDEUM DECORTICATUM.
    Decoctum Hordei.
MICA PANIS.
    Cataplasma Carbonis.
SACCHARUM PURIFICATUM.
    Confectio Rosæ Caninæ.
        ,, ,, *Gallicæ.*
        ,, *Sennæ.*
    Ferri Carbonas Saccharata.
    Liquor Calcis Saccharatus.
    Mistura Ferri Composita.
        ,, *Guaiaci.*
    Pilula Ferri Iodidi.
    Pulvis Cretæ Aromaticus.
        ,, *Amygdalæ Compositus.*
        ,, *Tragacanthæ Compositus.*
    All the Lozenges and Syrups.
THERIACA.
    Pilula Assafœtidæ Composita.
        ,, *Conii Composita.*
        ,, *Ipecacuanhæ cum Scilla.*
        ,, *Rhei Composita.*
        ,, *Scillæ Composita.*

Nat. Ord. IRIDACEÆ.

CROCUS.
    Decoctum Aloes Compositum.
    Pilula Aloes et Myrrhæ.
    Pulvis Cretæ Aromaticus.
    Tinctura Cinchonæ Composita.
        ,, *Croci.*
        ,, *Opii Ammoniata.*
        ,, *Rhei.*

Nat. Ord. LILIACEÆ.

ALOE BARBADENSIS.
Enema Aloes.
Extractum Aloes Barbadensis.
Pilula Aloes Barbadensis.
,, ,, *et Ferri.*
,, *Cambogiæ Composita.*
,, *Colocynthidis Composita.*
,, ,, *et Hyoscyami.*

ALOE SOCOTRINA.
Decoctum Aloes Compositum (*extract*).
Enema Aloes.
Extractum Aloes Socotrinæ.
,, *Colocynthidis Compositum* (*extract*).
Pilula Aloes et Assafœtidæ.
,, ,, *et Myrrhæ.*
,, ,, *Socotrinæ.*
,, *Rhei Composita.*
Tinctura Aloes.
,, *Benzoini Composita.*
Vinum Aloes.

SCILLA.
Acetum Scillæ.
Oxymel Scillæ.
Pilula Ipecacuanhæ cum Scilla.
,, *Scillæ Composita.*
Syrupus Scillæ.
Tinctura Scillæ.

Nat. Ord. MELANTHACEÆ.

COLCHICI CORMUS.
Extractum Colchici.
,, ,, *Aceticum.*
Vinum Colchici.

COLCHICI SEMINA.
Tinctura Colchici Seminum.

SABADILLA.

VERATRIA.
Unguentum Veratriæ.

VERATRI VIRIDIS RADIX.
Tinctura Veratri Viridis.

Nat. Ord. PALMACEÆ.

ARECA.

Nat. Ord. SMILACEÆ.

SARSÆ RADIX.
  Decoctum Sarsæ.
  ,, ,, *Compositum.*
  Extractum Sarsæ Liquidum.

Nat. Ord. ZINGIBERACEÆ.

CARDAMOMUM.
  Extractum Colocynthidis Compositum.
  Pulvis Cinnamomi Compositus.
  ,, *Cretæ Aromaticus.*
  Tinctura Cardamomi Composita.
  ,, *Gentianæ Composita.*
  ,, *Rhei.*
  Vinum Aloes.
CURCUMA.
  Turmeric Paper.
  Turmeric Tincture.
ZINGIBER.
  Confectio Opii.
  ,, *Scammonii.*
  Infusum Sennæ.
  Pilula Scillæ Composita.
  Pulvis Cinnamomi Compositus.
  ,, *Jalapæ Compositus.*
  ,, *Opii Compositus.*
  ,, *Rhei Compositus.*
  ,, *Scammonii Compositus.*
  Syrupus Rhamni.
  ,, *Zingiberis.*
  Tinctura Zingiberis.
  ,, ,, *Fortior.*
  Vinum Aloes.

CLASS III. ACOTYLEDONES.

Nat. Ord. LICHENES.

CETRARIA.
  Decoctum Cetrariæ.
LACMUS. LITMUS.
  Tincture of Litmus.
  Blue Litmus Paper.
  Red Litmus Paper.

Nat. Ord. FILICES.

FILIX MAS.
  Extractum Filicis Liquidum.

ANIMAL KINGDOM.

CLASS. MAMMALIA.

Order. CETACEA.

CETACEUM.
- *Charta Epispastica.*
- *Unguentum Cetacei.*

Order. PACHYDERMATA.

ADEPS PRÆPARATUS.
- *Emplastrum Cantharidis.*
- *Unguentum Aconitiæ.*
- ,, *Atropiæ.*
- ,, *Belladonnæ.*
- ,, *Hydrargyri.*
- ,, ,, *Nitratis.*
- ,, ,, *Subchloridi.*
- ,, *Iodi.*
- ,, *Potassæ Sulphuratæ.*
- ,, *Potassii Iodidi.*
- ,, *Sabinæ.*
- ,, *Simplex.*
- ,, *Sulphuris Iodidi.*
- ,, *Terebinthinæ.*
- ,, *Veratriæ.*

ADEPS BENZOATUS.
- *Suppositoria Acidi Tannici.*
- ,, *Hydrargyri.*
- ,, *Morphiæ.*
- ,, *Plumbi Composita*
- *Unguentum Gallæ.*
- ,, *Plumbi Acetatis.*
- ,, *Sulphuris.*
- ,, *Zinci.*

Order. RODENTIA.

CASTOREUM.
- *Tinctura Castorei.*

Order. RUMINANTIA.

FEL BOVINUM PURIFICATUM.

LAC.
- *Mistura Scammonii.*

LACTIS SACCHARUM.

MOSCHUS.
PEPSINA.
SEVUM PRÆPARATUM.
- *Emplastrum Cantharidis.*
- *Unguentum Hydrargyri.*

CLASS. AVES.

OVI ALBUMEN.
OVI VITELLUS.
- *Mistura Spiritus Vini Gallici.*

CLASS. PISCES.

ISINGLASS.
OLEUM MORRHUÆ.

CLASS. INSECTA.

Order. COLEOPTERA.

CANTHARIS.
- *Acetum Cantharidis.*
- *Charta Epispastica.*
- *Emplastrum Calefaciens.*
- ,, *Cantharidis.*
- *Liquor Epispasticus.*
- *Tinctura Cantharidis.*
- *Unguentum Cantharidis.*

Order. HEMIPTERA.

COCCUS.
- *Tinctura Cardamomi Composita.*
- ,, *Cinchonæ Composita.*
- ,, *Cocci.*

Order. HYMENOPTERA.

CERA ALBA.
- *Charta Epispastica.*
- *Suppositoria Acidi Tannici.*
- ,, *Hydrargyri.*
- ,, *Morphiæ.*
- ,, *Plumbi Composita.*
- *Unguentum Cetacei.*
- ,, *Plumbi Subacetatis Compositum.*
- ,, *Simplex.*

CERA FLAVA.
- *Emplastrum Calefaciens.*
- ,, *Cantharidis.*

Emplastrum Cerati Saponis.
  ,, *Galbani.*
  ,, *Picis.*
Unguentum Cantharidis.
  ,, *Hydrargyri Compositum.*
  ,, *Hydrargyri Oxidi Rubri.*
  ,, *Picis Liquidæ.*
  ,, *Resinæ.*
  ,, *Sabinæ.*
  ,, *Terebinthinæ.*

MEL.

MEL DEPURATUM.

Confectio Piperis.
  ,, *Scammonii.*
  ,, *Terebinthinæ.*
Mel Boracis.
Oxymel.
  ,, *Scillæ.*

CLASS. ANNELIDA.

HIRUDO.

AIDS TO MATERIA MEDICA AND THERAPEUTICS.

THE VEGETABLE KINGDOM.

CLASS I.—EXOGENÆ.

SUB-CLASS 1.—THALAMIFLORÆ.

Aurantiaceæ.

1. CITRUS BIGARADIA: THE SEVILLE OR BITTER ORANGE TREE.

Aurantii Cortex.—BITTER ORANGE PEEL.—The dried outer part of the RIND of Citrus Bigaradia. From the ripe fruit imported from the south of Europe.

Characters.—Thin, of a dark orange colour, nearly free from the inner white part of the rind, and possessing a fragrant odour and a bitter aromatic taste. Studded with oil-vesicles, which are convex in the sweet orange and concave in the bitter. Contains a *volatile oil*, a bitter extractive, *Hesperidin*, and a little gallic acid.

Officinal Preparations.—INFUSUM AURANTII.—Infusion of Orange Peel (bitter orange peel, cut small, ½ oz.; boiling distilled water, 10 fl. oz.). *Dose.*—1 to 2 fluid ounces.

INFUSUM AURANTII COMPOSITUM.—Compound Infusion of Orange Peel (bitter orange peel, cut small, ¼ oz.; fresh lemon peel, cut small, 60 gr.; cloves, bruised, 30 gr.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA AURANTII.—Tincture of Orange Peel (bitter orange peel, cut small and bruised, 2 oz.; proof spirit, 1 oct.). *Dose*, 1 to 2 fluid drachms.

SYRUPUS AURANTII.—Syrup of Orange Peel (tincture of orange peel, 1 fl. oz.; syrup, 7 fl. oz.). Contained in Confectio Sulphuris. *Dose*, 1 fluid drachm.

VINUM AURANTII.—Orange Wine (a wine produced by the addition of the fresh peel of the bitter orange to a fermented saccharine solution). Contains about 12 per cent. of alcohol. Used in the preparation of Vinum Ferri Citratis and Vinum Quiniæ.

Bitter Orange Peel also forms an ingredient of the Infusum Gentianæ Compositum, the Tinctura Cinchonæ Composita, and the Tinctura Gentianæ Composita.

Aurantii Floris Aqua.—ORANGE-FLOWER WATER.—The distilled WATER of the flowers of the bitter orange, Citrus Bigaradia, and also of the sweet orange, Citrus Aurantium. Possesses the odour of orange-blossoms, and contains a volatile oil (*Oil of Neroli*), but not similar to that contained in the cortex.

Officinal Preparation.—SYRUPUS AURANTII FLORIS.—Syrup of Orange-Flower (orange-flower water, 8 fl. oz.; refined sugar, 3 lb.; distilled water, 16 fl. oz., or a sufficiency). *Dose*, 1 fluid drachm.

Aurantii Fructus.—THE ORANGE FRUIT.—The ripe FRUIT of the bitter orange. Imported from the South of Europe.

Officinal Preparation.—TINCTURA AURANTII RECENTIS.—Tincture of Fresh Orange-Peel (the coloured part of the rind of the bitter orange in thin slices, 6 oz.; rectified spirit, 1 oct.). *Dose*, 1 to 2 fluid drachms.

Therapeutics.—The rind acts as a bitter stomachic tonic, and is useful as an adjunct in the treatment of dyspepsia; by it the taste of quinine is somewhat masked. The syrup of orange and orange-flower water are employed only as flavouring agents.

Adulterations.—The orange-flower water may be impregnated with lead, which is acquired in the vessels in which it is imported; in this case sulphuretted hydrogen will give a dark stain.

2.—ÆGLE MARMELOS. THE BAEL TREE.

Belæ Fructus.—BAEL FRUIT. The dried half-ripe FRUIT of Ægle Marmelos. From Malabar and Coromandel.

Characters.—The fruit is somewhat round, and about the size of a large orange, with a woody rind. It is usually imported in dried slices, or in fragments which consist of portions of rind with adherent dried pulp and seeds. Bael contains an astringent principle which may be somewhat allied to tannic acid.

Officinal Preparation. — EXTRACTUM BELÆ LIQUIDUM.— Liquid Extract of Bael (bael fruit, 1 lb. ; distilled water, 12 oct. ; rectified spirit, 2 fl. oz.).

Dose, 1 to 2 fluid drachms.

Therapeutics.—This drug enjoys considerable reputation in India for the treatment of dysentery and diarrhœa. From the *ripe* fruit a pulp may be obtained which, when made into a jelly, acts as a mild purgative.

3.—CITRUS LIMONUM. THE LEMON TREE.

Limonis Cortex.—LEMON PEEL.—The outer part of the RIND of the fresh fruit of Citrus Limonum. Lemons are imported from Southern Europe. The rind contains a pale-yellow *volatile oil*, tasting and smelling of the peel, a bitter *extractive*, and a little gallic acid ; also a principle crystallising in fine white needles (*Hesperidin*).

Officinal Preparations.— SYRUPUS LIMONIS. — Syrup of Lemons (fresh lemon peel, 2 oz. ; lemon juice, strained, 1 oct. ; refined sugar, 2¼ lb.). *Dose*, 1 fluid drachm.

TINCTURA LIMONIS.—Tincture of Lemon Peel (fresh lemon peel, sliced thin, 2½ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Lemon peel is also contained in the Infusum Aurantii Compositum and Infusum Gentianæ Compositum.

Limonis Oleum.— OIL OF LEMON.—The OIL expressed or distilled from fresh lemon peel. It consists of two isomeric oils composed of $C_{10}H_{16}$. Imported chiefly from Sicily.

Limonis Succus. — LEMON JUICE.—The freshly-expressed JUICE of the ripe fruit of Citrus Limonum.

Characters.—A yellowish, slightly-turbid liquor, having a grateful odour, and a sharp, acid taste. Contains citric acid and mucilage, together with small quantities of acid salts, especially those of potash ; also malic acid and sugar. About 32 grains of citric acid are contained in each ounce of lemon juice.

Therapeutics.—Lemon peel is an aromatic stomachic. The volatile oil, when given *internally*, is carminative and stimulant : when applied *externally*, it is rubefacient.

Lemon juice is refrigerant, and may be employed instead of, and in preference to, citric acid in the preparation of effervescing draughts; it is also eminently anti-scorbutic. Lemon juice is held in much favour and successfully employed by some physicians in the treatment of acute rheumatism.

Adulterations.—Oil of turpentine; this is difficult of detection, unless in large quantities. Lime juice is often mixed with lemon juice. A combination of sugar and water with diluted sulphuric acid has been substituted for lemon juice.

Byttneriaceæ.

THEOBROMA CACAO. CACAO BUTTER.

Theobromæ Oleum.—OIL OF THEOBROMA.—A concrete OIL, obtained by expression and heat from the ground seeds of Theobroma Cacao; it is used only in the formation of suppositories. The tree grows in South America and the West Indies.

Characters.—Of a yellowish colour, and the consistency of tallow, with an odour like chocolate. Does not turn rancid upon exposure to air, and breaks with a clean fracture. Contains mostly *Stearin* with a little *Olein.*

Canellaceæ.

CANELLA ALBA. THE LAUREL-LEAVED CANELLA.

Canellæ Albæ Cortex.—CANELLA ALBA BARK.—The BARK of Canella Alba. From the West Indies.

Characters.—In quills or broken pieces, hard, of a pale-orange or yellowish-white colour, somewhat lighter on the inner surface. Has a peppery acrid taste, and an aromatic clove-like odour. Contains a resin, some *volatile oil*, bitter *extractive*, *mannite sugar* and *starch;* no gallic or tannic acids. *Dose, of the powdered bark*, 15 to 30 grains.

Therapeutics.—An aromatic tonic and stomachic. It has been employed in dyspepsia, but is seldom used except in combination, as in Vinum Rhei.

Cruciferæ.

1.—COCHLEARIA ARMORACIA. HORSERADISH.

Armoraciæ Radix.—HORSERADISH ROOT.—The fresh ROOT of Cochlearia Armoracia. Cultivated in Britain.

Characters.—A long, cylindrical, fleshy root, about half an inch to an inch in diameter, expanding into several very short stems at the crown. Internally white. It emits a pungent odour when scraped, and has an acrid taste, due to the presence of a *volatile* oil, which is identical with the oil of mustard.

Officinal Preparation.—SPIRITUS ARMORACIÆ COMPOSITUS. —Compound Spirit of Horseradish (horseradish root, scraped, 20 oz.; bitter orange peel, cut small and bruised, 20 oz.; nutmeg, bruised, ½ oz.; proof spirit, 1 cong.; water, 2 oct.). *Dose*, 1 to 2 fluid drachms.

Therapeutics.—As a rule horseradish is only used as a condiment; the compound spirit may be given in dyspepsia, or as a sudorific in acute rheumatism, and as a diuretic in dropsies.

2.—SINAPIS NIGRA ET ALBA. BLACK AND WHITE MUSTARD.

Sinapis Semina.—The SEEDS of Sinapis Nigra and Sinapis Alba. Also the seeds reduced to powder, mixed.

Both the seeds contain a fixed oil; the black variety contains *Myronic Acid* united with potash, as myronate of potash, which, by the action of *Myrosine* (an albuminous substance also residing in the seeds) breaks up, in the presence of water, into glucose, sulphuric acid, volatile oil of mustard, some free sulphur, etc.

The *volatile oil* of mustard has the composition and properties of allyl sulphocyanate (C_3H_5CNS). It produces immediate vesication when applied to the skin. This oil is not yielded by the white mustard, in which variety a crystallisable compound (*Sulpho-sinapisin*) is contained, and which gives rise to a non-volatile acrid principle containing sulphur.

The *fixed oil* of mustard contains *Erucic Acid.*

Characters and Test of the Powder.—Greenish-yellow, with a bitterish, oily, pungent, acrid taste, without scent when dry, and when moistened exhaling a peculiar pungent odour, highly irritating to the eyes and nostrils.

Officinal Preparations.—CATAPLASMA SINAPIS. — Mustard Poultice (mustard, in powder, 2½ oz.; linseed meal, 2½ oz.; boiling water, 10 fl. oz.).

CHARTA SINAPIS.—Mustard Paper (black mustard seeds, in powder, 1 oz.; solution of gutta-percha, 2 fl. oz., or a sufficiency).

Sinapis Oleum.—OIL OF MUSTARD.—The OIL distilled with water from the seeds of Black Mustard after the expression of the fixed oil.

Officinal Preparation.—LINIMENTUM SINAPIS COMPOSITUM. —Compound Liniment of Mustard (ethereal extract of mezereon, 40 gr., and camphor, 120 gr., dissolved in rectified spirit, 4 fl. oz.; oil of mustard, 1 fl. dr., and castor oil, 5 fl. dr., being subsequently added.

Therapeutics.—Powerfully stimulant. Internally, in large doses, mustard induces speedy vomiting. In smaller doses it assists digestion. Externally applied in the form of a poultice, it is a powerful counter-irritant and rubefacient, and may be thus usefully employed for the relief of many inflammations of the serous and mucous membranes, as in pleurisy and bronchitis, or to alleviate neuralgia and other pains.

Adulterations. — Common flour, chilies, turmeric and pepper.

Guttiferæ.

GARCINIA MORELLA.

Cambogia.—GAMBOGE.—A GUM-RESIN obtained from Garcinia Morella. Imported from Siam. *Dose,* 1 to 4 grains.

Characters.—In cylindrical pieces, which break easily, with a glistening conchoidal smooth fracture; colour, tawny, turning yellow when it is rubbed with water; taste, acrid. Contains 75 per cent. of a resin, *Gambogic Acid,* with 25 per cent. of a soluble gum.

Officinal Preparation.—PILULA CAMBOGIÆ COMPOSITA.—Compound Pill of Gamboge (gamboge, in powder, 1 oz.; Barbadoes aloes, in powder, 1 oz.; compound powder of cinnamon, 1 oz.; hard soap, in powder, 2 oz.; syrup, a sufficiency). *Dose,* 5 to 10 grains.

Therapeutics.—A drastic hydragogue cathartic, frequently causing vomiting and griping. It is hardly ever given alone, but generally combined with some vegetable purgative, or with calomel or cream of tartar. It is useful as an anthelmintic, and should always be given with ginger or some aromatic oil. In regard to its purgative effects, it may be considered intermediate between colocynth and scammony.

Adulteration.—Sometimes adulterated with starch, an emulsion of which with boiling water will become green upon the addition of iodine.

Linaceæ.

LINUM USITATISSIMUM. COMMON LINSEED OR FLAX.

Lini Farina.—LINSEED MEAL.—The CAKE of linseed from which the oil has been pressed, reduced to powder.

Officinal Preparation.—CATAPLASMA LINI.—Linseed Poultice (linseed meal, 4 oz.; olive-oil, ½ fl. oz.; boiling water, 10 fl. oz.). Linseed meal is also contained in Cataplasmata Carbonis, Conii, Sinapis, and Sodæ Chloratæ.

Lini Oleum.—LINSEED OIL.—The OIL expressed with heat from linseed.

Characters.—Viscid, yellow, with a faint odour and oleaginous taste.

Lini Semina.—LINSEED.—The SEEDS of Linum Usitatissimum. Cultivated in Britain.

Characters.—Small, pointed, oval, flat, with acute edges, smooth, shining, externally brown, internally yellowish-white; of a mucilaginous oily taste. The kernel of the seeds contains a fixed oil; the testa or envelope, a mucilage; *Palmitin* and perhaps *Stearin* are contained in the fixed oil, together with a glyceride of linoleic acid.

Officinal Preparation.—INFUSUM LINI.—Infusion of Linseed (linseed, 160 gr.; fresh liquorice root, sliced, 60 gr.; boiling distilled water, 10 fl. oz.). *Dose,* ad libitum.

Therapeutics.—Administered *internally,* the infusion is demulcent, and is often given in urinary and catarrhal affections; in dysentery and diarrhœa. *Externally* the poultice is applied to inflamed or suppurating parts. The oil is a useful application to scalds or burns.

Magnoliaceæ.

ILLICIUM ANISATUM. THE STAR ANISE.

An OIL is obtained from the fruit of this plant which very closely resembles the true oil of anise. It is made officinal under the name of ANISI OLEUM, to which oil it is added.

Malvaceæ.

Gossypium.—COTTON WOOL. The HAIRS of the SEED of various species of Gossypium, carded.

Officinal Preparations.—PYROXYLIN.—Gun Cotton (cotton, 1 oz.; sulphuric acid, 5 oz.; nitric acid, 5 oz.), used for preparing

COLLODIUM.—Collodion (pyroxylin, 1 oz.; ether, 36 fl. oz.; rectified spirit, 12 fl. oz.).

COLLODIUM FLEXILE.—Flexible Collodion (collodion, 6 fl. oz.; Canada balsam, 120 gr.; castor oil, 1 fl. dr.).

Uses.—Collodion, on the evaporation of its ether, leaves a transparent film, and may be applied to inflamed or cut surfaces; it may be applied in such skin diseases as smallpox, and to chapped nipples, or to stay the hæmorrhage from leech bites.

Flexible collodion does not crack, and is therefore more serviceable than the other form.

Menispermaceæ.

1.—JATEORRHIZA CALUMBA. COCCULUS PALMATUS.

Calumbæ Radix.—CALUMBA ROOT.—The ROOT, cut transversely and dried, of Jateorrhiza Calumba. From the forests of Eastern Africa, between Ibo and the Zambesi.

Dose, in powder, 5 to 20 grains.

Characters.—Slices, flat, oval or circular, about two inches in diameter, and from two to four lines thick, softer and thinner towards the centre, greyish-yellow, bitter. Calumba root contains a non-nitrogenised neutral principle termed *Calumbine*, and an *Acid* termed *Calumbic*, together with an alkaloid, *Berberine.*

The infusion and tincture contain calumbate of berberine. The root also contains a large quantity of starch.

Officinal Preparations.—EXTRACTUM CALUMBÆ.—Extract of Calumba (calumba root, cut small, 1 lb. ; distilled water, 4 oct.). *Dose*, 2 to 10 grains.

INFUSUM CALUMBÆ.—Infusion of Calumba (calumba root, cut small, ½ oz. ; cold distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

TINCTURA CALUMBÆ.—Tincture of Calumba (calumba root, cut small, 2½ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Calumba root is also contained in Mistura Ferri Aromatica.

Therapeutics.—Calumba is a bitter tonic and stomachic. It contains no tannic or gallic acid, and is therefore compatible with the salts of iron. The cold infusion contains no starch in solution, so that no blue colour is developed upon the addition of iodine.

2.—CISSAMPELOS PAREIRA. THE VELVET LEAF.

Pareiræ Radix.—PAREIRA ROOT.—The dried ROOT of Cissampelos Pareira. Brazil.

Characters.—Cylindrical, oval or compressed pieces, entire or split longitudinally, four inches to four feet in length, and half an inch to four inches in diameter. The bark is greyish-brown, wrinkled longitudinally, and crossed transversely by annular elevations. The interior is woody, porous, with yellowish-grey, well-marked, often incomplete concentric rings and medullary rays. The taste is at first aromatic and sweetish, but afterwards intensely bitter.

Contains an active principle, *Pelosine* or *Cissampeline*, together with resin, starch, salts, and a yellow bitter matter. *Dose, in powder,* 30 to 60 grains.

Officinal Preparations.—DECOCTUM PAREIRÆ. Decoction of Pareira (pareira root, sliced, 1½ oz. ; distilled water, 1 oct.). *Dose,* 1 to 2 fluid ounces.

EXTRACTUM PAREIRÆ.—Extract of Pareira (pareira root, in coarse powder, 1 lb.; boiling distilled water, 1 cong., or a sufficiency). *Dose,* 10 to 20 grains.

EXTRACTUM PAREIRÆ LIQUIDUM.—Liquid Extract of Pareira (pareira root, in coarse powder, 1 lb. ; boiling distilled water, 1 cong., or a sufficiency ; rectified spirit, 3 fl. oz.). *Dose,* ½ fluid drachm to 2 fluid drachms.

Therapeutics.—A bitter tonic. It is supposed by some authors to exert a specific action upon the mucous membrane of the bladder, and to act as a diuretic.

Papaveraceæ.

1.—PAPAVER SOMNIFERUM. THE WHITE, GARDEN, OR OPIUM POPPY.

Opium.—OPIUM. The JUICE, inspissated by spontaneous evaporation, obtained by incision from the unripe capsules of the poppy, Papaver Somniferum, grown in Asia Minor.

Characters.—Turkey Opium is in irregular lumps, weighing from four ounces to two pounds ; enveloped in the remains of poppy-leaves, and usually covered with the chaffy fruits of a species of rumex ; when fresh, plastic, tearing with an irregular, slightly-moist, chestnut-brown surface, shining when rubbed smooth with the finger, having a peculiar odour and bitter taste.

The following are some of the most important of the crystalline principles contained in opium :

Meconic Acid ($C_7H_4O_7$), soluble in water ; forms insoluble salts with lead, baryta and lime. It yields a *blood-red* colour with the persalts of iron.

Morphia ($C_{17}H_{19}NO_3$), an alkaloid in the form of 6-sided prisms. When dry it gives a *yellow* colour, passing into *red* with strong nitric acid. It liberates iodine, and thus renders starch blue when it is added to iodic acid. Morphia and its salts, in solution, give a *greenish-blue* colour with persalts of iron.

Codeia ($C_{18}H_{21}NO_3 + H_2O$), an alkaloid, in octahedral crystals or rhombic prisms.

Papaverina ($C_{20}H_{21}NO_4$), an alkaloid in small acicular crystals. Sulphuric acid turns these crystals *blue,* and their

CKO. OCO. Ling. Vinum

solution produces brilliant prisms of the insoluble hydrochlorate when great excess of hydrochloric acid is added.

Paramorphia or Thebaia ($C_{19}H_{21}NO_3$), an alkaloid which crystallises in square silvery plates.

Narcotine ($C_{22}H_{23}NO_7$), in brilliant prisms.

Narceia ($C_{23}H_{20}NO_9$), silky crystals, reddened by strong sulphuric acid.

Opianyl or Meconine ($C_{10}H_{10}O_4$), in acicular crystals. It exists in opium, but may also be formed by the oxidation of narcotine.

Porphyroxine, a crystalline principle, becoming purple when heated with dilute hydrochloric acid.

In addition to the above bodies, several different resins are contained in opium, together with gummy, extractive and fatty matters, caoutchouc, a trace of *volatile oil* and inorganic salts.

Officinal Preparations of OPIUM.

CONFECTIO OPII.—Confection of Opium (compound powder of opium, 192 gr.; syrup, 1 fl. oz.). 1 part of opium in 40, nearly. *Dose,* 5 to 20 grains.

EMPLASTRUM OPII.—Opium Plaster (opium, in fine powder, 1 oz.; resin plaster, 9 oz.). 1 part in 10.

ENEMA OPII.—Enema of Opium (tincture of opium, ½ fl. dr.; mucilage of starch, 2 fl. oz.).

EXTRACTUM OPII.—Extract of Opium (opium, in thin slices, 1 lb.; distilled water, 6 oct.). About 1 part from 2.

Dose, ½ grain to 2 grains.

EXTRACTUM OPII LIQUIDUM.—Liquid Extract of Opium (extract of opium, 1 oz.; distilled water, 16 fl. oz.; rectified spirit, 4 fl. oz.). 22 gr. of the extract in 1 fl. oz., nearly. *Dose,* 10 to 40 minims. (1 in 23 nearly)

LINIMENTUM OPII.—Liniment of Opium (tincture of opium, 2 fl. oz.; liniment of soap, 2 fl. oz.). 1 volume tincture in 2 volumes.

PILULA	IPECACUANHÆ CUM SCILLA ...	1 part in 23, nearly.
,,	PLUMBI CUM OPIO	1 part in 8.
,,	SAPONIS COMPOSITA	1 part in 6, nearly.
PULVIS	CRETÆ AROMATICUS CUM OPIO	1 part in 40.
,,	IPECACUANHÆ COMPOSITUS ...	1 part in 10.
,,	KINO COMPOSITUS	1 part in 20.

PULVIS OPII COMPOSITUS. — Compound Powder of Opium (opium, in powder, 1½ oz.; black pepper, in powder, 2 oz.; ginger, in powder, 5 oz.; caraway fruit, in powder, 6 oz.; tragacanth, in powder, ½ oz.). 1 part in 10.

Dose, 2 to 5 grains.

Suppositoria Plumbi Composita. 1 gr. of opium in each suppository.

Tinctura Camphoræ Composita. 2 gr. of opium to 1 fl. oz.

Tinctura Opii.—Tincture of Opium (opium, in coarse powder, 1½ oz.; proof spirit, 1 oct.). 33 gr. to 1 fl. oz., nearly. *Dose,* 5 to 40 minims. (1 in 14½)

Tinctura Opii Ammoniata.—Ammoniated Tincture of Opium (opium, in coarse powder, 100 gr.; saffron, cut small, 180 gr.; benzoic acid, 180 gr.; oil of anise, 1 fl. dr.; strong solution of ammonia, 4 fl. oz.; rectified spirit, 16 fl. oz.). 5 gr. to 1 fl. oz. *Dose,* ½ to 1 fluid drachm.

Trochisci Opii.—Opium Lozenges (extract of opium, 72 gr.; tincture of tolu, ½ fl. oz.; refined sugar, in powder, 16 oz.; gum acacia, in powder, 2 oz.; extract of liquorice, 6 oz.; distilled water, a sufficiency). $\frac{1}{10}$ grain of extract in each. *Dose,* 1 to 6 lozenges.

Unguentum Gallæ cum Opio. 32 gr. of opium to 1 oz.

Vinum Opii.—Wine of Opium (extract of opium, 1 oz.; cinnamon bark, bruised, 75 gr.; cloves, bruised, 75 gr.; sherry, 1 oct.). 22 gr. extract in 1 fl. oz., nearly. = 44 gr to ℥i *Dose,* 10 to 40 minims.

Morphiæ Acetas.—Acetate of Morphia ($C_{17}H_{19}NO_3,C_2H_4O_2$) (hydrochlorate of morphia, 2 oz.; solution of ammonia, acetic acid and distilled water, of each a sufficiency; chloride of ammonium is formed, the acetic acid uniting with the morphia. *Dose,* $\frac{1}{8}$ to ½ grain. The *Officinal Preparation* of this salt is

Liquor Morphiæ Acetatis.—Solution of Acetate of Morphia (acetate of morphia, 4 gr.; diluted acetic acid, 8 minims; rectified spirit, 2 fl. dr.; distilled water, 6 fl. dr.). 4 gr. to the oz. *Dose,* 10 to 60 minims.

Morphiæ Hydrochloras.—Hydrochlorate of Morphia ($C_{17}H_{19}NO_3,HCl,3H_2O$) (opium, sliced, 1 lb.; chloride of calcium, ¾ oz.; purified animal charcoal, ¼ oz.; diluted hydrochloric acid, 2 fl. oz., or a sufficiency; solution of ammonia and distilled water, of each, a sufficiency).

The watery solution of opium contains chiefly the meconate and sulphate of morphia and codeia; to this solution is added a strong solution of chloride of calcium, by which means meconate and sulphate of lime are thrown down, the chlorine combining with the morphia and codeia. The whole is evaporated to a solid mass, and then wrapped in calico and subjected to strong pressure in order to remove the mother liquor, in which much colouring matter is contained. Boiling water is now added to the cake to dissolve the hydrochlorate of codeia and morphia, the solution being then filtered and washed; it is again evaporated, and the pressed cake finally dissolved in boiling water with purified animal charcoal, to remove all trace of colouring matter, and, after filtration, slight excess of ammonia is added, which precipitates the morphia, the codeia being left in solution. The pure crystalline morphia which separates is dissolved in hydrochloric acid, and the hydrochlorate of morphia allowed to crystallise. *Dose*, $\frac{1}{8}$ to $\frac{1}{2}$ grain. The *Officinal Preparations* of this salt are

Injectio Morphiæ Hypodermica.—Hypodermic Injection of Morphia (hydrochlorate of morphia, 88 gr.; solution of ammonia, acetic acid, distilled water, of each, a sufficiency).

Contains 1 gr. of acetate of morphia in 12 minims of the injection. *Dose, by subcutaneous injection*, 1 minim to 6 minims.

Liquor Morphiæ Hydrochloratis.—Solution of Hydrochlorate of Morphia (hydrochlorate of morphia, 4 gr.; diluted hydrochloric acid, 8 minims; rectified spirit, 2 fl. dr.; distilled water, 6 fl. dr.). 4 gr. to the oz.

Dose, 10 to 60 minims.

Suppositoria Morphiæ.—Morphia Suppositories (hydrochlorate of morphia, 6 gr.; benzoated lard, 64 gr.; white wax, 20 gr.; oil of theobroma, 90 gr.).

$\frac{1}{2}$ gr. of the morphia salt in each suppository.

Suppositoria Morphiæ cum Sapone.—Morphia Suppositories with Soap (hydrochlorate of morphia, 6 gr.; glycerine of starch, 50 gr.; curd soap, in powder, 100 gr; starch, in powder, a sufficiency).

$\frac{1}{2}$ gr. of the morphia salt in each suppository.

Trochisci Morphiæ.—Morphia Lozenges (hydrochlorate of morphia, 20 gr.; tincture of tolu, $\frac{1}{2}$ fl. oz.; refined sugar, in powder, 24 oz.; gum acacia, in powder, 1 oz.; mucilage of gum acacia, a sufficiency; distilled water, $\frac{1}{2}$ fl. oz.). $\frac{1}{36}$ gr. in each lozenge. *Dose*, 1 to 6 lozenges.

Trochisci Morphiæ et Ipecacuanhæ.—Morphia and Ipecacuanha Lozenges (hydrochlorate of morphia, 20 gr.; ipecacuanha, in fine powder, 60 gr.; tincture of tolu, $\frac{1}{2}$ fl. oz.; refined sugar, in powder, 24 oz.: gum acacia, in powder, 1 oz.; mucilage of gum acacia, a sufficiency; distilled water, $\frac{1}{2}$ fl. oz.). $\frac{1}{36}$ grain of the morphia salt and $\frac{1}{12}$ grain of ipecacuanha are contained in each lozenge.

Dose, 1 to 6 lozenges.

Therapeutics of Opium and the Morphia Salts.

When opium is taken internally in small doses, increased rapidity and fulness of the pulse are at first produced, together with very pleasant sensations and exaltation of the mental functions. After about half an hour there follows a feeling of drowsiness, and finally sound sleep, generally accompanied by perspirations. Upon awakening, there is often headache and nausea, loss of appetite, a furred tongue, thirst and constipation. If the dose be of tolerable amount, and the patient unaccustomed to the drug, the soporific effect is soon produced. If very large, there is intense sleepiness, and difficulty in awakening the patient. Poisonous symptoms may supervene, the sleep passing into coma and stupor, the respiration becoming slower, the pulse feeble, and the pupils contracted ; cold perspirations appear, and death ensues.

The influence of Opium upon the various functions and organs of the body.

Upon the *Brain* and *Nervous System* the influence is most powerfully marked, as is observed in the exaltation of the mental faculties, followed by sleep and stupor. The pupils may be contracted even to a pin's point. The spine is sometimes, though rarely, affected, tetanic spasms occurring.

Upon the *Digestive Organs:* appetite and digestion are impared, thirst and constipation are caused, and the secretions from the whole mucous membrane are diminished.

Upon the *Cutaneous System:* free perspiration is produced, which may be much increased by combination of the drug with camphor, ipecacuanha, etc.

Upon the *Vascular System* the effect is first stimulant and then sedative, these effects being probably induced through the agency of the nervous system.

Upon the *Respiratory Organs* a sedative effect is produced, shown in the diminution of the respirations and the subsequently impared oxidation of the blood.

Upon the *Excreting* and *Secreting Organs*—excepting that of the skin and breasts, the activity of these organs is lessened ; pale-coloured fæces are produced, from the diminution of the bile, the salivary and buccal mucus and the urine often becomes scanty.

Upon the *Sexual System* a stimulating effect is produced, especially in males ; and opium has been used in Eastern countries as an aphrodisiac.

When applied to the skin, pain may be allayed. If the cutis be denuded, absorption takes place, and the constitutional effects of the drug are produced. The local and general symptoms are produced when opium is applied to the mucous membrane of the rectum, either as enema or suppository. When opium or the salts of morphia are injected hypodermically, pain and spasm are equally relieved, whether the application be close to the seat of disease or at a distance; in fact, the effect is solely produced through the blood. Contraction of the pupil does *not* take place when opium or morphia is applied to the conjunctiva.

Opium may be given to relieve *spasm* and *pain* in nearly every condition of the system, as in neuralgia and colic, in inflammations of different kinds, in tetanus, or during the passage of renal or biliary calculi.

In *Inflammation*, diseased action is controlled. Opium may be usefully combined with calomel in cases of inflammation, in which it is valuable by preventing the mercurial from running away by the bowels. It may also be combined with tartar emetic in various forms of inflammation. When the air passages are affected, the drug must be administered with caution. It is of great value when the intestinal tube is implicated, as in dysentery, in which it allays irritability, and checks the secretions.

In *Fevers:* opium has been occasionally used with advantage in the treatment of ague.

In diseases of the *Nervous System*, opium is generally injurious when vascular action is increased; but in delirium tremens, and those allied affections in which the power of the circulation is defective, its value is very manifest.

In *Hæmorrhages* opium may be usefully combined with gallic acid and acetate of lead.

In *Urinary Diseases*, for diminishing the amount of urine, as in diabetes, and for the relief of irritability of the bladder, opium is advantageously employed.

In *Mucous Discharges*, especially in *diarrhœa*, this drug is of great service.

In *Affections of the Chest* opium must be cautiously used. The cough is often relieved, but if there is considerable impairment of the respiratory functions the drug may produce dyspnœa. It also tends to lessen expectoration; but this result sometimes does harm, although it is at times desirable.

In painful *Diseases of the Bladder and Rectum*, and *Chordee*, opium may be used in the form of a suppository or as an enema; over *painfully-inflamed joints* it may be applied as a fomentation; and in *neuralgia* and *rheumatism* as a plaster or liniment.

Circumstances influencing the action of Opiates.

Age.—Children are far more susceptible than adults, and much more so than in proportion to the age. The greatest caution must be observed in administering opium to infants and very young children.

Idiosyncrasy.—Some persons are peculiarly susceptible, and in these, instead of calm sleep, much restlessness and excitement are occasioned.

Disease.—The presence of disease often offers resisting power to the action of opium, especially when there is much pain.

Habit or Custom has the most notable effect upon the action of opium. If the dose be increased gradually, large quantities may be taken without any particular results. Garrod states that a young man was in the habit of taking 60 grains of Smyrna opium night and morning, and often an ounce to an ounce and a half of laudanum in addition during the day. The same author once had a patient who stated that he had taken 72 grains of acetate of morphia in one day, and had also swallowed a pint of laudanum. No ordinary dose of opium appeared to exert any influence upon the man.

If a large dose be resumed, after the discontinuance of the drug for some time, poisonous effects may occur.

Action of the Salts of Morphia.

These substances possess the soporific and anodyne powers of opium, and most of the valuable properties of the drug are due to them; but they have less tendency to produce headache and nausea, and are much less stimulant in their operation. Morphia possesses about 4 times the strength of opium.

Adulterations of Opium.—Opium may contain mechanical impurities, as clay, sand, bullets, stone, etc., and it may be mixed with vegetable extracts of different kinds, treacle and sugar, or it may contain much water, or a good deal of its active matter may have been extracted by water and afterwards dried.

Papaveris Capsulæ.—POPPY CAPSULES.—The nearly ripe, dried CAPSULES of Papaver Somniferum, growing native in Syria and Egypt, and cultivated in Britain.

Characters.—Globular, two or three inches in diameter, crowned by a sessile, stellate stigma.

Officinal Preparations.—DECOCTUM PAPAVERIS.—Decoction of Poppies (poppy capsules, bruised, 2 oz.; distilled water, 1½ oct.). Only used externally.

EXTRACTUM PAPAVERIS.—Extract of Poppies (poppy capsules, dried, freed from the seeds and coarsely powdered, 1 lb. ; rectified spirit, 2 oz. ; boiling distilled water, a sufficiency). *Dose,* 2 to 5 grains.

SYRUPUS PAPAVERIS.—Syrup of Poppies (poppy capsules, dried, freed from the seeds and coarsely powdered, 36 oz. ; rectified spirit, 16 fl. oz. ; refined sugar, 4 lb. ; boiling distilled water, a sufficiency). *Dose,* 1 fluid drachm.

Therapeutics.—The preparations of the poppy capsules act in a similar manner to those of opium, but they are much weaker and more uncertain in their action. The decoction is only used as an external application to allay pain ; the syrup is useful for the relief of cough, and as an opiate for children, but it should be employed with caution.

2.—PAPAVER RHŒAS. THE RED POPPY.

Rhœados Petala.—RED POPPY PETALS.—The fresh PETALS of Papaver Rhœas. From indigenous plants.

Characters.—Of a scarlet colour and poppy odour. These petals yield a red colouring matter to water, and also contain traces of the constituents of opium.

Officinal Preparation.—SYRUPUS RHŒADOS.—Syrup of Red Poppy (fresh red poppy petals, 13 oz. ; refined sugar, 2¼ lb. ; distilled water, 1 oct., or a sufficiency ; rectified spirit, 2½ fl. oz.). *Dose,* 1 fluid drachm.

Therapeutics.—The action of the red poppy is exceedingly mild and very uncertain. It is usually employed only as a colouring agent.

Polygalaceæ.

1.—KRAMERIA TRIANDRA. RHATANY.

Krameriæ Radix.—RHATANY ROOT. The dried ROOT of Krameria Triandra. Imported from Peru.

Characters.—About an inch in diameter, branches numerous, long, brownish-red and rough externally, reddish-yellow internally. Contains *Krameric Acid,* tannin, and a red astringent matter. It is sweet and astringent to the taste, and tinges the saliva red. *Dose, in powder,* 20 to 60 grains.

Officinal Preparations.—EXTRACTUM KRAMERIÆ.—Extract of Rhatany (rhatany root, in coarse powder, 1 lb. ; distilled water, a sufficiency). *Dose,* 5 to 20 grains.

INFUSUM KRAMERIÆ.—Infusion of Rhatany (rhatany root, bruised, ½ oz. ; boiling distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

TINCTURA KRAMERIÆ.— Tincture of Rhatany (rhatany root, in coarse powder, 2½ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Rhatany root, in powder, is also contained in the Pulvis Catechu Compositus.

Therapeutics.—A powerful astringent. May be given in all conditions in which tannin is indicated. It is employed in all hæmorrhages and in chronic diarrhœa and dysentery. The diluted tincture or infusion is useful in sore throat, leucorrhœa and prolapsus ani.

2.—POLYGALA SENEGA.

Senegæ Radix.—SENEGA ROOT.—The dried ROOT of Polygala Senega, from North America.

Characters.—A knobby root-stock, with a branched tap-root, about the thickness of a quill, twisted and keeled; bark yellowish-brown, sweetish, afterwards pungent, inducing salivation; interior woody, inert and tasteless. Contains a glucoside, *Senegin* or *Polygalic Acid*, which breaks up when boiled with diluted acid into glucose and a substance termed Sapogenin. Tannin, pectin and gum are also contained in the root. *Dose, in powder*, 20 to 60 grains.

Officinal Preparations.—INFUSUM SENEGÆ.—Infusion of Senega (senega root, bruised, ½ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA SENEGÆ.—Tincture of Senega (senega root, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Therapeutics.—A stimulant to the mucous membranes, especially of the bronchial tubes; diaphoretic and sometimes diuretic: may be employed in chronic pneumonia and chronic bronchitis. It is occasionally useful in dysmenorrhœa. It may be combined with carbonate of ammonia and other expectorants and diaphoretics.

Adulterations.—The root of Panax Quinquefolium and Gillenia.

Ranunculaceæ.

1.—ACONITUM NAPELLUS. ACONITE. THE MONKSHOOD.

Aconiti Folia.—ACONITE LEAVES.—The fresh LEAVES and flowering tops of Aconitum Napellus, gathered when about one-third of the flowers are expanded, from plants cultivated in Great Britain.

Characters.—Leaves smooth, palmate, divided into five deeply-cut, wedge-shaped segments, exciting slowly, when chewed, a sensation of tingling. Flowers numerous, irregular, deep-blue, in dense racemes.

Officinal Preparation.—EXTRACTUM ACONITI.—Extract of Aconite (the fresh leaves and flowering tops of aconite, 112 lb.). *Dose*, 1 to 2 grains.

Aconiti Radix.—ACONITE ROOT.—The dried ROOT of Aconitum Napellus. Imported from Germany, or cultivated in Britain, and collected in the winter or early spring, before the leaves have appeared.

Characters.—Usually from one to three inches long, not thicker than the finger at the crown, tapering, blackish-brown; internally whitish. A minute portion, cautiously chewed, causes prolonged numbness and tingling.

Officinal Preparations.—LINIMENTUM ACONITI.—Liniment of Aconite (aconite root, in coarse powder, 20 oz.; camphor, 1 oz.; rectified spirit, a sufficiency).

TINCTURA ACONITI.—Tincture of Aconite (aconite root, in coarse powder, 2½ oz.; rectified spirit, 1 oct.).

Dose, 5 to 15 minims.

Aconitia.—ACONITIA ($C_{30}H_{47}NO_7$).—An alkaloid obtained from aconite (aconite root, in coarse powder, 14 lb.; rectified spirit, distilled water, solution of ammonia, pure ether, and diluted sulphuric acid, of each a sufficiency). The aconite root contains resinous matter and *Aconitate of Aconitia.* These substances are extracted from the root by means of rectified spirit; upon the addition of water the resinous matter is separated from the alkaloidal salt. A solution of ammonia is now added, *Aconitate of Ammonia* being formed and aconitia precipitated, the latter being then dissolved in ether, and afterwards recovered by distillation. Sulphuric acid is now added to form sulphate of aconitia, which is afterwards decomposed by solution of ammonia, sulphate of ammonia remaining in solution and *Aconitia* being precipitated. The alkaloid so obtained is dissolved in water and finally dried between folds of blotting-paper.

Characters.—A white amorphous powder and a very active poison, which, when rubbed on the skin, produces a sensation of tingling, followed by prolonged numbness. Aconitia is contained in all parts of the aconite plant, united with *Aconitic Acid*, and in company with a base termed *Aconella*, which does not possess the active properties of the first-named alkaloid.

Officinal Preparation.—UNGUENTUM ACONITIÆ.—Ointment of Aconitia (aconitia, 8 gr.; rectified spirit, ½ fl. dr.; prepared lard, 1 oz.).

Therapeutics.—In small doses aconite produces numbness and tingling of the lips. It has some repute in the treatment of neuralgia and other painful affections. It causes contraction of the pupil, and acts as a sedative to the heart's action. Some authors strongly recommend this drug as a substitute for depletory measures in the treatment of acute inflammations.

Adulterations.—The alkaloid is often impure. It may be mixed with delphinia, or may contain aconella. It is stated that $\frac{1}{50}$ of a grain of pure aconitia will destroy a dog, whereas very little effect has been produced by the action of 1 grain of the spurious alkaloid.

2.—PODOPHYLLUM PELTATUM. THE AMERICAN MAY APPLE.

Podophylli Radix. — PODOPHYLLUM ROOT. — The dried RHIZOME of Podophyllum Peltatum. Imported from North America.

Characters.—In pieces of variable length, about two lines thick, mostly wrinkled longitudinally, dark reddish-brown externally, whitish within, breaking with a short fracture ; accompanied with pale-brown rootlets. Powder yellowish-grey, sweetish in odour, bitterish and nauseous in taste. Contains an active principle termed *Berberine.*

Dose in powder, 10 to 20 grains.

Podophylli Resina.—RESIN OF PODOPHYLLUM (podophyllum root, in coarse powder, 1 lb. ; rectified spirit, 3 oct., or a sufficiency ; distilled water, a sufficiency ; hydrochloric acid, a sufficiency). *Dose*, $\frac{1}{4}$ to 1 grain.

Characters.—A pale greenish-brown amorphous powder.

Therapeutics.—The root is not much employed. The resin, PODOPHYLLIN, acts as a drastic purgative. It often causes emptying of the gall-bladder, but it is doubtful if it increases the secretion of bile. It frequently causes griping, and should be combined with hyoscyamus, belladonna, or cannabis indica. It is much used in congestion of the portal system, and may be given in dropsies in combination with calomel and acid tartrate of potash.

Rutaceæ.

1.—BAROSMA : BETULINA, CRENULATA, AND SERRATIFOLIA.

Buchu Folia.—BUCHU LEAVES.—The dried LEAVES of the three varieties of Barosma. Imported from the Cape of Good Hope.

Characters.—Smooth, marked with pellucid dots at the indentations and apex; possess a powerful odour and warm camphoraceous taste. The leaves of the Barosma Betulina are three quarters of an inch in length, obovate, with sharp cartilaginous spreading teeth, and a recurved truncated apex; those of the Crenulata are about an inch long, obtuse, five-nerved, and minutely crenated; those of the Serratifolia are from an inch to an inch and a half in length, are linear-lanceolate, tapering at each end, three-nerved, sharply and finely serrated; they all contain a light brownish-yellow *volatile oil*, which gives odour to the leaves, and a bitter extractive matter, *Barosmin* or *Diosmin.*

Officinal Preparations:

INFUSUM BUCHU.—Infusion of Buchu (buchu leaves, bruised, ½ oz.; boiling distilled water, 10 fl. oz.).

Dose, 1 to 4 fluid ounces.

TINCTURA BUCHU.—Tincture of Buchu (buchu leaves, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, 1 to 2 fluid drachms.

Therapeutics.—A slight stomachic and tonic, used chiefly for its action on the urinary organs, as in chronic catarrh of the bladder; also diuretic and sometimes diaphoretic.

2.—GALIPEA CUSPARIA. THE ANGUSTURA BARK TREE.

Cuspariæ Cortex.—CUSPARIA BARK.—The BARK of Galipea Cusparia. From tropical South America.

Characters.—In straight pieces more or less incurved at the sides, from half a line to a line in thickness, pared away at the edges; epidermis mottled, brown or yellowish-grey; inner surface yellowish-brown, flaky; breaks with a short fracture; taste bitter and slightly aromatic. When the cut surface is examined with a lens, numerous white points or minute lines are exhibited, these being raphides of oxalate of lime and liber-fibres. The inner surface of the bark, when touched with nitric acid, becomes blueish-black; in the case of the false bark the acid produces a red colour. Contains a trace of volatile oil, resin, and a principle, *Cusparine* or *Angusturin.*

Dose in powder, 10 to 40 grains.

Officinal Preparation:

INFUSUM CUSPARIÆ.—Infusion of Cusparia (cusparia bark, in coarse powder, ½ oz.; distilled water at 120° Fah. 10 fl. oz.)

Dose, 1 to 2 fluid ounces.

Therapeutics.—An aromatic stomachic; given in diarrhœa, dysentery, dyspepsia, and debility. It is employed in South America for the treatment of low malignant fevers.

Adulterations.—The bark of Strychnos Nux Vomica, or false Augustura bark, which yields strychnia and brucia ; these substances are not found in the true bark.

3.—RUTA GRAVEOLENS. THE COMMON RUE.

Rutæ Oleum.—OIL OF RUE. The OIL distilled from the fresh herb of Ruta Graveolens.

Characters.—Odour disagreeable, colour pale yellow, taste bitter and acrid. Contains a volatile oil which is said to consist mainly of *Euodic Aldehyde* combined with a little *Lauric Aldehyde*, also a bitter *extractive* matter.

Dose, 2 to 6 minims.

Therapeutics.—A powerful topical stimulant, employed in flatulent colic. It appears to be useful in hysteria and epilepsy.

Simarubaceæ.

PICRÆNA EXCELSA.

Quassiæ Lignum.—QUASSIA WOOD.—The WOOD of Picræna Excelsa. From Jamaica.

Characters.—Billets of variable size, seldom thicker than the thigh ; wood dense, tough, yellowish white, intensely and purely bitter. Also chips of the same. Contains a neutral crystallisable principle, *Quassine*, but possesses no tannin or gallic acid, and may therefore be combined with the salts of iron. *Dose in powder*, 10 to 20 grains.

Officinal Preparations.—EXTRACTUM QUASSIÆ.—Extract of Quassia (quassia wood, rasped, 1 lb. ; distilled water, a sufficiency). *Dose*, 3 to 5 grains.

INFUSUM QUASSIÆ.—Infusion of Quassia (quassia wood, in chips, 60 gr. ; cold distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

TINCTURA QUASSIÆ.—Tincture of Quassia (quassia wood, in chips, ¾ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Therapeutics.—A pure bitter stomachic, without astringency. Used in dyspepsia and debility, and given as an enema for the destruction of thread worms.

Vitaceæ.

VITIS VINIFERA. THE GRAPE-VINE.

Uvæ.—RAISINS.—The ripe FRUIT of Vitis Vinifera. Dried in the sun or by artificial heat ; imported from Spain. They contain much *Grape Sugar, Acid Tartrate of Potash, and Malic Acid.*

Officinal Preparations.—Raisins are contained in the Compound Tincture of Cardamoms and Tincture of Senna.

Therapeutics.—Slightly refrigerant, but only used for sweetening preparations.

Zygophyllaceæ.

GUAIACUM OFFICINALE.

Guaiaci Lignum.—GUAIACUM WOOD.—The WOOD of Guaiacum Officinale. Imported from St. Domingo and Jamaica, and reduced by the turning-lathe to the form of a coarse powder or small chips. Contained in Decoctum Sarsæ Compositum.

Guaiaci Resina.—GUAIACUM RESIN.—The RESIN of Guaiacum Officinale. Obtained from the stem by natural exudation, by incisions, or by heat.

Characters.—In large masses of a brownish or greenish-brown colour; fractured surface resinous, and translucent at the edges. Contains three *Acids*, viz., *Guaiacic, Guaiaretic*, and *Guaiaconic Acids*, with other vegetable matters. A solution of the resin in spirit developes a blue colour upon the inner surface of a paring of raw potato, due to the gluten being acted upon by the guaiacic acid. *Dose*, 10 to 30 grains.

Officinal Preparations. — MISTURA GUAIACI. — Guaiacum Mixture (guaiacum resin, in powder, ½ oz.; refined sugar, ½ oz.; gum acacia, powdered, ¼ oz; cinnamon water, 1 oct.). *Dose*, ½ to 2 fluid ounces.

TINCTURA GUAIACI AMMONIATA.—Ammoniated Tincture of Guaiacum (guaiacum resin, in powder, 4 oz.; aromatic spirit of ammonia, a sufficiency). *Dose*, ½ to 1 fluid drachm.

Resin of guaiacum is also contained in Pilula Hydrargyri Subchloridi Composita or Compound Calomel Pill.

Therapeutics.—The resin, when internally administered, produces a sensation of heat in the throat, and in large doses induces purging. After absorption it is stimulant, alterative, and diaphoretic, and is also stated to be emmenagogue. It may be given in chronic rheumatism, especially the 'cold' variety, or that in which warmth relieves the suffering; in syphilitic periosteal affections, in gout, dysmenorrhœa, and in skin diseases. Gon.

Adulterations.—Other resins, as those of the Coniferæ, known by their turpentine odour. If the tincture be thrown into water, it becomes milky by the precipitation of the resin; this milkiness is cleared by potash if only guaiacum resin is present, but not if there are other resins.

SUB-CLASS II. CALYCIFLORÆ.

Amyridaceæ.

1.—CANARIUM COMMUNE?

Elemi.—ELEMI.—A concrete resinous exudation, the botanical source of which is undetermined, but is probably Canarium Commune. Chiefly imported from Manilla.

Characters.—A soft, unctuous, adhesive mass, becoming harder and more resinous by age. Of a yellowish-white colour, with a rather fragrant fennel-like odour and a bitter aromatic taste. Contains a crystalline resin, *Elemin* or *Amyrin*, together with bitter crystalline neutral principles, *Bryoidin* and *Breidine.*

Officinal Preparation.—UNGUENTUM ELEMI.—Ointment of Elemi (elemi, ¼ oz.; simple ointment, 1 oz.).

Therapeutics.—Only used externally as an application to indolent sores and boils.

2.—BALSAMODENDRON MYRRHA.

Myrrha.—MYRRH.—A GUM RESINOUS EXUDATION from the stem of Balsamodendron Myrrha. Collected in Arabia Felix and Abyssinia.

Characters.—In irregular-shaped tears or masses of variable size, somewhat translucent, of a reddish-yellow or reddish-brown colour; fractured surface, irregular and somewhat oily; odour agreeable and aromatic, taste acrid and bitter. Contains a volatile oil, *Myrrhol,* gum, a resin, *Myrrhin,* and certain salts.

Officinal Preparation.—TINCTURA MYRRHÆ.—Tincture of Myrrh (myrrh, in coarse powder, 2½ oz.; rectified spirit, 1 oct.). *Dose,* ½ to 1 fluid drachm.

Myrrh is also contained in Mistura Ferri Composita, in Pilula Aloes et Myrrhæ, Pilula Assafœtidæ Composita, and Pilula Rhei Composita.

Therapeutics.—Internally administered, myrrh increases the secretion of the mucous membrane, especially of the bronchial tubes, and is said to possess emmenagogue, tonic and antispasmodic powers; it is often combined with iron and aloetic preparations in the treatment of amenorrhœa, in leucorrhœa, and mucous discharges associated with debility, and has been given in phthisis and chronic bronchitis as an expectorant. It is applied externally, as a topical stimulant, to spongy gums and aphthous sore mouth.

Anacardiaceæ.

PISTACIA LENTISCUS.

Mastiche.—MASTICH.—A RESINOUS EXUDATION obtained by incision from the stem of Pistacia Lentiscus. Produced in the island of Scio.

Characters.—Small, irregular, yellowish tears, brittle, becoming soft and ductile when chewed, having a faint, agreeable odour. Consists of *Mastichic Acid* and *Masticin.*

Dose, if administered internally, 20 to 40 grains.

Therapeutics.—The action is the same as that of the resin of turpentine. It is little used, but from the agreeable odour it imparts to the breath, is sometimes employed as a masticatory.

Cucurbitaceæ.

1.—CITRULLUS COLOCYNTHIS. THE WILD CUCUMBER.

Colocynthidis Pulpa.—COLOCYNTH PULP.—The dried decorticated FRUIT (pepo), freed from seeds, of Citrullus Colocynthis. Imported chiefly from Smyrna, Trieste, France, and Spain.

Characters.—Light, spongy, white or yellowish-white in colour, intensely bitter in taste. Contains a bitter resin, a bitter principle, mucilaginous matters, lignin, a crystallisable glucoside, *Colocynthin,* and phosphates of lime and magnesia. *Dose, in powder,* 2 to 8 grains.

Officinal Preparations.—EXTRACTUM COLOCYNTHIDIS COMPOSITUM.—Compound Extract of Colocynth (colocynth pulp, 6 oz.; extract of socotrine aloes, 12 oz.; resin of scammony, 4 oz.; hard soap, in powder, 3 oz.; cardamom seeds, in fine powder, 1 oz.; proof spirit, 1 cong.). *Dose,* 3 to 10 grains.

PILULA COLOCYNTHIDIS COMPOSITA.—Compound Pill of Colocynth (colocynth pulp, in powder, 1 oz.; Barbadoes aloes, in powder, 2 oz.; scammony, in powder, 2 oz.; sulphate of potash, in powder, ¼ oz.; oil of cloves, 2 fl. dr.; distilled water, a sufficiency). *Dose,* 5 to 10 grains.

PILULA COLOCYNTHIDIS ET HYOSCYAMI.—Pill of Colocynth and Hyoscyamus (compound pill of colocynth, 2 oz.; extract of hyoscyamus, 1 oz.). *Dose,* 5 to 10 grains.

Therapeutics.—A drastic purgative, producing watery motions, and powerfully stimulating the pelvic organs. When given alone it is apt to gripe, and it is therefore usually combined with other purgatives and carminatives. It is useful in obstinate and habitual constipation, in relieving the portal system in dropsical effusions, in amenorrhœa, and other uterine obstructions. Inflammation of the intestines may be occasioned by very large doses of colocynth.

Adulterations.—The extract is sometimes made with the pulp and seeds, by which a less active product is yielded.

2.—ECBALIUM OFFICINARUM. THE SQUIRTING CUCUMBER.

Ecbalii Fructus.—SQUIRTING CUCUMBER FRUIT.—The FRUIT, very nearly ripe, of Ecbalium Officinarum.

Characters.—A small elliptical pepo, about 1½ inches long, green, covered with soft prickles, and containing the seeds, surrounded by a juicy tissue; these, when ripe, are forcibly expelled, hence the name squirting cucumber.

Elaterium.—ELATERIUM.—A SEDIMENT from the juice of the Squirting Cucumber (squirting cucumber fruit, very nearly ripe, 1 lb.). The fruit is cut lengthwise, and the juice pressed lightly out; it is then strained through a hair sieve and set aside to deposit; the supernatant fluid is carefully poured off, and the sediment dried on porous tiles at a gentle heat.

Characters.—In light friable slightly incurved cakes, about one line thick, greenish-grey, acrid and bitter; fracture finely granular. Contains an active principle, *Elaterine*, *Elatin* or *Momordicine*, together with green resinous matter and woody fibre. *Dose*, $\frac{1}{16}$ to ½ grain.

Officinal Preparation.—PULVIS ELATERII COMPOSITUS. Compound Powder of Elaterium (elaterium, 10 gr.; sugar of milk, 90 gr., rubbed in a mortar until reduced to fine powder and intimately mixed). *Dose*, ½ grain to 5 grains.

Therapeutics.—A very powerful hydragogue purgative, chiefly employed in dropsical affections, especially when these are complicated with heart-disease; it is apt to cause depression and nausea unless very carefully administered.

Adulterations.—May contain starch, flour, or chalk, or but little elaterine (only 4 to 6 per cent.).

Leguminosæ.

SUB-ORDER. PAPILIONACEÆ.

1.—MYROXYLON PEREIRÆ.

Balsamum Peruvianum.—BALSAM OF PERU.—A BALSAM obtained from Myroxylon Pereiræ. It exudes from the trunk of the tree after the bark has been scorched and removed. From Salvador, in Central America.

Characters.—A reddish-brown or nearly black liquid, translucent in thin films; of the consistency of syrup, having a slightly bitter acrid taste, and a balsamic odour due to a neutral volatile oil, *Cinnamein*. Also contains a crystallisable solid, *Meta-Cinnamein*, with *Cinnamic Acid* and resins, and *Styracin* or *Cinnamate of Cinnamyl*.

Dose, 10 to 15 minims, and upwards, made into an emulsion with yolk of egg or mucilage.

Therapeutics.—A stimulant and expectorant, given in chronic bronchitis and rheumatism; also used in gleet, leucorrhœa, etc. Locally a stimulant, and applied to ulcers and bed-sores.

2.—MYROXYLON TOLUIFERA.

Balsamum Tolutanum.—BALSAM OF TOLU.—A BALSAM obtained from Myroxylon Toluifera. It exudes from the trunk of the tree after incisions have been made into the bark. From New Granada.

Characters.—A soft, tenacious reddish or yellowish-brown solid, with a fragrant balsamic odour.

Similar in composition to balsam of Peru, but in addition containing a volatile oil, *Tolene*. *Dose*, 10 to 20 grains.

Officinal Preparations.—SYRUPUS TOLUTANUS.—Syrup of Tolu (balsam of tolu, 1¼ oz.; refined sugar, 2 lb.; distilled water, 1 oct., or a sufficiency). *Dose*, 1 fluid drachm.

TINCTURA TOLUTANA.—Tincture of Tolu (balsam of tolu, 2½ oz.; rectified spirit, a sufficiency to make 1 oct.). Contained in Trochisci Acidi Tannici; Morphiæ; Morphiæ et Ipecacuanhæ; Opii. *Dose*, 20 to 40 minims.

Balsam of tolu is also contained in Tinctura Benzoini Composita.

Therapeutics.—Identical with balsam of Peru.

3.—GLYCYRRHIZA GLABRA.

Glycyrrhizæ Radix.—LIQUORICE ROOT.—The ROOT or underground stem, fresh and dried, of Glycyrrhiza Glabra. Cultivated in Britain.

Characters.—In long cylindrical branched pieces, an inch or less in diameter, pliable and tough; externally greyish-brown, internally yellow, without odour, of a sweet mucilaginous and slightly acrid taste. Contains gum, mucilage, and *Asparagine*, and a peculiar substance, *Glycyrrhizine*, or 'liquorice sugar,' which, when boiled with hydrochloric acid, yields *Glycyrretin*, a bitter resinous matter.

Officinal Preparations.—EXTRACTUM GLYCYRRHIZÆ.—Extract of Liquorice (liquorice root, in coarse powder, 1 lb.; distilled water, 4 oct.). Contained in Confectio Sennæ, Decoctum Aloes Compositum, Mistura Sennæ Composita, Tinctura Aloes and Trochisci Opii.

EXTRACTUM GLYCYRRHIZÆ LIQUIDUM.—Liquid Extract of Liquorice (liquorice root, in coarse powder, 1 lb.; distilled water, 4 oct.). *Dose*, 1 fluid drachm.

PULVIS GLYCYRRHIZÆ COMPOSITUS.—Compound Powder of Liquorice (senna, in fine powder, 2 oz.; liquorice root, in fine powder, 2 oz.; refined sugar, in powder, 6 oz.).

Dose, 30 to 60 grains.

Liquorice root is also contained in Confectio Terebinthinæ, Decoctum Sarsæ Compositum, Infusum Lini, Pilula Hydrargyri and Pilula Ferri Iodidi.

Therapeutics.—A demulcent, allaying cough, but more frequently used to cover the taste of other medicines. The compound powder is purgative.

4.—PTEROCARPUS MARSUPIUM.

Kino.—KINO.—The inspissated JUICE obtained from incisions made in the trunk of Pterocarpus Marsupium. Imported from Malabar.

Characters.—In small, angular, brittle, glistening, reddish-black fragments, translucent, and ruby-red on the edges, inodorous, very astringent. Tinges the saliva red when chewed. Contains red gummy matter and *Mimo-tannic* or *Kino-tannic* or *Catechu-tannic Acid*, and an astringent principle, *Catechin*. *Dose*, 10 to 30 grains.

Officinal Preparations.—PULVIS KINO COMPOSITUS.—Compound Powder of Kino (kino, in powder, 3¾ oz.; opium, in powder, ¼ oz.; cinnamon bark, in powder, 1 oz.).

Dose, 5 to 20 grains.

TINCTURA KINO.—Tincture of Kino (kino, in coarse powder, 2 oz.; rectified spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Powdered Kino is also contained in Pulvis Catechu Compositus.

Therapeutics.—A powerful general and local astringent, useful in diarrhœa, dysentery, and relaxed sore throat. May be given wherever tannin is indicated.

5.—PHYSOSTIGMA VENENOSUM.

Physostigmatis Faba.—Calabar Bean.—The seed of Physostigma Venenosum. Western Africa.

Characters.—About the size of a very large horse-bean, with a firm, hard, shining integument of a brownish-red, pale chocolate or ash-grey colour. Irregularly kidney-shaped, with two flat sides, and a furrow running longitudinally along its convex margin, ending in an aperture near one end of the seed. Within the shell is a kernel consisting of two cotyledons, weighing on an average about 46 grains, hard, white and pulverisable. The kernel is composed of starch, legumin, and a fatty oil, with mucilage, a little sugar, and the active principle *Physostigmia* or *Eseria*. *Dose in powder*, 1 to 4 grains.

Officinal Preparation. — Extractum Physostigmatis.—Extract of Calabar Bean (Calabar bean, in coarse powder, 1 lb.; rectified spirit, 4 oct.). *Dose*, $\frac{1}{16}$ to $\frac{1}{4}$ grain.

Therapeutics.—In poisonous doses Calabar bean may cause death by asphyxia or cardiac paralysis. In medium doses, or when the poison is absorbed gradually, asphyxia takes place; when the dose is large, or when the poison is directly introduced into the system, death ensues from paralysis of the heart. The asphyxia is due to 'a reduction and final abolition of the diastaltic function of the spinal cord,' and not to paralysis of the motor nerves.

This drug acts as a depressant on the heart, reducing the number of its pulsations; applied to the eye, the pupil is made to contract; this contraction may occur when internal administration of the drug has produced rapid poisoning, but it may be overlooked by the subsequent dilatation.

Physostigma has been employed internally in the treatment of strychnia-poisoning, chorea, tetanus, and general paralysis of the insane, and externally in certain conditions of the eye.

6.—PTEROCARPUS SANTALINUS.

Pterocarpi Lignum.—Red Sandal-Wood.—The wood of Pterocarpus Santalinus. From Ceylon.

Contained in Tinctura Lavandulæ Composita.

Characters.—Dense, heavy billets, outwardly dark-brown, internally variegated with dark and lighter red rings, if cut transversely. Powder blood-red, of a faint, peculiar odour, and an obscurely astringent taste. Also chips of the same. Contains a dark-red crystalline principle, *Santalin* or *Santalic Acid*, also *Santal*, and a small quantity of *Kino-Tannic Acid*. Solutions of metallic salts are incompatible with sandal wood, since acids precipitate the *Santalin*, throwing down red or violet precipitates.

Use.—To give colour to the Compound Tincture of Lavender, and through this to Liquor Arsenicalis.

7.—SAROTHAMNUS SCOPARIUS.

Scoparii Cacumina.—BROOM TOPS.—The fresh and dried TOPS of Sarothamnus Scoparius. From indigenous plants.

Characters.—Straight, angular, dark-green, smooth, tough, of a bitter, nauseous taste, and of a peculiar odour when bruised. Contain a neutral principle *Scoparine*, on which the diuretic properties depend, and *Sparteia* a volatile liquid alkaloid.

Officinal Preparations.—DECOCTUM SCOPARII. — Decoction of Broom (broom tops, dried, 1 oz. ; distilled water, 1 oct.). *Dose*, 2 to 4 fluid ounces.

SUCCUS SCOPARII.—Juice of Broom (fresh broom tops, 7 lb.; rectified spirit, a sufficiency ; one measure of spirit is added to every three of juice). *Dose*, 1 to 2 fluid drachms.

Therapeutics.—A diuretic. Chiefly used in dropsies, dependent upon cardiac disease. Causes vomiting and purging in large doses.

Sparteia is analogous to conia. It diminishes the reflex excitability of the spinal cord and paralyses the motor nerves ; and is said in addition to paralyse the cardiac inhibitory branches of the pneumogastric. Mammals are destroyed by sparteia from impairment of the activity of the respiratory centre in the medulla oblongata.

8.—ASTRAGALUS VERUS.

Tragacantha.—TRAGACANTH.—A GUMMY EXUDATION from the stems of Astragalus Verus, and possibly other species. Collected in Asia Minor.

Characters.—White or yellowish, in broad, shell-like, slightly incurved plates, tough and elastic ; very sparingly soluble in cold water ; but swelling into a gelatinous mass. Contains two distinct gums, *Arabine*, soluble in water, and *Bassorine*, insoluble in water, together with starch.

Officinal Preparations.—MUCILAGO TRAGACANTHÆ.—Mucilage of Tragacanth (tragacanth, in powder, 60 gr. ; distilled water, 10 fl. oz.).

PULVIS TRAGACANTHÆ COMPOSITUS.—Compound Powder of Tragacanth (tragacanth, in powder, 1 oz. ; gum acacia, in powder, 1 oz. ; starch, in powder, 1 oz. ; refined sugar, in powder, 3 oz.). *Dose*, 20 to 60 grains.

Powdered tragacanth is also contained in Confecto Opii and Pulvis Opii Compositus.

Therapeutics.—A simple demulcent. The mucilage is used for suspending heavy powders, as the subnitrate of bismuth. One part of tragacanth is said to render water more viscid than 25 parts of gum arabic.

SUB-ORDER. CÆSALPINEÆ.

9.—CASSIA FISTULA. THE PURGING CASSIA.

Cassiæ Pulpa.—CASSIA PULP.—The PULP obtained from the pods of Cassia Fistula. Imported from the West Indies; or recently extracted from pods imported from the East or West Indies. Used in Confectio Sennæ.

Characters.—Blackish-brown, viscid, sweet in taste, and somewhat sickly in odour; usually containing the seeds and dissepiments. Contains pectin, sugar, mucilage, and a principle probably similar to that found in Senna.

Dose, of the prepared pulp, 120 grains and upwards.

Therapeutics.—A mild laxative; seldom given alone, since it is liable to produce flatulence.

10.—COPAIFERA MULTIJUGA.

Copaiba.—COPAIVA.—The OLEO-RESIN obtained from incisions made in the trunk of Copaifera Multijuga, and other species of Copaifera. Chiefly from the valley of the Amazon.

Characters.—About the consistence of olive oil, light yellow, transparent, with a peculiar odour, and an acrid aromatic taste. Consists of a resin, *Copaivic Acid*, and a *volatile oil* closely allied to oil of turpentine. Also contains a soft brown resinous matter. *Dose*, ½ to 1 fluid drachm.

Copaibæ Oleum.—OIL OF COPAIVA.—The OIL distilled from Copaiva.

Characters.—Colourless or pale yellow, with the odour and taste of Copaiva. *Dose*, 5 to 20 minims.

Therapeutics.—Copaiba is used very successfully in affections of the bladder and urethra, as cystitis, gleet and leucorrhœa. It should be avoided in febrile conditions, or in renal dropsy, or where there is evidence of renal congestion; but may be employed with advantage in chronic bronchitis, especially when accompanied by excessive secretion of mucus. It is powerfully diuretic. The action of the volatile oil is similar to that of the balsam.

Adulterations.—Turpentine and fixed oils. Turpentine may be detected by its odour when the suspected drug is heated on paper, and all fixed oils by a greasy ring which surrounds the resinous stain left by pure copaiva.

11.—HÆMATOXYLUM CAMPECHIANUM.

Hæmatoxyli Lignum.—LOGWOOD.—The sliced HEART-WOOD of Hæmatoxylum Campechianum. Imported from Campeachy, Honduras, and Jamaica.

Characters.—The logs are externally of a dark colour, internally they are reddish-brown; the chips have a feeble agreeable odour, and sweetish taste; a small portion, when chewed, imparts to the saliva a dark pink colour. Contains an active principle, *Hæmatoxyline*, together with tannin and resin, and ordinary wood constituents. When fused with caustic potash Hæmatoxyline is converted into Pyrogallic Acid.

Officinal Preparations.—DECOCTUM HÆMATOXYLI.—Decoction of Logwood (logwood, in chips, 1 oz.; cinnamon bark, in coarse powder, 60 gr.; distilled water, 1 oct.).

Dose, 1 to 2 fluid ounces.

EXTRACTUM HÆMATOXYLI.—Extract of Logwood (logwood, in fine chips, 1 lb.; boiling distilled water, 1 cong.). *Dose,* 10 to 30 grains.

Therapeutics.—Chiefly used as an astringent in diarrhœa, chronic dysentery, and some forms of atonic dyspepsia, and often given to children.

12.—CASSIA LANCEOLATA. CASSIA OBOVATA.

Senna Alexandrina.—ALEXANDRIAN SENNA.—The LEAFLETS of Cassia Lanceolata and Cassia Obovata. Imported from Alexandria; carefully freed from the flowers, pods, and leaf-stalks of the same, and from the leaves, flowers, and fruit of Solenostemma Argel.

Characters.—Lanceolate or obovate leaflets, about an inch long, unequally oblique at the base, brittle, greyish-green, of a faint peculiar odour, and mucilaginous sweetish taste. The unequally oblique base and absence of bitterness distinguish the senna from the Argel leaves, which are, moreover, stiffer and thicker.

Officinal Preparations.—CONFECTIO SENNÆ.—Confection of Senna (senna, in fine powder, 7 oz.; coriander fruit, in fine powder, 3 oz.; figs, 12 oz.; tamarind, 9 oz.; cassia pulp, 9 oz.; prunes, 6 oz.: extract of liquorice, ¾ oz.; refined sugar, 30 oz.; distilled water, a sufficiency).

Dose, 60 to 120 grains.

INFUSUM SENNÆ.—Infusion of Senna (senna, 1 oz.; ginger, sliced, 30 grs.; boiling distilled water, 10 fl. oz.). *Dose,* 1 to 2 fluid ounces. Contained in

MISTURA SENNÆ COMPOSITA.—Compound Mixture of Senna (sulphate of magnesia, 4 oz.; extract of liquorice, ½ oz.;

tincture of senna, 2½ fl. oz.; compound tincture of cardamoms, 10 fl. oz.; infusion of senna, a sufficiency).

Dose, 1 to ½ fluid ounce.

SYRUPUS SENNÆ.—Syrup of Senna (senna, broken small, 16 oz.; oil of coriander, 3 minims; refined sugar, 24 oz.; distilled water, 5 oct., or a sufficiency; rectified spirit, 2 fl. oz.). *Dose*, 1 to 4 drachms.

TINCTURA SENNÆ.—Tincture of Senna (senna, broken small, 2½ oz.; raisins, freed from seeds, 2 oz.; caraway fruit, bruised, ½ oz.; coriander fruit, bruised, ½ oz.; proof spirit, 1 oct.). *Dose*, 1 to 4 fluid drachms.

13.—CASSIA ELONGATA.

Senna Indica.—TINNIVELLY SENNA.—The LEAFLETS of Cassia Elongata. From plants cultivated in Southern India. May be used in place of the Alexandrian Senna.

Characters.—About two inches long, lanceolate, acute, unequally oblique at the base, flexible, entire, green, without any admixture; odour and taste those of Alexandrian Senna.

Senna has a faint odour, and a nauseous taste, and contains *Cathartine* or *Cathartic Acid*, which, when boiled with alcohol and hydrochloric acid, is resolved into sugar and *Cathartogenic Acid.* It also contains a yellow colouring matter identical with Chrysophanic Acid, and, according to some, a crystalline sugar, *Catharto-Mannite.*

Therapeutics.—Senna is a somewhat brisk purgative; appears to act chiefly on the small intestines; sometimes creates griping and nausea if given alone, and is therefore usually combined with salines, as tartrate of potash or Epsom salts and some aromatic, forming the 'black draught.'

14.—TAMARINDUS INDICA.

Tamarindus.—TAMARIND.—The preserved PULP of the fruit of Tamarindus Indica. Imported from the West Indies. Contained in Confectio Sennæ.

Characters.—A brown, sweetish, sub-acid pulp, preserved in sugar, containing strong fibres and brown shining seeds, each enclosed in a membranous coat. Contains sugar, gum, pectin, free citric, tartaric, and malic acids, acid tartrate of potash, etc. The seeds contain much tannin. By boiling the pulp with milk, a whey may be obtained.

Dose, ¼ ounce and upwards.

Therapeutics.—A very slight laxative; refrigerant, on account of the acid contained, and useful when infused, as a cooling drink in febrile affections.

SUB-ORDER. MIMOSEÆ.

15.—ACACIA.

Acaciæ Gummi.—GUM ACACIA.—A GUMMY EXUDATION from the stems of one or more undetermined species of Acacia.

Characters.—In spheroidal tears, usually from half an inch to an inch in length, nearly colourless, and opaque, from numerous minute cracks, or in fragments with shining surfaces; brittle; bland and mucilaginous in taste. Contains *Gummic* or *Arabic Acid*, or *Arabin*, combined with magnesia, lime and potash; also small quantities of malate of calcium, chlorides of calcium, and potassium, with traces of iron, silicon, and phosphate of calcium.

Officinal Preparation.—MUCILAGO ACACIÆ.—Mucilage of Gum Acacia (gum acacia, in small pieces, 4 oz.; distilled water, 6 fl. oz.).

Gum Acacia is also contained in Mistura Cretæ, Mistura Guaiaci, Pulvis Amygdalæ Compositus, Pulvis Tragacanthæ Compositus, and in all the Trochisci.

16.—INDIGOFERA.

Indigo.—A BLUE PIGMENT prepared from various species of Indigofera.

Characters.—In cubical plates of an intense blue colour, without odour, and having a metallic taste. When rubbed with a smooth hard body it assumes a coppery hue. Contains a blue colouring matter, *Indigotin*. Indigo is introduced into the appendix of the Pharmacopœa for making the

Solution of Sulphate of Indigo (indigo, dry and in fine powder, 5 gr.; sulphuric acid, 10 fl. oz.).

Characters.—Contains a compound of sulphuric acid and indigotin, called *Sulphindigotic Acid*. This solution is used as a test for free chlorine in hydrochloric acid and liquor sodæ chloratæ. Free chlorine destroys the blue colour.

Therapeutics.—Indigo has been employed in epilepsy, but its action as a therapeutic agent demands further investigation.

Myrtaceæ.

1.—CARYOPHYLLUS AROMATICUS.

Caryophyllum.—CLOVES.—The dried unexpanded FLOWER-BUDS of Caryophyllus Aromaticus. Cultivated in Penang, Bencoolen, and Amboyna.

Dose, in powder, 5 to 20 grains or more.

Characters.—About six lines long, dark reddish-brown, plump, and heavy, consisting of a nearly cylindrical body surmounted by four teeth and a globular head, with a strong, fragrant odour, and a bitter spicy pungent taste. Emits oil when indented with the nails. Contains a volatile oil, consisting of a hydrocarbon isomeric with oil of turpentine, holding in solution *Eugenic Acid*, a crystalline body, *Caryophylline*, and *Eugenine.* Cloves also contain salicylic acid and a variety of tannin; they are therefore incompatible with salts of iron.

Officinal Preparation.—INFUSUM CARYOPHYLLI.—Infusion of Cloves (cloves, bruised, ¼ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 4 fluid ounces.

Cloves are also contained in Infusum Aurantii Compositum, Mistura Ferri Aromatica, and Vinum Opii.

Caryophylli Oleum.—OIL OF CLOVES.—The OIL distilled in Britain from cloves.

Characters.—Colourless when recent, but gradually becoming red-brown, having the odour of cloves and a pungent spicy taste. Sinks in water.

Contained in Confectio Scammonii, Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

Therapeutics.—Cloves and the oil are aromatic, carminative and stimulant; they are employed in dyspepsia, to relieve flatulence, and to allay vomiting in pregnancy. The oil may be used as an adjunct to purgatives, or locally to stay the pain of carious teeth.

2.—MELALEUCA MINOR.

Cajuputi Oleum.—OIL OF CAJUPUT.—The OIL distilled from the leaves of Melaleuca Minor. Imported from Batavia and Singapore.

Characters.—Very mobile, transparent, of a fine pale, blueish-green colour. Has a strong disagreeable odour, and a warm aromatic taste, and leaves a sensation of coldness in the mouth. When distilled, a colourless oil comes over which constitutes two thirds of the crude oil and is really *Hydrate of Cajuputene.*

Officinal Preparation.—SPIRITUS CAJUPUTI.—Spirit of Cajuput (oil of cajuput, 1 fl. oz.; rectified spirit, 49 fl. oz.).

Dose, ½ to 1 fluid drachm.

Oil of cajuput is also contained in Linimentum Crotonis.

Therapeutics.—A powerful general and topical stimulant and antispasmodic, useful in hysteria, cholera, and flatulent colic, also in low states of the system and in chronic rheumatism. Mixed with olive-oil, it is used externally over gouty and chronic rheumatic parts.

Adulteration.—Copper. Camphor dissolved in oil of rosemary and coloured by copper has been stated to be substituted for the genuine oil.

3.—PUNICA GRANATUM.

Granati Radicis Cortex.—POMEGRANATE ROOT-BARK.—The dried BARK of the root of Punica Granatum. Obtained from the south of Europe.

Characters.—In quills or fragments of a greyish-yellow colour externally, yellow internally, having a short fracture, little odour, and an astringent slightly bitter taste. The rind contains extractive and mucilaginous matters, and tannin. The root-bark also contains tannin and a principle called *Punicine.*

Officinal Preparation. — DECOCTUM GRANATI RADICIS.—Decoction of Pomegranate Root (pomegranate root bark, sliced, 2 oz.; distilled water, 2 oct.).

Dose, 1 to 2 fluid ounces.

Therapeutics.—The rind is somewhat astringent. It may be used when tannin is indicated. The root is also slightly astringent, and has been used to expel tape-worms.

4.—EUGENIA PIMENTA. THE ALLSPICE-TREE.

Pimenta.—PIMENTO.—The dried unripe BERRIES of Eugenia Pimenta. West Indies.

Characters.—Of the size of a small pea, brown, rough, crowned with the teeth of the calyx, yellowish within, and containing two dark-brown seeds. Odour and taste aromatic, hot, and peculiar. Contains a fixed oil, resin, a large quantity of tannin, and a volatile oil identical with oil of cloves.

Officinal Preparation.—AQUA PIMENTÆ. — Pimento Water (pimento, bruised, 14 oz.; water, 2 cong.; distilled to one gallon).

Pimenta is also contained in Syrupus Rhamni.

Pimentæ Oleum.—OIL OF PIMENTO.—The OIL distilled in Britain from pimento.

Characters.—Colourless or slightly-reddish when recent, but becoming brown by age, having the odour and taste of pimento. Sinks in water.

Therapeutics.—The same as cloves.

Rhamnaceæ.

RHAMNUS CATHARTICUS. THE COMMON BUCKTHORN.

Rhamni Succus.—Buckthorn Juice.—The recently expressed JUICE of the ripe berries of Rhamnus Catharticus.

Characters.—Of a green colour and nauseous odour. Contains sugar, mucilage, malic acid and two principles, *Rhamnine* and *Rhamnegine*, both resolvable into crystalline sugar and *Rhamnetin*.

Officinal Preparation.—Syrupus Rhamni.—Syrup of Buckthorn (buckthorn juice, 4 oct. ; ginger, sliced, ¾ oz. ; pimento, bruised, ¾ oz. ; refined sugar, 5 lb. or a sufficiency ; rectified spirit, 6 fl. oz.). *Dose*, 1 fluid drachm.

Therapeutics.—A brisk hydragogue purgative, often attended by nausea and griping ; the syrup was at one time occasionally given to children, but its use is now almost entirely abandoned.

Rosaceæ.

1.—AMYGDALUS COMMUNIS. THE ALMOND TREE.

Amygdala Amara.—Bitter Almond.—The SEED of the bitter almond tree, Amygdalus Communis. Brought chiefly from Mogadore.

Characters.—Similar to the sweet almond in appearance, but rather broader and shorter ; has a bitter taste, and when rubbed with water emits a characteristic odour.

Amygdala Dulcis.—Sweet Almond.—The SEED of the sweet almond tree, Amygdalus Communis. Cultivated about Malaga.

Characters.—Above an inch in length, lanceolate, acute, with a clear cinnamon-brown seed-coat, and a bland sweetish nutty-flavoured kernel. Does not evolve the odour of bitter almonds when bruised with water.

Both varieties of almond yield on expression the Oleum Amygdalæ, together with *Emulsine* or *Synaptase*, sugar, gum, woody fibre, and inorganic salts, especially phosphates of potash, lime, and magnesia. In addition to these the bitter almond contains *Amygdaline*.*

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* *See* 'Hydrocyanic Acid. Part I.

Officinal Preparations.—MISTURA AMYGDALÆ.—Almond Mixture (compound powder of almonds, 2½ oz.; distilled water, 1 oct.). *Dose,* 1 to 2 fluid ounces.

PULVIS AMYGDALÆ COMPOSITUS.—Compound Powder of Almonds (sweet almonds, 8 oz.; refined sugar, in powder, 4 oz.; gum acacia, in powder, 1 oz.).

Amygdalæ Oleum.—The OIL expressed from bitter and sweet almonds.

Characters.—Pale yellow, nearly inodorous, or having a nutty odour, with a bland oleaginous taste. It is contained in the following Unguenta: Cetacei; Hydrargyri Oxidi Rubri; Plumbi Subacetatis Compositum; Unguentum Simplex and the preparations in which that ointment is contained.

Therapeutics.—Sweet almonds are nutritive and demulcent. They are commonly used as vehicles for the administration of other remedies. In large doses the fixed oil is purgative. The bitter almonds in large quantities are poisonous, and their employment is not to be recommended, since the amount of prussic acid generated is very variable.

An almond-cake, made from the non-amylaceous powder of the sweet almond, has been proposed as a substitute for bread in the treatment of Diabetes Mellitus.

2.—BRAYERA ANTHELMINTICA.

Cusso.—KOUSSO.—THE FLOWERS and tops of Brayera Anthelmintica. Collected in Abyssinia.

Characters.—Flowers small, reddish-brown, on hairy stalks, outer limb of calyx five-parted, the segments oblong or oblong-lanceolate, reticulated. Contains a volatile oil, gum, sugar, tannic acid, wax, and a crystallisable principle, *Koussine* or *Kosin.* Has a tea-like odour, and when viewed *en masse* is yellowish-green. *Dose,* ¼ to ½ ounce.

Officinal Preparation. — INFUSUM CUSSO. — Infusion of Kousso (kousso, in coarse powder, ½ oz.; boiling distilled water, 8 fl. oz.). *Dose,* 4 to 8 fluid ounces.

3.—PRUNUS LAUROCERASUS. THE COMMON CHERRY-LAUREL.

Laurocerasi Folia.—CHERRY-LAUREL LEAVES.—The fresh LEAVES of Prunus Laurocerasus.

Characters. — Ovate-lanceolate or elliptical, distantly toothed, furnished with glands at the base, smooth and shining, deep green, on strong short footstalks; emitting a ratafia odour when bruised. On distillation with water they yield some hydrocyanic acid and a volatile oil, neither of which pre-exist in the leaves. Only half as much hydrocyanic acid is yielded in winter as in July and August.

Officinal Preparation.—AQUA LAUROCERASI.—Laurel Water (fresh leaves of common cherry-laurel, 1 lb.; water, 2½ oct.; distil one pint of liquid). *Dose*, 5 to 30 minims.

4.—PRUNUS DOMESTICA. THE PLUM.

Prunum.—PRUNE.—The dried DRUPE of Prunus Domestica. From Southern Europe. It is contained in Confectio Sennæ. Has a sweet, somewhat austere taste. Contains free malic acid, glucose, gum, pectin, oxalate of lime, and a purgative principle, the nature of which is unknown. Its action is laxative.

5. (*a*) ROSA CANINA. THE DOG-ROSE.

Rosæ Caninæ Fructus.—FRUIT OF THE DOG-ROSE.—HIPS.—The ripe FRUIT of Rosa Canina and other indigenous allied species.

Characters.—The ripe fruit deprived of hairy seeds (achenes). An inch or more in length, ovate, scarlet, smooth, shining; taste sweet, sub-acid, pleasant. The pulp contains malic and citric acids, malates and citrates of potash and lime, tannic acid, sugar, gum, and a trace of volatile oil.

Officinal Preparation.—CONFECTIO ROSÆ CANINÆ.—Confection of Hips (hips, deprived of their seeds, 1 lb.; refined sugar, 2 lbs.).

Also contained in Pilula Quiniæ and used as a basis for other pill masses.

(*b*) ROSA CENTIFOLIA. THE HUNDRED-LEAVED OR CABBAGE-ROSE.

Rosæ Centifoliæ Petala.—CABBAGE-ROSE PETALS.—The fresh PETALS, fully expanded, of Rosa Centifolia. From plants cultivated in Britain.

Characters.—Taste sweetish, bitter, and faintly astringent; odour roseate; both readily imparted to water. The odour is due to a volatile faint straw-coloured oil termed *Otto*, or *Attar*, of *Roses*, which is prepared in India. The petals also contain colouring matter, a slight laxative principle, traces of tannic, gallic, malic, and tartaric acids, fat, resin, and sugar.

Officinal Preparation.—AQUA ROSÆ.—Rose-water (fresh petals of the hundred-leaved rose, 10 lb.—or an equivalent quantity of the petals preserved while fresh with common salt —water, 2 cong. Distil one gallon). Contained in Mistura Ferri Composita and Trochisci Bismuthi. *Dose,* ad libitum.

Therapeutics.—Used chiefly as a vehicle for medicines, lotions, and collyria.

(*c*) ROSA GALLICA. THE RED ROSE.

Rosæ Gallicæ Petala.—RED ROSE PETALS.—The fresh and dried unexpanded PETALS of Rosa Gallica. From plants cultivated in Britain.

Characters.—Colour fine purplish-red, retained after drying; taste bitterish, feebly acid and astringent; odour roseate, developed by drying. Contain red colouring matter, a trace of volatile oil, a little fat, sugar, tannic and gallic acids, and a glucoside, *Quercitrin* (the crystallisable yellow colouring matter of Quercus Tinctoria), which, when boiled with diluted sulphuric acid, is resolved in *Quercetin* and glucose. An infusion of the petals becomes green with alkalies and red with acids.

Officinal Preparations.—CONFECTIO ROSÆ GALLICÆ.—Confection of Roses (fresh red-rose petals, 1 lb.; refined sugar, 3 lb.). Contained in Pilulæ: Aloes Barbadensis; Aloes et Assafœtidæ; Aloes et Ferri; Aloes et Myrrhæ; Aloes Socotrinæ; Ferri Carbonatis; Hydrargyri; Plumbi cum Opio.

INFUSUM ROSÆ ACIDUM.—Acid Infusion of Roses (dried red-rose petals, broken up, ¼ oz.; diluted sulphuric acid, 1 fl. dr.; boiling distilled water, 10 fl. oz.)

Dose, 1 to 2 fluid ounces.

SYRUPUS ROSÆ GALLICÆ.—Syrup of Red Roses (dried red-rose petals, 2 oz.; refined sugar, 30 oz.; boiling distilled water, 1 oct.). *Dose,* 1 fluid drachm.

Therapeutics.—Slightly astringent. The confection is used as a pill basis, and is also applied to aphthous conditions of the mouth in the form of a linctus. The acid infusion is chiefly employed as a gargle, an astringent, or an agreeable vehicle for more powerful medicines, as Epsom salts, sulphate of quinia, etc. The syrup is used as a colouring agent.

Umbelliferæ.

1. DOREMA AMMONIACUM.

Ammoniacum. — AMMONIACUM.—A GUM-RESINOUS EXUDATION from Dorema Ammoniacum. Collected in Persia and the Punjaub.

Characters.—In tears or masses; the tears from two to eight lines in diameter, pale cinnamon-brown, breaking with a smooth, shining, opaque white surface; the masses composed of agglutinated tears; hard and brittle when cold, but readily softening with heat. Has a faint odour, and a bitter, acrid, nauseous taste. Rubbed with water it forms a nearly white emulsion. Contains a resin and a volatile oil which is destitute of sulphur. It yields a little *Resorcin* on fusion with potash. Ammoniacum, when rubbed with camphor, at once forms a mass which is suitable for pills. *Dose*, 10 to 20 grains.

Officinal Preparations.—EMPLASTRUM AMMONIACI CUM HYDRARGYRO.—Ammoniacum and Mercury Plaster (ammoniacum, 12 oz.; mercury, 3 oz.; olive oil, 1 fl. dr.; sublimed sulphur, 8 gr.).

MISTURA AMMONIACI.—Ammoniacum Mixture (ammoniacum, in coarse powder, ¼ oz.; distilled water, 8 fl. oz.). *Dose*, ½ to 1 fluid ounce.

Ammoniacum is also contained in Emplastrum Galbani, Pilula Scillæ Composita, and Pilula Ipecacuanhæ cum Scilla.

Therapeutics.—Ammoniacum in large doses may cause nausea; after absorption its action seems chiefly directed to the mucous membranes, especially of the bronchial tubes. It is a powerful stimulating expectorant, very useful in some cases of chronic bronchitis. Externally applied, local irritation is produced, and the Emplastrum Ammoniaci cum Hydrargyro may cause a papular or even pustular eruption. Ammoniacum is often applied to indolent tumours and chronically enlarged joints.

2.—ANETHUM GRAVEOLENS. THE DILL.

Anethi Fructus.—Dill Fruit.—The FRUIT of Anethum Graveolens. Cultivated in England, or imported from middle and Southern Europe.

Characters.—Oval, flat, about a line and a half in length, with a pale membranous margin, odour aromatic, taste warm, somewhat bitter.

Officinal Preparation.—AQUA ANETHI.—Dill water (dill fruit, bruised, 1 lb.; water, 2 cong.; distil 1 gallon).

Dose, 1 to 2 fluid ounces. For infants, 1 to 2 fluid drachms.

Anethi Oleum.—OIL OF DILL.—The OIL distilled in Britain from dill fruit.

Characters.—Colour pale yellow, odour pungent, taste acrid, sweetish. Resembles oil of caraway, and is said to consist of a hydrocarbon, *Anethene*, and an *Oil* ($C_{10}H_{14}O$) identical with *Carvol*. *Dose*, 2 to 5 minims.

Therapeutics.—Aromatic, carminative, and stimulant. Useful as an adjunct to purgatives, and employed in the flatulence of children.

3. PIMPINELLA ANISUM. ANISE.

Anisi Oleum.—OIL OF ANISE.—The OIL distilled in Europe from the fruit of Pimpinella Anisum. And the oil distilled in China from the fruit of Illicium Anisatum, Star Anise.*

Characters.—Colourless or pale yellow; with the odour of anise and a warm sweetish taste. Concretes at 50°Fah. Consists of two portions, about $\frac{1}{5}$th being a liquid oil isomeric with oil of turpentine ($C_{10}H_{16}$), and $\frac{4}{5}$ths an oil solidifying below 50° and termed *Anethol* or *Anise-Camphor*, which is easily oxidised, yielding substances containing the radical *Anisyl* ($C_8H_7O_2$). By the action of dilute nitric acid upon oil of anise, *oxalic* and *Anisic Acids* are formed, together with *Anisyl Hydrate*, which possesses the odour of new hay.

Dose, 2 to 5 minims.

Officinal Preparation.—ESSENTIA ANISI.—Essence of Anise (oil of anise, 1 fl. oz.; rectified spirit, 4 fl. oz.).

Dose, 10 to 20 minims.

Oil of anise is also contained in Tinctura Camphoræ Composita and Tinctura Opii Ammoniata.

Therapeutics.—Stimulant, aromatic, and carminative; used for the relief of flatulence.

4.—NARTHEX ASSAFŒTIDA.

Assafœtida.—ASSAFŒTIDA.—A GUM RESIN obtained by incision from the living root of Narthex Assafœtida. In Afghanistan and the Punjaub.

Characters.—In irregular masses, partly composed of tears, moist or dry. The colour of a freshly-cut or broken piece is opaque white, but gradually becomes purplish-pink and finally dull-yellowish or pinkish-brown. Taste bitter, acrid; odour fetid, alliaceous and persistent. Almost entirely dissolves in rectified spirit, and its pulverisation is facilitated by rubbing with carbonate of ammonia. Contains a *volatile oil* consisting

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* See page 29.

of *Sulphide of Allyl, gum,* and a *resin* yielding *Ferulaic Acid. Dose,* 5 to 20 grains.

Officinal Preparations.—ENEMA ASSAFŒTIDÆ.—Enema of Assafœtida (assafœtida, 30 grains ; distilled water, 4 fl. oz.).

PILULA ASSAFŒTIDÆ COMPOSITA.—Compound Pill of Assafœtida (assafœtida, 2 oz. ; galbanum, 2 oz. ; myrrh, 2 oz. ; treacle, by weight, 1 oz.). *Dose,* 5 to 10 grains.

TINCTURA ASSAFŒTIDÆ.—Tincture of Assafœtida (assafœtida, in small fragments, 2½ oz. ; rectified spirit, a sufficiency). *Dose,* ½ to 1 fluid drachm.

Assafœtida is also contained in Pilula Aloes et Assafœtidæ and Spiritus Ammoniæ Fœtidus.

Therapeutics.—A powerful stimulant and antispasmodic to the nervous system, especially valuable in convulsive hysterical affections; also used in asthma and pertussis. May be employed as an enema in tympanites. Useful as an expectorant in some forms of chronic bronchitis. Garrod considers assafœtida one of the most valuable remedies of the Materia Medica, and far above all other ordinary antispasmodics. He attributes its value to the contained sulphur oil. Galbanum and ammoniacum possess no true antispasmodic powers when given alone, since they are devoid of the sulphur oil.

Adulterations.—Mechanical impurities, as stones and sand, which are occasionally present.

5.—CARUM CARUI. THE CARAWAY.

Carui Fructus.—CARAWAY FRUIT.—The dried FRUIT of Carum Carui. Cultivated in England and Germany.

Characters.—Fruit usually separating into two parts, which are about two lines long, curved, tapering at each end, brown, with five paler longitudinal ridges ; having an agreeable aromatic odour and spicy taste. Contains a *volatile* oil consisting of two liquid portions, the oxidised *Carvol* ($C_{10}H_{14}O$), and the unoxidised, *Carvene* ($C_{10}H_{16}$).

Officinal Preparations.—AQUA CARUI. — Caraway Water (caraway fruit, bruised, 1 lb. ; water, 2 cong. Distil one gallon.). Caraway fruit is also contained in Confectio Opii, Confectio Piperis, in Pulvis Opii Compositus, Tinctura Cardamomi Composita, and Tinctura Sennæ Composita.

Dose, 1 to 2 fluid ounces.

Carui Oleum.—OIL OF CARAWAY.—The OIL distilled in Britain from Caraway fruit.

Characters.—Colourless or pale yellow, odour aromatic, and taste spicy. Contained in Confectio Scammonii and Pilula Aloes Barbadensis. *Dose,* 2 to 5 minims.

Therapeutics.—Similar to Anise and Dill.

6.—CONIUM MACULATUM. THE SPOTTED HEMLOCK.

Conii Folia.—HEMLOCK LEAVES.—The fresh LEAVES and young BRANCHES of Conium Maculatum; also the leaves separated from the branches and carefully dried; gathered from wild British plants when the fruit begins to form.

Characters.—Fresh leaves decompound, smooth, arising from a smooth stem with dark purple spots; dried leaves of a full green colour and characteristic odour. The leaf rubbed with solution of potash emits strongly the mouse-like odour of conia. *Dose in powder*, 2 to 8 grains.

Officinal Preparations. — CATAPLASMA CONII. — Hemlock Poultice (hemlock leaf, in powder, 1 oz.; linseed meal, 3 oz.; boiling water, 10 fl. oz.).

EXTRACTUM CONII.—Extract of Hemlock (the fresh leaves and young branches of hemlock, 112 lb.). *Dose*, 2 to 6 grains. Used in the two following, viz., in

PILULA CONII COMPOSITA.—Compound Pill of Hemlock (extract of hemlock, 2½ oz.; ipecacuanha, in powder, ½ oz.; treacle, a sufficiency). *Dose*, 5 to 10 grains. And in

VAPOR CONIÆ.—Inhalation of Conia (extract of hemlock, 60 gr.; solution of potash, 1 fl. dr.; distilled water, 10 fl. dr.; mix). Put 20 minims of the mixture on a sponge, in a suitable apparatus, so that the vapour of hot water passing over it may be inhaled.

SUCCUS CONII.—Juice of Hemlock (fresh leaves of hemlock, 7 lb.; rectified spirit, a sufficiency). *Dose*, ½ to 1 fluid drachm.

Conii Fructus.—Hemlock Fruit.—The dried ripe FRUIT of Conium Maculatum.

Characters.—Broadly ovate, compressed laterally; half fruit (mericarp), with five-waved or crenated edges. Reduced to powder and rubbed with solution of potash, emit strongly the odour of conia.

Officinal Preparation.—TINCTURA CONII.—Tincture of Hemlock (hemlock fruit, bruised, 2½ oz.; proof spirit, 1 oct.); 54½ grains to 1 fl. oz. *Dose*, 20 to 60 minims.

Both the leaves and fruit of Conium contain a non-poisonous volatile oil, together with *Conia* or *Cicutine* ($C_8H_{15}N$), a volatile liquid alkaloid, combined with *Conic Acid* as *Conate of Conia*.

Conia is a strongly alkaline fluid, and neutralises strong acids. With *nitric acid* it gives a *blood-red* colour; by *sulphuric acid* it is turned *purplish-red*, changing to *green;* when gently warmed with *hydrochloric acid* it forms a *greenish-blue* crystalline mass. Conia produces a greasy stain on paper which disappears on heating; it is always accompanied by *Methyl-Conia* ($CH_3C_8H_{14}N$) and *Conhydrine* ($C_8H_{15}N,H_2O$).

The vapour of conia is inflammable.

Therapeutics.—Hemlock owes its physiological effects to the conia and methyl-conia it contains. The strength of the preparations of the plant is extremely uncertain, since these alkaloids are very volatile and prone to decomposition.

Conia is said to cause paralysis of the voluntary muscles by a selective action upon the end-organs of the motor nerves. The brain, the spinal cord, the muscular tissue, and the afferent nerves remain unaffected. Gradual enfeeblement of the respiratory muscles takes place, and death by asphyxia results from their ultimate paralysis. The heart's action is not directly interfered with.

Methyl-conia acts specifically upon the spinal cord as well as upon the end-organs of the motor nerves, first exalting and then abolishing the reflex function of that cord. From this circumstance the action of pure conia is considerably modified, since it is invariably associated with methyl-conia.

If a full dose of any active preparation of conium is given to a healthy man, weakness of the legs and staggering ensue; early implication of the third cranial nerve takes place, causing ptosis and dilatation of the pupil; the cerebral functions are unaffected, but the muscular debility increases, drowsiness and sleep ensue; and coldness of the extremities, nausea and pallor are not unfrequently observed.

Conium is employed to allay muscular spasm in paralysis agitans, mercurial tremor, chorea, and the severe twitchings of the legs which sometimes take place in paraplegia. In strychnia poisoning and tetanus the drug is useless.

It may be employed as the vapor coniæ to relieve the cough of bronchitis, pertussis, or phthisis. It has been advocated in acute mania, and was once said to be a remedy for cancer, in which it often diminishes the pain and improves the general health.

Dr. John Harley considers the succus the only reliable preparation of conium for internal use, but he also states that even this cannot always be depended upon, since the proportion of the active principle contained is very variable.

7.—CORIANDRUM SATIVUM. CORIANDER.

Coriandri Fructus.—Coriander Fruit.—The dried ripe fruit of Coriandrum Sativum. Cultivated in Britain.

Characters.—Globular, nearly as large as white pepper, beaked, finely-ribbed, yellowish-brown; has an agreeable aromatic odour and flavour. Contained in Confectio Sennæ, Mistura Gentianæ, Syrupus Rhei, Tinctura Rhei, and Tinctura Sennæ. *Dose, of the powdered fruit*, 10 to 30 grains or more.

Coriandri Oleum.—OIL OF CORIANDER.—The OIL distilled in Britain from coriander fruit.

Characters.—Yellowish, having the odour of coriander. *Dose*, 2 to 5 minims.

Therapeutics.—Similar to Anethum, Anisum, and Carum Carui. Seldom given alone.

8.—FŒNICULUM DULCE. FENNEL.

Fœniculi Fructus.—FENNEL FRUIT.—The FRUIT of Fœniculum Dulce. Imported from Malta.

Characters.—About three lines long and one line broad; elliptical, slightly curved, beaked, having eight pale-brown longitudinal ribs, the two lateral being double; taste and odour aromatic. Contains a volatile oil identical with oil of anise, and possessing the characteristic odour of the fruit.

Officinal Preparation.—AQUA FŒNICULI.—Fennel Water (fennel fruit, bruised, 1 lb.; water, 2 cong.; distil one gallon). *Dose*, 1 to 2 fluid ounces.

Therapeutics.—As of Anethum, Anisum, etc.

9.—FERULA GALBANIFLUA (?).

Galbanum.—GALBANUM.—A GUM-RESIN, derived from Ferula Galbaniflua (?). Imported from India and the Levant.

Characters.—In irregular tears about the size of a pea, usually agglutinated into masses; of a greenish-yellow colour, translucent, having a strong disagreeable odour, and an acrid bitter taste.

Contains a *volatile oil* destitute of sulphur and isomeric with oil of turpentine; also a *resin* which yields a substance termed *Umbelliferone* ($C_9H_6O_3$). *Dose*, 10 to 30 grains or more.

Officinal Preparation.—EMPLASTRUM GALBANI.—Galbanum Plaster (galbanum, 1 oz.; ammoniacum, 1 oz.; yellow wax, 1 oz.; lead plaster, 8 oz.).

Galbanum is also contained in Pilula Assafœtidæ Composita.

Therapeutics.—Similar to assafœtida, but possessing far less powerful antispasmodic properties. Probably more allied in its action to ammoniacum. It is sometimes used as an expectorant, and is given in amenorrhœa from its supposed stimulating action on the uterus. Externally it is somewhat stimulating, and is employed to discuss indolent tumours.

10.—EURYANGIUM SUMBUL (?).

Sumbul Radix.—SUMBUL ROOT.—The dried transverse sections of the root of Euryangium Sumbul (?). Imported from Russia and also from India.

Characters.—The pieces are nearly round, from 2½ to 5 inches in diameter, and from ¾ to 1½ inch in thickness. They are covered on the outer edge with a dusky-brown rough bark, frequently beset with short bristly fibres. The interior is porous, consisting of easily-separated, irregular fibres. It has a strong odour, resembling that of musk. The taste is at first sweetish, becoming after a time bitterish and balsamic. That brought from India differs from the Russian, being closer in texture, more dense and firm, and of a reddish tint. The root contains a resin, a little *volatile oil*, *Umbelliferone*, *Angelic Acid*, and a trace of *Valerianic Acid*. The resin is converted by potash into *Sumbulic Acid*, which smells strongly of musk.

Officinal Preparation. — TINCTURA SUMBUL.—Tincture of Sumbul (sumbul root, in coarse powder, 2½ oz. ; proof spirit, 1 oct.). *Dose*, 10 to 30 minims.

Therapeutics.—A nervine stimulant similar to Valerian. Used in Russia for cholera and febrile disease of an adynamic or typhoid type. Has been advocated in chorea, epilepsy, and other nervous disorders, and is said to be sometimes beneficial in delirium tremens. The resin separated from the root has been occasionally used in doses of from ½ grain upwards.

SUB-CLASS III. COROLLIFLORÆ.

Asclepiadaceæ.

HEMIDESMUS INDICUS.

Hemidesmi Radix.—HEMIDESMUS ROOT.—The dried ROOT of Hemidesmus Indicus. Imported from India.

Characters.—Yellowish-brown, cylindrical, tortuous, furrowed, and with annular cracks, having a fragrant odour and a very agreeable flavour. Contains a volatile, crystallisable substance, *Hemidesmic Acid*.

Officinal Preparation.—SYRUPUS HEMIDESMI.—Syrup of Hemidesmus (hemidesmus root, bruised, 4 oz. ; refined sugar, 28 oz. ; boiling distilled water, 1 oct.). *Dose*, 1 fluid drachm.

Therapeutics.—Said to be tonic, alterative, diaphoretic and diuretic. Sometimes used as a substitute for sarsaparilla in the treatment of syphilitic cutaneous eruptions, especially in India. The syrup must be regarded more as a flavouring than a medicinal agent, the amount of the drug contained in an ordinary dose of that preparation being very small. If the real action of hemidesmus is required, a decoction may be made from the root, *Dose*, from 1 to 4 fluid ounces.

Atropaceæ.

1.—ATROPA BELLADONNA. THE DEADLY NIGHTSHADE.

Belladonnæ Folia.—BELLADONNA LEAVES.—The fresh LEAVES, with the branches to which they are attached, of Atropa Belladonna; also the leaves separated from the branches and carefully dried; gathered from wild or cultivated British plants when the fruit has begun to form.

Characters.—Leaves alternate, three to six inches long, ovate, acute, entire, smooth, the uppermost in pairs and unequal. The expressed juice, or an infusion, dropped into the eye, dilates the pupil. Contain *Atropia*, and, in addition to ordinary ingredients, *Asparagin*, a neutral substance converted by alkalies or acids into ammonia and *Aspartic Acid.*

Officinal Preparations.—EXTRACTUM BELLADONNÆ.—Extract of Belladonna (the fresh leaves and young branches of belladonna, 112 lb.) *Dose*, ¼ to 1 grain. Contained in the two following:

EMPLASTRUM BELLADONNÆ.—Belladonna Plaster (extract of belladonna, 3 oz.; resin plaster, 3 oz.; rectified spirit, 6 fl. oz.).

UNGUENTUM BELLADONNÆ.—Ointment of Belladonna (extract of belladonna, 80 grs.; prepared lard, 1 oz.).

SUCCUS BELLADONNÆ.—Juice of Belladonna (fresh leaves and young branches of belladonna, 7 lb.; rectified spirit, a sufficiency). *Dose*, 5 to 15 minims.

TINCTURA BELLADONNÆ.—Tincture of Belladonna (belladonna leaves, in coarse powder, 1 oz.; proof spirit, 1 oct.). *Dose*, 5 to 20 minims.

Belladonnæ Radix.—BELLADONNA ROOT.—The dried ROOT of Atropa Belladonna. Cultivated in Britain or imported from Germany.

Characters.—From one to two feet long, and from half an inch to two inches thick, branched and wrinkled, brownish-white. An infusion dropped into the eye dilates the pupil. Contains *Atropia,* together with *Belladonnin*, an amorphous alkaloid, and a red colouring matter, *Atrosin.*

Officinal Preparations.—LINIMENTUM BELLADONNÆ.—Liniment of Belladonna (belladonna root, in coarse powder, 20 oz.; camphor, 1 oz.; rectified spirit, a sufficiency).

Atropia.—ATROPIA, $C_{17}H_{23}NO_3$.—An alkaloid obtained from Belladonna (belladonna root, recently dried and in coarse powder, 2 lb.; rectified spirit, 10 oct.; slaked lime, 1 oz.; diluted sulphuric acid, and carbonate of potash, of each a sufficiency; chloroform, 3 fl. oz.; purified animal charcoal, a sufficiency; distilled water, 10 fl. oz.).

The root is digested with rectified spirit to exhaust it of the *Malate of Atropia:* upon the addition of lime, *Malate of Lime* is formed and *Atropia* liberated; sulphuric acid is added to form *Sulphate of Atropia;* carbonate of potash is then added to neutralisation in order to separate the resinous matter, which is subsequently removed by filtration. Carbonate of potash is again added in sufficient quantity to produce alkalinity, *Sulphate of Potash* being formed, and *Atropia* liberated and removed by chloroform; the chloroform is distilled off, and the *Atropia* purified by solution in spirit, digestion with animal charcoal, filtration and evaporation.

Characters and Tests.—In colourless acicular crystals, sparingly soluble in water, more readily soluble in alcohol and ether. Its solution in water has an alkaline reaction, and a bitter taste, powerfully dilates the pupil, and gives a *citron-yellow* precipitate with terchloride of gold. It is an active poison, and is decomposed by strong hydrochloric acid, or by caustic alkalies, baryta or lime water, into *Tropic Acid* ($C_9H_{10}O_3$) and *Tropine* ($C_8H_{15}NO$).

Officinal Preparations.—LIQUOR ATROPIÆ.—Solution of Atropia (atropia, 4 gr.: rectified spirit, 1 fl. dr.; distilled water, 7 fl. dr.).

UNGUENTUM ATROPIÆ.—Ointment of Atropia (atropia, 8 gr.; rectified spirit, ½ fl. dr.; prepared lard, 1 oz.).

uta **Atropiæ Sulphas.**—Sulphate of Atropia (atropia, 120 gr.; distilled water, 4 fl. dr.; diluted sulphuric acid, a sufficiency).

Characters.—A colourless powder, insoluble in chloroform, and which, applied in solution to the eye, dilates the pupil. A powerful poison.

Officinal Preparation.—LIQUOR ATROPIÆ SULPHATIS.—Solution of Sulphate of Atropia (sulphate of atropia, 4 gr.; distilled water, 1 fl. oz.)

Therapeutics.—The physiological action of belladonna depends exclusively upon the amount of atropia it contains. The pigeon, dog and rabbit are peculiarly insusceptible to its action; 15 grains being the minimum fatal dose for the rabbit.

Applied topically to the web of the frog, contraction of the arterioles is caused, succeeded by stasis of blood in the veins, soon extending to the arteries—anæmia, followed by congestion. Applied to the conjunctiva, the pupil becomes dilated and accommodation impaired. It is probable these effects are due to the terminal filaments of the 3rd cranial nerve (motor oculi) being paralysed. When atropia is introduced into the blood, the same effects are produced upon the iris and ciliary muscle, but they are then not unilateral, but symmetrical.

When a small dose of atropia is injected into the jugular vein of a dog, the (*a*) cardiac and (*b*) respiratory movements are accelerated, and the (*c*) blood-pressure in the arteries is raised. The first of these events (*a*) is due to a selective action upon the cardiac inhibitory filaments of the vagi, which are paralysed; the second (*b*) to stimulation of the respiratory centre in the medulla oblongata; the third (*c*) to contraction of the systemic arterioles, in all probability through the medium of the sympathetic. Upon the spinal cord a paralysing and stimulant action is exerted, the former greater in amount than the latter.

In dogs atropia causes purging and diuresis. It is eliminated by the urine, in which its presence may be easily shown. It arrests all other secretions, as saliva, milk, etc. The secretion of the submaxillary gland is arrested by paralysis of the terminal filaments of the chorda tympani.

The action of atropia is said to be antagonistic to that of opium, Calabar bean and hydrocyanic acid.

If belladonna be taken by a healthy man, the first symptoms observed are dryness of the throat, thirst, and difficulty of swallowing; if the drug be continued, or given in larger doses, the pupils dilate, and vision for near objects becomes indistinct. Further effects are—an erythematous rash, somewhat like that of scarlatina, dryness of skin, quickened pulse, vertigo, sleeplessness, excitement passing into delirium, and accompanied by confusion of speech and hallucinations. The bowels may be relaxed and micturition become frequent. Beyond this, great muscular weakness and tremors may occur, with hurried breathing, convulsions, coma and death.

Belladonna and atropia may be applied topically to relieve pain, to moderate inflammatory action, to check secretion, and for some ophthalmic purposes:

*1. Belladonna plasters and fomentations are useful in certain forms of hyperæsthesia and neuralgia, especially when due to spinal irritation.

2. Applied to the female breast, Belladonna checks the *secretion of milk*. Applied to the skin of any part of the body,

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* Garrod.

it checks sweating, *e.g.*, the sweating of the head in rickets (Ringer).

3. It is said to exert a favourable influence on carbuncles, and even to check suppuration if applied early enough to the inflamed part.

4. In ophthalmic practice it is used :

(*a.*) To dilate the pupil for ophthalmoscopic examination. In early stages of central cataract, to admit more light into the eye. In iritis, to prevent posterior synechia. To counteract the effect of Calabar bean.

(*b.*) To paralyse accommodation, as in hypermetropia.

(*c.*) To reduce intra-ocular tension, as in some forms of corneal ulcer, and glaucomatous conditions of the globe. It is worthy of notice that atropia, applied to the conjunctival surface, may be absorbed ; sometimes, though rarely, giving rise to constitutional effects.

As a constitutional remedy, belladonna may be given in the form of extract, tincture, or juice ; the sulphate of atropia should be reserved for subcutaneous injection.

Belladonna is administered :

1. As an antidote in poisoning by opium, Calabar bean or hydrocyanic acid. ∵ supposed to stimulate the heart.

2. As a laxative in chronic constipation.

3. To check incontinence of urine in children and paraplegic patients.

4. To check profuse sweating. Dr. Ringer found that the hypodermic injection of $\frac{1}{200}$ grain of atropia arrested sweating for a whole night in a case of phthisis.

5. In the idiopathic (non-mercurial) salivation of children.

6. In many nervous disorders ; epilepsy, chorea, pertussis, laryngismus stridulus, asthma.

7. To allay pain and spasm in neuralgic affections, gastrodynia, colic, and spasm of the different sphincters, as of the uterus, bladder, and rectum.

8. To diminish polyuria in diabetes mellitus and insipidus. Atropia is unsuitable for internal administration ; if prescribed, the dose should be from $\frac{1}{100}$ gr. carefully increased. Dr. Garrod has seen very uncomfortable symptoms resulting from $\frac{1}{25}$ gr. If injected under the skin, the amount should be from $\frac{1}{250}$ gr., upwards. The sulphate of atropia is employed only for the preparation of its solution, which is much used by ophthalmic surgeons, because it is free from alcohol : The extract or ointment of belladonna smeared round the eye may be used for the same purpose.

Incompatibles.—The caustic fixed alkalies, as potash and soda, which, when in contact with preparations of atropia or belladonna, destroy their activity by decomposing the atropia contained in them.

2.—HYOSCYAMUS NIGER. HENBANE.

Hyoscyami Folia. — HYOSCYAMUS LEAVES. — The fresh LEAVES, with the branches to which they are attached, of Hyoscyamus Niger; also the leaves separated from the branches and carefully dried; gathered from wild, or cultivated British, biennial plants, when about two-thirds of the flowers are expanded.

Characters.—Leaves sinuated, clammy, and hairy. The fresh herb has a strong unpleasant odour, and a slightly acrid taste, both which nearly disappear on drying. The fresh juice, dropped into the eye, *dilates* the pupil.

All parts of the plant contain an alkaloid, *Hyoscyamia* united with *Malic Acid*, and closely allied to atropia. This alkaloid is an oily liquid concreting into warty crystals, having a tobacco-like odour, and soluble in water, alcohol and ether; it is converted by caustic alkalies into *Hyoscina*, a volatile alkaloid, and *Hyoscinic Acid*, a crystallisable substance, with the odour of benzoic acid.

Officinal Preparations.—EXTRACTUM HYOSCYAMI.—Extract of Hyoscyamus (the fresh leaves and young branches of hyoscyamus, 112 lbs.). Contained in Pilula Colocynthidis et Hyoscyami. *Dose*, 5 to 10 grains.

SUCCUS HYOSCYAMI.—Juice of Hyoscyamus (fresh leaves and young branches of hyoscyamus, 7 lb.; rectified spirit, a sufficiency). *Dose*, ½ fluid drachm to 1 fluid drachm.

TINCTURA HYOSCYAMI.—Tincture of Hyoscyamus (hyoscyamus leaves, in coarse powder, 2½ oz.; proof spirit, 1 oct.). *Dose*, ½ to 1 fluid drachm.

Therapeutics.—Appears to act like stramonium and belladonna, but is much milder, and chiefly used as a sedative in those excited conditions of the nervous system in which opium is not advisable. It is often given to allay irritation of the bladder, to diminish pain, to obviate the griping of purgative medicines, to ease cough, and to relax spasm in many diseases. May be used in the place of belladonna to dilate the pupil. Henbane has been observed, when administered internally in large doses, to produce similar symptoms to those of stramonium and belladonna; viz., dilatation of the pupil and presbyopia, dryness of the fauces and mouth, delirium, eruption on the skin and loss of power over the bladder in cases of slight paraplegia.

Incompatibles.—Caustic fixed alkalies, as soda or potash, in contact with henbane preparations, destroy the activity of the latter by decomposing the hyoscyamia.

3.—DATURA STRAMONIUM. THE THORN APPLE.

Stramonii Folia.—STRAMONIUM LEAVES.—The dried LEAVES of Datura Stramonium. Collected from plants in flower, cultivated in Britain.

Characters.—Large, ovate, sinuous, deeply cut; of a heavy odour, which is strongest while they are drying, and of a mawkish faintly bitter nauseous taste.

Stramonii Semina.—STRAMONIUM SEEDS.—The ripe SEEDS of Datura Stramonium.

Characters.—Brownish-black, reniform, flat, rough; in taste feebly bitter and mawkish; inodorous, unless bruised, when they emit a peculiar heavy smell.

All parts of the plant contain an alkaloid, *Daturia*, identical with *Atropia*, and united with *Malic acid.*

Officinal Preparations.—EXTRACTUM STRAMONII.—Extract of Stramonium (stramonium seeds, in coarse powder, 1 lb.; ether, 1 oct., or a sufficiency; distilled water and proof spirit, of each a sufficiency). *Dose*, ¼ to ½ grain.

TINCTURA STRAMONII.—Tincture of Stramonium (stramonium seeds, bruised, 2½ oz.; proof spirit, 1 oct.).

Dose, 10 to 30 minims.

Therapeutics.—Apparently identical with belladonna. It is supposed to be antispasmodic to the respiratory organs, and has been much used in asthma, chiefly in the form of smoke from the burning leaf. The extract has been given in convulsive coughs, and as an anodyne in gastrodynia and other painful affections.

Incompatibles.—The caustic fixed alkalies, as potash and soda, which decompose the active principle.

The leaves of DATURA TATULA, a plant of the same genus as stramonium, have been employed, as a cigar or in a pipe, for the treatment of spasmodic asthma. The activity of this plant is no doubt due to the same alkaloid as that of stramonium.

4.—NICOTIANA TABACUM. VIRGINIAN TOBACCO.

Tabaci Folia.—LEAF TOBACCO.—The dried LEAVES of Nicotiana Tabacum. Cultivated in America.

Characters.—Large mottled-brown ovate or lanceolate acuminate leaves, bearing numerous short glandular hairs; having a peculiar heavy odour and nauseous bitter acrid taste;

yielding, when distilled with solution of potash, an alkaline fluid having the peculiar odour of *Nicotia*, and thrown down by perchloride of platinum and tincture of galls. Contains, in addition to Nicotia, a concrete volatile oil, *Nicotianin*, or tobacco-camphor. The leaves should not be manufactured, since in the process they undergo many chemical changes.

Officinal Preparation.—ENEMA TABACI.—Enema of Tobacco (leaf tobacco, 20 gr. ; boiling water, 8 fl. oz.). Contains about the quantity of the drug safe to administer at a time.

Therapeutics.—Internally administered, a powerful sedative, especially affecting the heart ; frequently causes diuresis, and has been given in dropsy. Its employment is sometimes followed by dangerous depression. Externally, tobacco is a powerful irritant, occasionally used in the form of snuff, as an errhine in head affections ; also in the form of smoke, as an expectorant and sedative in some varieties of asthma. Frequent use of the drug greatly influences the susceptibility of individuals. Use establishes tolerance, as in the case of opium.

Caprifoliaceæ.

SAMBUCUS NIGRA. THE ELDER TREE.

Sambuci Flores.—ELDER FLOWERS.—The dried FLOWERS of Sambucus Nigra. From indigenous plants.

Characters.—Flowers small, white, fragrant, crowded in large cymes. Yield, on distillation, a *volatile oil*, easily altered by exposure to air, and containing a hydrocarbon, *Sambucene*, and perhaps a little camphor.

Officinal Preparation. — AQUA SAMBUCI. — Elder-Flower Water (fresh elder flowers, separated from the stalks, 10 lb. ; or an equivalent quantity of the flowers preserved while fresh with common salt ; water, 2 cong. ; distil one gallon).

Dose, 1 fluid ounce to 2 fluid ounces.

Therapeutics.—The flowers are gently stimulant, and are used in the form of ointment by heating the flowers in hot lard. The Aqua is used as an agreeable vehicle for medicines or lotions.

Cinchonaceæ.

1.—UNCARIA GAMBIR.

Catechu Pallidum.—PALE CATECHU.—An EXTRACT of the leaves and young shoots of Uncaria Gambir. Prepared at Singapore, and in other places in the Eastern Archipelago.

Characters.—In cubes or masses formed of coherent cubes ;

the former about an inch in diameter, externally brown, internally ochrey-yellow or pale brick-red, breaking easily, with a dull earthy fracture. Taste bitter, very astringent and mucilaginous, succeeded by slight sweetness. Entirely soluble in boiling water, and containing no starch.

Catechu consists of *Catechu-tannic* or *Mimo-tannic Acid*, and *Catechin* or *Catechuic Acid*. The former acid gives a *green* precipitate with ferric salts, and catechin is converted by alkalies into *Japonic* and *Rubinic Acids*. *Dose*, 10 to 30 grains.

Officinal Preparations.—INFUSUM CATECHU. — Infusion of Catechu (pale catechu, in coarse powder, 160 gr. ; cinnamon bark, bruised, 30 gr. ; boiling distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

PULVIS CATECHU COMPOSITUS. — Compound Powder of Catechu (pale catechu, in powder, 4 oz. ; kino, in powder, 2 oz. ; rhatany root, in powder, 2 oz. ; cinnamon bark, in powder, 1 oz. ; nutmeg, in powder, 1 oz.).

Dose, 20 to 40 grains.

TINCTURA CATECHU.—Tincture of Catechu (pale catechu, in coarse powder, 2½ oz. ; cinnamon bark, bruised, 1 oz. ; proof spirit, 1 oct.). *Dose*, ½ to 2 fluid drachms.

TROCHISCI CATECHU.—Catechu Lozenges (pale catechu, in powder, 720 gr. ; refined sugar, in powder, 25 oz. ; gum acacia, in powder, 1 oz. ; mucilage of gum acacia, 2 fl. oz. ; distilled water, a sufficiency). Each lozenge contains one grain of catechu. *Dose*, 1 to 6 lozenges.

Therapeutics. — A powerful astringent ; used chiefly in diarrhœa, and some forms of dyspepsia, attended by pyrosis ; also employed in hæmorrhages and mucous discharges. Externally used as an ointment. May be chewed, and the juice swallowed gradually, in relaxation of the uvula and palate, etc., and in some forms of hoarseness.

2. (*a.*)—CINCHONA CALISAYA.

Cinchonæ Flavæ Cortex. — YELLOW CINCHONA BARK. — The BARK of Cinchona Calisaya. Collected in Bolivia and Southern Peru.

Characters.—In flat pieces, uncoated, or deprived of the periderm, rarely in coated quills, from six to eighteen inches long, one to three inches wide, and two to four lines thick, compact and heavy ; outer surface brown, marked by shallow irregular longitudinal depressions ; inner surface tawny-yellow, fibrous ; transverse fracture, shortly and finely fibrous. Powder cinnamon-brown, somewhat aromatic, persistently bitter.

100 grains of this bark should yield not less than 2 grains of Quinine. *Dose, in powder*, 10 to 60 grains.

Officinal Preparations. — DECOCTUM CINCHONÆ FLAVÆ. — Decoction of Yellow Cinchona (yellow cinchona bark, in coarse powder, 1¼ oz. ; distilled water, 1 oct.).

Dose, 1 to 2 fluid ounces.

EXTRACTUM CINCHONÆ FLAVÆ LIQUIDUM.—Liquid Extract of Yellow Cinchona (yellow cinchona bark, in coarse powder, 1 lb. ; distilled water, a sufficiency ; rectified spirit, 1 fl. oz.).

Dose, 10 to 30 minims.

INFUSUM CINCHONÆ FLAVÆ.—Infusion of Yellow Cinchona (yellow cinchona bark, in coarse powder, ½ oz. ; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA CINCHONÆ FLAVÆ.—Tincture of Yellow Cinchona (yellow cinchona bark, in moderately fine powder, 4 oz. ; proof spirit, 1 oct.). *Dose*, ½ to 2 fluid drachms.

Quiniæ Sulphas.—SULPHATE OF QUINIA, $C_{20}H_{24}N_2O_2H_2SO_4, 7H_2O$.—The SULPHATE of an ALKALOID, prepared from Yellow Cinchona Bark, and from the Bark of Cinchona Lancifolia. Prepared as follows : (yellow cinchona bark, in coarse powder, 1 lb. ; hydrochloric acid, 3 fl. oz. ; distilled water, a sufficiency ; solution of soda, 4 oct. ; diluted sulphuric acid, a sufficiency).

The yellow bark contains *Quinia* and *Cinchonia* united to an acid, *Kinic* or *Quinic Acid*, as *Kinate* or *Quinate* of *Quinia* and *Cinchonia*. Upon the addition of *Hydrochloric Acid*, Hydrochlorates of these alkaloids are formed, which are then precipitated by a *solution of soda*, chloride of sodium being produced. *Sulphuric Acid* is finally added, *Sulphates of Quinia* and *Cinchonia* being formed, of which the former separates first.

Tests.—Solutions of quinia present a blue fluorescent appearance ; and if treated with ammonia and fresh strong chlorine water, produce a deep *emerald-green* colour due to the presence of a substance termed *Thalleioquin*.

Dose, 1 to 5 grains, but larger doses may be given under certain circumstances.

Officinal Preparations.—FERRI ET QUINIÆ CITRAS.—Citrate of Iron and Quinia (solution of persulphate of iron, 4½ fl. oz.; sulphate of quinia, 1 oz. ; diluted sulphuric acid, 12 fl. dr. ; citric acid, 3 oz. ; solution of ammonia and distilled water, of each a sufficiency).

Characters. — Thin scales of a greenish golden-yellow colour, somewhat deliquescent, and soluble in cold water. Taste bitter and chalybeate. *Dose*, 5 to 10 grains.

* Pilula Quiniæ.—Pill of Quinia (sulphate of quinia, 60 gr., confection of hips, 20 gr.). *Dose*, 2 to 10 grains.

Tinctura Quiniæ.—Tincture of Quinia (sulphate of quinia, 160 gr. ; tincture of orange-peel, 1 oct.).

Dose, ½ to 2 fluid drachms.

* Tinctura Quiniæ Ammoniata.—Ammoniated Tincture of Quinia (sulphate of quinia, 160 gr. ; solution of ammonia, 2½ fl. oz. ; proof spirit, 17½ fl. oz.).

Dose, ½ to 2 fluid drachms.

Vinum Quiniæ.—Wine of Quinia (sulphate of quinia, 20 gr. ; citric acid, 30 gr. ; orange wine, 1 oct.).

Dose, ½ to 1 fluid ounce.

(*b.*)—CINCHONA CONDAMINEA.

Cinchonæ Pallidæ Cortex. — Pale Cinchona Bark.—The bark of Cinchona Condaminea. Collected about Loxa, in Ecuador.

Characters.—From half a line to a line thick, in single or double quills, which are from six to fifteen inches long, two to eight lines in diameter, brittle, easily splitting longitudinally, and breaking with a short transverse fracture ; outer surface brown and wrinkled, or grey and speckled, with adherent lichens, with or without numerous transverse cracks ; inner surface bright-orange or cinnamon-brown ; powder pale-brown, slightly bitter, very astringent.

Dose, in powder, 10 to 60 grains.

200 grains of this bark should yield not less than 1 grain of alkaloids.

Officinal Preparation.—Tinctura Cinchonæ Composita.—Compound Tincture of Cinchona (pale cinchona bark, in moderately fine powder, 2 oz. ; bitter orange peel, cut small and bruised, 1 oz. ; serpentary root, bruised, ½ oz. ; saffron, 60 gr. ; cochineal, in powder, 30 gr. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Pale Cinchona Bark is also contained in Mistura Ferri Aromatica.

(*c.*)—CINCHONA SUCCIRUBRA.

Cinchonæ Rubræ Cortex. — Red Cinchona Bark. — The bark of Cinchona Succirubra. Collected on the Western slopes of Chimborazo.

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* These preparations are copied literally from the "British Pharmacopœia," but it is almost impossible to prepare either of them by the methods specified, in consequence of the large bulk of quinia in the former, and since in the latter the ammonia precipitates the quinia.

Characters.—In flat or incurved pieces, less frequently in quills, coated with the periderm, varying in length from a few inches to two feet, from one to three inches wide, and two to six lines thick, compact and heavy; outer surface brown or reddish-brown, rarely white from adherent lichens, rugged or wrinkled longitudinally, frequently warty, and crossed by deep transverse cracks; inner surface redder; fractured surface often approaching to brick-red; transverse fracture finely fibrous; powder red-brown; taste bitter and astringent.

100 grains of this bark should yield not less than 1·5 grain of alkaloids. *Dose*, in powder, 10 to 60 grains.

The chief constituents of Cinchona Barks are:

Alkaloids	and	Acid Principles.
Quinia.		Quinic or Kinic Acid.
Quinidia.		Cincho-tannic Acid.
Quinamia.		Cincho-fulvic Acid.
Cinchonia.		Quinovin.
Cinchonidia.		Quinovic Acid.

Roughly speaking, the *Yellow* bark yields the most *Quinia;* the *Pale* the most *Cinchonia*, and the *Red* about *equal quantities* of Quinia and Cinchonia.

Therapeutics of the Cinchona Barks and Quinia.

The Cinchona Barks are tonic, antiperiodic, antipyretic, and astringent. They are employed in fevers, malarious diseases, neuralgias, debility, etc.

Experiments have shown that Quinia possesses the following properties:

1. It is fatal to the lowest forms of vegetable and animal life.

2. It exerts a similar inhibitory action on many fermentations, arresting the solvent action of the gastric juice, that of emulsin upon amygdalin, the vinous and butyric fermentations.

3. Weakens or arrests the spontaneous movements of the white blood corpuscles, checking their emigration from the vessels.

4. In large doses paralyses the heart, causing a sudden fall of blood pressure, convulsions and death.

5. Has a powerful sedative action upon the brain and spinal cord, finally abolishing reflex movements.

6. Lowers the heat of the body in healthy animals.

Quinia is medicinally employed:

1. As a *Tonic.* Increases the appetite and checks the sweating of debility.

2. As an *Antiperiodic.* Given in agues, miasmatic neuralgia, malarious remittents, splenic and hepatic congestions, etc.

3. Exceedingly useful in neuralgias *not* of malarial origin.

4. As an *Antipyretic.* Doses of 5—20 grains notably reduce the temperature in pyrexia arising from whatever cause.

5. Appears to check the tendency to suppuration in acute inflammations of various organs and tissues.

6. Large doses of Quinia are very valuable in certain septic conditions of blood, as surgical and puerperal septicæmia.

7. Externally applied as an antiseptic and stimulant to unhealthy ulcers ; may be used as a gargle in putrid sore throat, or as a dentifrice to spongy gums.

Large doses of Quinia produce symptoms of *Quinism*, viz., buzzing in the ears, giddiness, deafness, wakefulness, and occasionally nausea with anorexia.

Adulterations.—The officinal barks may be substituted by inferior non-officinal cinchonas, or by barks of other kinds.

The Adulterations of Quinia are the following :

* (*a.*) *Sulphates of Lime, Chalk* and *Magnesia ;* these are insoluble in alcohol, and when heated on platinum foil leave an ash, the nature of which is ascertained by the ordinary tests.

(*b.*) *Cinchonia*, *Cinchonidia* and *Quinidia ;* detected by their different solubilities in water, alcohol and ether.

(*c.*) *Salicine ;* gives a *blood-red* colour with sulphuric acid.

(*d.*) *Sugars ;* a solution of the salt, after the precipitation of the alkaloid by an alkali, is sweet.

(*e.*) *Starch ;* gives a *blue* colour with iodine.

(*f.*) *Stearic Acid ;* insoluble in dilute acids.

(*g.*) *Boracic Acid ;* an alcoholic solution, burns with a *green* flame.

3.—CEPHAËLIS IPECACUANHA.

Ipecacuanha.—IPECACUANHA.—The dried ROOT of Cephaëlis Ipecacuanha. Imported from Brazil.

Characters.—In pieces three or four inches long, about the size of a small quill, contorted and irregularly annulated. Colour brown of various shades. It consists of two parts, the cortical or active portion, which is brittle, and a slender, tough white woody centre. Powder, pale-brown, with a faint nauseous odour and a somewhat acrid and bitter taste.

Contains a feeble alkaloid, *Emetina*, united with *Cephaëlic*

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* Handsell Griffiths.

or *Ipecacuanhic Acid;* also starch, sugar, gum, pectin, albumen, and fatty or oily matters.

Dose, as an *expectorant*, ½ grain to 2 grains.
,, as an *emetic*, 15 ,, to 30 grains.

Officinal Preparations.—PILULA IPECACUANHÆ CUM SCILLA. — Pill of Ipecacuanha with Squill (compound powder of ipecacuanha, 3 oz.; squill, in powder, 1 oz.; ammoniacum, in powder, 1 oz.; treacle, a sufficiency). Contains 1 part of opium in 23, nearly.

Dose, 5 to 10 grains.

PULVIS IPECACUANHÆ COMPOSITUS.—Compound Powder of Ipecacuanha (ipecacuanha, in powder, ½ oz.; opium, in powder, ½ oz.; sulphate of potash, in powder, 4 oz.).

Dose, 5 to 15 grains.

TROCHISCI IPECACUANHÆ.—Ipecacuanha Lozenges (ipecacuanha, in powder, 180 gr.; refined sugar, in powder, 25 oz.; gum acacia, in powder, 1 oz.; mucilage of gum acacia, 2 fl. oz.; distilled water, 1 fl. oz., or a sufficiency). Each lozenge contains ¼ grain of ipecacuanha. *Dose*, 1 to 3 lozenges.

VINUM IPECACUANHÆ.—Wine of Ipecacuanha (ipecacuanha, bruised, 1 oz.; sherry, 1 oct.).

Dose, as an *expectorant*, 5 to 40 minims.
,, as an *emetic*, 3 to 6 fluid drachms.

Ipecacuanha is also contained in Pilula Conii Composita, and Trochisci Morphiæ et Ipecacuanhæ.

Therapeutics.—When topically applied, ipecacuanha and emetina exert an irritant effect upon mucous membranes and raw surfaces. When injected hypodermically, emetina has caused vomiting in the lower animals. It lowers the pulse, and relaxes the muscular spasm induced by strychnia. In medicinal doses Ipecacuanha is an emetic, but not so speedy as mustard or sulphate of zinc. In small doses it becomes absorbed and acts upon the different mucous membranes, especially those of the alimentary canal and respiratory passages; it is therefore expectorant, and sometimes laxative. It is also diaphoretic. It is very useful as an emetic in chest and throat affections attended by fever, as in bronchitis, phthisis and diphtheria, in which the *after-expectorant* effect is very serviceable: and it may be given to unload the stomach in certain forms of dyspepsia. It may be used as an *expectorant* in all forms of bronchial diseases; and, *in consequence of its action upon the alimentary canal*, it is of great value in diarrhœa and chronic dysentery. It is regarded almost as a specific in acute dysentery of the tropics; large doses are given at intervals of 8—10 hours. Ipecacuanha is frequently given in catarrhal affections as a *diaphoretic* in the form of Dover's powder. The combination with opium seems to increase its sudorific action.

In some persons who are peculiarly susceptible, the effluvia from the powdered drug will cause coughing, sneezing, and a species of asthma.

Adulterations.—Peruvian or *Striated* ipecacuanha, the produce of Psychotria Emetica, and other roots. It is also sometimes largely adulterated with almond meal.

Compositæ.

1.—ANTHEMIS NOBILIS. THE COMMON CHAMOMILE.

Anthemidis Flores. — CHAMOMILE FLOWERS. — The dried single and double FLOWER-HEADS of Anthemis Nobilis. Wild and cultivated.

Characters.—The single variety consists of both yellow tubular, and white strap-shaped florets; the double, of white strap-shaped florets only; all arising from a conical scaly receptacle; both varieties, but especially the single, are bitter and very aromatic. Contain a *volatile oil*, said to be a mixture of *Butylic* and *Amylic Angelate* and *Valerate.* When heated with caustic potash, *Potassium Angelate* is formed, which upon the addition of sulphuric acid yields *Angelic Acid.* Also contain a bitter extractive principle.

Officinal Preparations.—EXTRACTUM ANTHEMIDIS.—Extract of Chamomile (chamomile flowers, 1 lb.; oil of chamomile, 15 min.: distilled water, 1 cong.). *Dose*, 2 to 10 grains.

INFUSUM ANTHEMIDIS.—Infusion of Chamomile (chamomile flowers, ½ oz.; boiling distilled water, 10 fl. oz.).

Dose, 1 to 4 fluid ounces.

Anthemidis Oleum.—OIL OF CHAMOMILE.—The oil distilled in Britain from Chamomile Flowers.

Characters.—Pale-blue or greenish-blue, but gradually becoming yellow; with the peculiar odour and aromatic taste of the flowers. Contained in Extractum Anthemidis.

Therapeutics.—An aromatic stomachic and tonic; in large doses, emetic; given in dyspepsia, and to assist the action of emetics. The oil is carminative and stimulant, and is a useful adjunct to purgatives.

2.—ARNICA MONTANA.

Arnicæ Radix.—ARNICA ROOT. — The dried RHIZOME and Rootlets of Arnica Montana. Collected in the mountainous parts of Middle and Southern Europe.

Characters.—Rhizome from one to three inches long, and two or three lines thick, cylindrical, contorted, rough from the scars of the coriaceous leaves, and furnished with numerous long slender fibres; has a peppery taste and peculiar odour. Contains *Arnicin,* a bitter resinous principle; a yellowish volatile oil (C_9H_9O) and Trimethylamine have also been obtained from it.

Officinal Preparation. — TINCTURA ARNICÆ.—Tincture of Arnica (arnica root, in coarse powder, 1 oz.; rectified spirit, 1 oct.). *Dose,* 1 to 2 fluid drachms.

Therapeutics.—Internally administered, arnica is an irritant and stimulant. It is supposed to act upon the spinal cord, and is said to be useful in nervous headache and chronic rheumatic pains. It is chiefly used as an external application for bruises and sprains, and for the discussion of tumours, but its virtues are very questionable. The tincture is used either alone or diluted with water; and it is sometimes added to liniments.

3.—LACTUCA VIROSA. THE WILD LETTUCE.

Lactuca. — LETTUCE. — The flowering HERB of Lactuca Virosa. The concrete juice of this plant is termed

Lactucarium, and is obtained by pressing out the juice from the flowering herb, and afterwards inspissating it with a gentle heat. It possesses a bitter taste and an opium-like odour, and is known as *Thridace,* or *Lettuce-Opium.* It yields to alcohol a bitter extractive, and a crystalline substance, *Lactucone;* also *Lactucin* and *Lactucic Acid.*

Officinal Preparation.—EXTRACTUM LACTUCÆ.—Extract of Lettuce (the flowering herb of lettuce, 112 lb.).

Dose, 5 to 15 grains.

Therapeutics.—Some narcotic powers have been ascribed to the lettuce, which is occasionally eaten at bed-time to procure sleep. The extract and lactucarium have been given to obtain sleep and allay cough in cases in which opium is not well borne. The powers of lettuce are certainly very feeble as compared with those of opium, and 30 grains and more of good lactucarium have been given, and the dose repeated every four hours, without any decided narcotic effect having been noticed.

4.—ANACYCLUS PYRETHRUM. THE PELLITORY.

Pyrethri Radix.—PELLITORY ROOT.—The ROOT of Anacyclus Pyrethrum. Imported from the Levant.

Characters.—In pieces about the length and thickness of the little finger, covered with a thick brown bark, studded with black shining points. Breaks with a resinous fracture, and presents internally a radiated structure. When chewed, it excites a prickling sensation on the lips and tongue, and a glowing heat. Contains two resins, one, *Pyrethric Acid* or *Pyrethrin*, insoluble in liquor potassæ, the other soluble, together with a yellow acrid oil, gum, tannin, colouring matter, and salts.

Officinal Preparation.—TINCTURA PYRETHRI.—Tincture of Pellitory (pellitory root, in coarse powder, 4 oz. : rectified spirit, 1 oct.).

Therapeutics.—A topical irritant, causing a pricking sensation in the mouth, and a flow of buccal mucus and saliva. Used in relaxed throat and aphonia, and as a local stimulant in odontalgia or neuralgia of the teeth, and as a masticatory in paralysis of parts about the mouth.

Pyrethrum is not given internally, but the tincture, diluted with water, is used as a gargle.

5.—ARTEMISIA SANTONICA. THE WORM SEED.

Santonica.—SANTONICA.—The unexpanded FLOWER-HEADS of Artemisia Santonica. Imported from Russia.

Characters.—Flower-heads rather more than a line in length, and nearly half a line in breadth, fusiform, blunt at each end, pale greenish-brown, smooth; resembling seeds in appearance, but consisting of imbricated involucral scales with a green midrib, enclosing four or five tubular flowers; odour strong, taste bitter, camphoraceous. Flower-heads not round or hairy. Contain a *volatile oil* consisting chiefly of *Cinæbene Camphor*. *Dose*, 10 to 60 grains.

The most important constituent of Santonica, and which it contains in the proportion of 1½ to 2 per cent., is

Santoninum.—SANTONIN, $C_{15}H_{18}O_3$.—A crystalline, neutral principle, prepared from Santonica (santonica, bruised, 1 lb. ; slaked lime, 7 oz. ; hydrochloric acid, a sufficiency ; solution of ammonia, ½ fl. oz. ; rectified spirit, 14 fl. oz. ; purified animal charcoal, 60 gr. ; distilled water, a sufficiency).

The Santonica is bruised with lime and water to form *Santonate of Lime*. Hydrochloric Acid is added to this, *Chloride of Calcium* being formed and *Santoninum* precipitated. The precipitate is washed with water, and ammonia added to free it from acid ; *Animal Charcoal* is added to decolorise, and the *Santonin* dissolved out by boiling spirit. Is then set aside to crystallise in the dark, and kept in bottles protected from the light, in order to prevent the crystals becoming yellow.

Characters.—Colourless, flat rhombic prisms, feebly bitter, fusible and sublimable by a moderate heat; scarcely soluble in cold water, sparingly in boiling water, but abundantly so in chloroform and rectified spirit. Sunlight renders it yellow; soluble in caustic fixed alkalies, by which it is converted into *Santonic Acid*, but not in diluted mineral acids. Santonin, by prolonged boiling in diluted nitric acid, is converted into *Succinic Acid. Dose*, 2 to 6 grains.

Therapeutics. — Internally administered, yellow vision (Xanthopsy) is occasioned. This is due to some specific influence either upon the visual centre of the brain or upon the retina. The sensibility of the retina for violet rays is apparently first stimulated and then blunted.

A dose of 3 grains will stain the urine *yellow*. In large doses, giddiness, vomiting, headache, convulsions, and even death have been occasioned.

Santonin is employed as an anthelmintic especially suitable for children. It is useless against the thread-worm (oxyuris vermicularis), and the tape-worm (tænia solium), but destroys the round worm (ascaris lumbricoides). Its administration should be followed by some mild purgative.

Adulterations of Santonin.—Gum, detected by its solubility in water; and boracic acid, an alcoholic solution of which burns with a green flame.

6.—TARAXACUM DENS LEONIS. THE DANDELION.

Taraxaci Radix.—Dandelion Root.—The fresh and dried roots of Taraxacum Dens Leonis. Gathered between September and February, from meadows and pastures in Britain.

Characters and Tests.—Tap-shaped roots, smooth and dark-brown externally, white within, easily broken, and giving out an inodorous bitter milky juice, which becomes pale-brown by exposure. Not wrinkled or pale-coloured externally; juice not watery; any adherent leaves runcinate and quite smooth.

Officinal Preparations.—Decoctum Taraxaci.—Decoction of Dandelion (dried dandelion root, sliced and bruised, 1 oz.; distilled water, 1 oct.). *Dose*, 2 to 4 fluid ounces.

Extractum Taraxaci.—Extract of Dandelion (fresh dandelion root, 4 lb.). *Dose*, 5 to 30 grains.

Succus Taraxaci. —Juice of Dandelion (fresh dandelion root, 7 lb.; rectified spirit, a sufficiency). Contains resinous matter, sugar, gum, and a bitter extractive, from which has been obtained *Taraxacine*, a crystalline principle.

Dose, 1 to 2 fluid drachms.

Therapeutics.—Said to act specifically upon the liver, increasing and modifying its secretion. It is usually combined with a purgative in the treatment of dropsies resulting from hepatic obstruction; but its value as a remedy admits of much doubt. It produces a marked diuretic action in some persons.

Convulvulaceæ.

1.—EXOGONIUM PURGA.

Jalapa.—JALAP. — The dried TUBERCLES of Exogonium Purga. Imported from Mexico.

Characters.—Varying from the size of a nut to that of an orange, ovoid, the larger tubercles frequentlyin cised, covered with a thin brown wrinkled cuticle; presenting, when cut, a yellowish-grey colour, with dark-brown concentric circles.

Dose, 10 to 30 grains.

Officinal Preparations.—EXTRACTUM JALAPÆ.—Extract of Jalap (jalap, in coarse powder, 1 lb.; rectified spirit, 4 oct.; distilled water, 1 cong.). *Dose*, 5 to 15 grains.

PULVIS JALAPÆ COMPOSITUS.—Compound Powder of Jalap (jalap, in powder, 5 oz.; acid tartrate of potash, 9 oz.; ginger, in powder, 1 oz.). *Dose*, 20 to 60 grains.

TINCTURA JALAPÆ.—Tincture of Jalap (jalap, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Jalap, in powder, is also contained in Pulvis Scammonii Compositus.

Jalapæ Resina.—RESIN OF JALAP.—Jalap, in coarse powder, 8 oz.; rectified spirit and distilled water, a sufficiency.

Characters and Tests.—In dark-brown opaque fragments, translucent at the edges, brittle, breaking with a resinous fracture, readily reduced to a pale-brown powder, sweetish in odour, acrid in the throat, easily soluble in rectified spirit, but only partially so in ether. Is known in commerce as *Jalapin*, and consists of *Convolvulin* or *Rhodeoretin*, the active constituent, and *Jalapic Acid.* Convolvulin is converted by alkalies into *Convolvulic Acid*, and by nitric acid into oxalic acid and *Ipomæic Acid.* Jalap Resin is not readily miscible with milk. *Dose*, 2 to 5 grains.

Jalap Resin is contained in Pilula Scammonii Composita.

Therapeutics.—A brisk purgative, inducing watery discharge; much allied to scammony, but less irritant; apparently acts more upon the small than the large intestines. Is used as an ordinary purgative in costiveness, and given in dropsies as a hydragogue, especially when combined with calomel or acid tartrate of potash. It has little taste, and is therefore a convenient purgative for children, and is often employed as a vermifuge.

Adulterations.—Other roots, as that of Ipomœa Orizabensis, etc.

2.—CONVOLVULUS SCAMMONIA.

Scammoniæ Radix.—SCAMMONY ROOT.—The dried ROOT of Convolvulus Scammonia. From Syria and Asia Minor.

Characters.—Tap-shaped roots, sometimes three inches in diameter at the top, brown without, white within, slightly odorous, but tasteless. Ether agitated with the powder and evaporated leaves a residue having the properties of scammony resin. *Dose, in powder,* 5 to 10 grains.

Scammoniæ Resina.—RESIN OF SCAMMONY.—(Scammony root, in coarse powder, 8 oz.; rectified spirit and distilled water, a sufficiency.) *Dose,* 3 to 8 grains.

Characters.—In brownish translucent pieces, brittle, resinous in fracture, of a sweet fragrant odour if prepared from the root. It cannot form singly an emulsion with water, thus distinguishing it from the gum resin (scammonium). Its tincture does not render the fresh-cut surface of a potatoe blue, showing the absence of guaiacum resin.

Officinal Preparations.—MISTURA SCAMMONII.—Scammony Mixture (resin of scammony, 4 gr.; milk, 2 fl. oz.).

Dose, ½ to 2 fluid ounces (for a child).

PILULA SCAMMONII COMPOSITA.—Compound Scammony Pill (resin of scammony, 1 oz.; resin of jalap, 1 oz.; curd soap, in powder, 1 oz.; strong tincture of ginger, 1 fl. oz.; rectified spirit, 2 fl. oz.). *Dose,* 5 to 15 grains.

Scammony resin is also contained in Extractum Colocynthidis Compositum.

The chief constituent of this resin is a glucoside identical with *Jalapin,* allied to *Convolvulin,* and termed

Scammonium.—SCAMMONY.—A GUM RESIN, obtained by incision from the living root of Convolvulus Scammonia, chiefly in Asia Minor.

Characters and Tests.—Ash-grey and rough externally; fresh fracture resinous, splintery, shining, black when dry; odour and flavour cheesy; causes, when chewed, a slight prickly sensation in the back of the throat; easily triturated into a dirty-grey powder, and converted by water into a smooth emulsion. Contains no starch. *Dose*, 5 to 10 grains.

Officinal Preparations.—Confectio Scammonii.—Confection of Scammony (scammony, in fine powder, 3 oz.; ginger, in fine powder, 1½ oz.; oil of caraway, 1 fl. dr.; oil of cloves, ½ fl. dr.; syrup, 3 fl. oz.; clarified honey, 1½ oz.).

Dose, 10 to 30 grains.

Pulvis Scammonii Compositus.—Compound Powder of Scammony (scammony, in powder, 4 oz.; jalap, in powder, 3 oz.; ginger, in powder, 1 oz.). *Dose*, 10 to 20 grains.

Scammonium is also contained in Pilula Colocynthidis Composita and Pilula Colocynthidis et Hyoscyami.

Therapeutics.—A drastic purgative, usually causing much watery discharge, and frequently griping; used in constipation, cerebral and dropsical effusions, and as a vermifuge for children.

Adulterations.—Mostly adulterated with *chalk*, *flour*, *other resins*, and *extracts*; sometimes the drug contains only a small percentage of real scammony.

Ericaceæ.

ARCTOSTAPHYLOS UVA URSI. THE BEARBERRY.

Uvæ Ursi Folia.—Bearberry Leaves.—The dried leaves of Arctostaphylos Uva Ursi. From indigenous plants.

Characters.—Obovate entire coriaceous shining leaves, about three-fourths of an inch in length, reticulated beneath, with a strong astringent taste, and a feeble hay-like odour when powdered; leaves not dotted beneath, nor toothed on the margin. Contain Gallic and Tannic Acids, and two crystallisable principles, *Ursone* ($C_{20}A_{32}O_2$) and *Arbutin* ($C_{12}H_{16}O_7$), with bitter extractive, etc.

Dose, in powder, 10 to 30 grains.

Officinal Preparation.—Infusum Uvæ Ursi.—Infusion of Bearberry (bearberry leaves, bruised, ½ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

Therapeutics.—A diuretic and astringent, used in urethral and vesical affections, as catarrhus vesicæ chronicus, to diminish mucous discharges and irritability; also in gleets. May be administered with acids or alkalies.

Adulterations.—The leaves of *Vaccinium Vitis Idœa* or *Red Whortleberry*. These are known by their being dotted, not reticulated, on the under surface, and by their crenated margins; also the common *Box* leaves; these latter are devoid of astringency.

Gentianaceæ.

1.—OPHELIA CHIRATA. CHIRETTA

Chirata.—CHIRETTA.—The entire plant, Ophelia Chirata. Collected in Northern India.

Characters.—Stems about three feet long, of the thickness of a goose-quill, round, smooth, pale-brown, branched ; branches opposite ; flowers small, numerous, panicled ; the whole plant intensely bitter.

Contains a bitter resinous substance, *Chiratin*, and *Ophelic Acid.*

Officinal Preparations.—INFUSUM CHIRATÆ.—Infusion of Chiretta (chiretta, cut small, ¼ oz. ; distilled water, at 120° Fah., 10 oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA CHIRATÆ.—Tincture of Chiretta (chiretta, cut small and bruised, 2½ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Therapeutics.—A pure bitter tonic; given in atonic dyspepsia.

2.—GENTIANA LUTEA. THE YELLOW GENTIAN.

Gentianæ Radix.—GENTIAN ROOT.—The dried ROOT of Gentiana Lutea. Collected in the mountainous districts of Central and Southern Europe.

Characters.—From half an inch to one inch in thickness, several inches in length, often twisted, much wrinkled, or marked with close transverse rings ; brown externally, yellow within, tough and spongy ; taste at first sweetish, afterwards very bitter.

Contains *Gentianic Acid*, and a crystalline bitter principle, *Gentio-Picrin.* No starch or tannic acid, and therefore compatible with salts of iron. *Dose, in powder*, 10 to 30 grains.

Officinal Preparations.—EXTRACTUM GENTIANÆ.—Extract of Gentian (gentian root, sliced, 1 lb.; boiling distilled water, 1 cong.). *Dose*, 2 to 10 grains.

INFUSUM GENTIANÆ COMPOSITUM.—Compound Infusion of Gentian (gentian root, sliced, 60 gr. ; bitter orange peel, cut small, 60 gr. ; fresh lemon peel, cut small, ¼ oz. ; boiling distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

MISTURA GENTIANÆ.—Gentian Mixture (gentian root, sliced, ¼ oz. ; bitter orange peel, cut small, 30 gr. ; coriander fruit, bruised, 30 gr. ; proof spirit, 2 fl. oz. ; distilled water, 8 fl. oz.). *Dose*, ½ to 1 fluid ounce.

TINCTURA GENTIANÆ COMPOSITA.—Compound Tincture of

Gentian (gentian root, cut small and bruised, 1½ oz.; bitter orange peel, cut small and bruised, ¾ oz.; cardamom seeds, freed from the pericarps and bruised, ¼ oz.; proof spirit, 1 oct.). *Dose,* ½ to 2 fluid drachms.

Therapeutics.—A simple, bitter stomachic tonic, exceedingly useful in convalescence from acute disease, in atonic dyspepsia and in debility generally. It improves the appetite, and gives tone to the stomach.

Labiatæ.

1.—LAVANDULA VERA. THE TRUE LAVENDER.

Lavandulæ Oleum.—OIL OF LAVENDER.—The OIL distilled in Britain from the flowers of Lavandula Vera.

Characters.—Colourless or pale yellow, with the odour of lavender, and a hot bitter aromatic taste.

Dose, 1 to 6 minims.

Contains a hydrocarbon ($C_{10}H_{16}$) and yields camphor by oxidation.

Officinal Preparations. — SPIRITUS LAVANDULÆ.—Spirit of Lavender (oil of lavender, 1 fl. oz.; rectified spirit, 49 fl. oz.). *Dose,* ½ to 1 fluid drachm.

TINCTURA LAVANDULÆ COMPOSITA.—Compound Tincture of Lavender (oil of lavender, 1½ fl. dr.; oil of rosemary, 10 min.; cinnamon bark, bruised, 150 gr.; nutmeg, bruised, 150 gr.; red sandalwood, 300 gr.; rectified spirit, 2 oct.). *Dose,* ½ to 2 fluid drachms.

Oil of Lavender is also contained in Linimentum Camphoræ Compositum.

Therapeutics.—Stimulant and carminative, given in colic and flatulence; also in hypochondriasis, hysteria, and other nervous affections.

Adulterations.—The oil of spike (lavandula spica) is sometimes mixed with or substituted for the true oil; oil of turpentine is also mixed with it.

2.—MENTHA PIPERITA. PEPPERMINT.

Menthæ Piperitæ Oleum.—OIL OF PEPPERMINT.—The OIL distilled in Britain from fresh flowering Mentha Piperita.

Characters.—Colourless or pale-yellow, with the odour of peppermint; taste warm, aromatic, succeeded by a sensation of coldness in the mouth.

Consists of a hydrocarbon, *Menthene* ($C_{10}H_{18}$), and *Menthol* or *Peppermint-Camphor* ($C_{10}H_{20}O$). *Dose,* 1 to 5 minims.

Officinal Preparations.—Aqua Menthæ Piperitæ.—Peppermint Water (oil of peppermint, 1½ fl. dr. ; water, 1½ cong. Distil one gallon). *Dose*, 1 to 2 fluid ounces.

Contained in Mistura Ferri Aromatica.

Essentia Menthæ Piperitæ.—Essence of Peppermint (oil of peppermint, 1 fl. oz. ; rectified spirit, 4 fl. oz.).

Dose, 10 to 20 minims.

Spiritus Menthæ Piperitæ.—Spirit of Peppermint (oil of peppermint, 1 fl. oz. ; rectified spirit, 49 fl. oz.).

Dose, ½ to 1 fluid drachm.

Oil of peppermint is also contained in Pilula Rhei Composita.

Therapeutics.—Carminative and stimulant; given as an adjunct to purgatives, to relieve flatulence.

3.—MENTHA VIRIDIS. SPEARMINT.

Menthæ Viridis Oleum.—Oil of Spearmint.—The oil distilled in Britain from fresh flowering spearmint, Mentha Viridis.

Characters.—Colourless or pale-yellow, with the odour and taste of spearmint. Consists of a hydrocarbon, identical with oil of turpentine, mixed with an oxidised oil, or stearoptene, isomeric with *Carvol* ($C_{10}H_{14}O$). *Dose*, 1 to 5 minims.

Officinal Preparation. — Aqua Menthæ Viridis.—Spearmint Water (Oil of spearmint, ½ fl. dr. ; water, 1½ cong. Distil one gallon). *Dose*, 1 to 2 fluid ounces.

Therapeutics.—The same as Peppermint.

4.—ROSMARINUS OFFICINALIS. ROSEMARY.

Rosmarini Oleum.—Oil of Rosemary.—The oil distilled from the flowering tops of Rosmarinus Officinalis.

Characters.—Colourless, with the odour of rosemary, and a warm aromatic taste.

The rosemary tops contain a *volatile oil* ($C_{10}H_{16}$), bitter extractive and tannin.

Officinal Preparation. — Spiritus Rosmarini. — Spirit of Rosemary (oil of rosemary, 1 fl. oz. ; rectified spirit, 49 fl. oz.).

Dose, 1 to 5 minims.

Oil of Rosemary is also contained in Linimentum Saponis and Tinctura Lavandulæ Composita.

Therapeutics. — Powerfully stimulant; given in nervous headache and hysteria; externally used for its odour, and as a rubefacient.

Lobeliaceæ.

LOBELIA INFLATA. INDIAN TOBACCO.

Lobelia.—Lobelia.—The dried flowering herb of Lobelia Inflata. Imported from North America.

Characters. — Stem angular; leaves alternate, ovate, toothed, somewhat hairy beneath; capsule ovoid, inflated, ten-ribbed; herb acrid. Usually in compressed rectangular parcels, somewhat like chopped hay. Has a peculiar odour, and a burning taste, which is not apparent until some time after it has been chewed. Contains a volatile oil, *Lobelic Acid*, and *Lobelina*, an alkaline active principle, which is a yellowish liquid with a tobacco-like odour.

Officinal Preparations.—Tinctura Lobeliæ.—Tincture of Lobelia (lobelia, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, 10 minims to ½ fluid drachm.

Tinctura Lobeliæ Ætherea. — Ethereal Tincture of Lobelia (lobelia, in coarse powder, 2½ oz.; spirit of ether, 1 oct.). *Dose*, 10 minims to ½ fluid drachm.

Therapeutics.—Expectorant and diaphoretic in small doses; emetic or cathartic in larger doses. In too great quantity it produces much depression, nausea, cold sweats, and even death, preceded by convulsions; very similar to tobacco in its action. Has enjoyed much favour in the treatment of spasmodic asthma, and other affections of the air passages attended by dyspnœa. Sometimes useful as an adjunct to diuretics.

Loganiaceæ.

STRYCHNOS NUX VOMICA.

Nux Vomica.—Nux Vomica.—The seeds of Strychnos Nux Vomica. Imported from the East Indies.

Characters.—Nearly circular and flat, about an inch in diameter, umbilicated and slightly convex on one side, externally of an ash-grey colour, thickly covered with short satiny hairs, internally translucent, tough and horny, taste intensely bitter, inodorous. Contains three alkaloids, *Strychnia*, *Brucia*, and *Igasuria*, united with *Strychnic* or *Igasuric Acid*. *Dose, in powder*, 2 to 5 grains.

Officinal Preparations.—Extractum Nucis Vomicæ.—Extract of Nux Vomica (nux vomica, 1 lb.; rectified spirit, a sufficiency. *Dose*, ½ grain to 2 grains.

Tinctura Nucis Vomicæ.—Tincture of Nux Vomica (nux vomica, 2 oz.; rectified spirit, 1 oct.).

Dose, 10 to 20 minims.

Strychnia. — STRYCHNIA, $C_{21}H_{22}N_2O_2$.—An ALKALOID obtained from Nux Vomica (nux vomica, 1 lb.; acetate of lead, 180 gr.; solution of ammonia, rectified spirit and distilled water, of each a sufficiency).

By digestion with water and rectified spirit, the seeds are exhausted of the *Igasurates of Strychnia* and *Brucia;* Acetate of lead is added, with the formation of *Acetates* of *Strychnia* and *Brucia,* and the precipitation of *Igasurate* of *Lead.* Ammonia is now added to precipitate the alkaloids, *Acetate of Ammonia* being left in the solution. The precipitated alkaloids are dissolved in spirit, and the spirituous solution evaporated, the yellowish mother liquor, containing the brucia of the seeds, being cautiously poured off from the white crust of strychnia which adheres to the vessel. The strychnia is washed until the washings no longer give a red colour with nitric acid, indicating the absence of brucia, and it is finally dissolved in boiling water, and crystallised.

Tests.—(1) Strychnia is intensely bitter, and (2) gives, with sulphuric acid, a colourless solution which, when bichromate of potash is added, yields an *iridescent play* of colours, passing from yellow to violet.

Officinal Preparation.—LIQUOR STRYCHNIÆ. — Solution of Strychnia (strychnia, in crystals, 4 gr.; diluted hydrochloric acid, 6 min.; rectified spirit, 2 fl. dr.; distilled water, 6 fl. dr.); 4 grains of strychnia in 1 ounce of the liquor.

Dose, 5 to 10 minims.

BRUCIA is more soluble in water than strychnia. It gives a *deep red colour* with nitric acid, turning to violet on the addition of stannous chloride.

IGASURIC OR STRYCHNIC ACID in solution precipitates copper salts *bright-green.*

Therapeutics. — Strychnia acts especially upon the motor tract of the spinal cord, increasing the reflex excitability of that cord, and if the drug has been taken in poisonous doses, the slightest stimulus excites tetanic spasms. It is said to cause a rise of blood pressure and a contraction of the peripheral arterioles; it does not directly influence the cerebral centres, the voluntary muscles, or the heart.

In man this drug produces rigidity and twitching of the muscles, succeeded by tetanic spasms, consciousness being retained. The muscles are relaxed during the intervals of the paroxysms. A fatal issue may result from exhaustion between the spasms, or from apnœa during a spasm, due to protracted rigidity of the respiratory muscles. The alkaloid affects paralysed parts more readily than the sound; it is eliminated by the urine.

From Dr. Garrod's experience, Brucia, when *pure*, produces none of the effects of strychnia, even in large doses ; it may, perhaps, be antiperiodic and tonic. Chloroform, chloral, and physostigma, and keeping up artificial respiration, have been employed to counteract the fatal effects of strychnia.

Medicinally the action of strychnia is that of a bitter stomachic, and it is given in some forms of dyspepsia, as pyrosis. When combined with purgatives, it increases their efficacy.

Nux Vomica is much employed in the treatment of paralysis, especially when dependent upon lead poisoning, and is sometimes given in paraplegia and hemiplegia. It is also useful in giving tone to the muscular system in cases of debility, and may be administered in hysteria and depression of spirits. Its aphrodisiac properties are often well marked, and it is given in impotence from nervous exhaustion. Finally, it may be given in chorea and chronic spasmodic affections.

Some persons are exceedingly sensitive to the action of strychnia and nux vomica ; 10 minims of tincture of nux vomica, and $\frac{1}{48}$ gr. of strychnia, have caused serious symptoms.

Hypodermically administered, 1 to 5 minims of the liquor strychniæ may be used.

Adulteration of Strychnia.—Brucia in variable quantity, detected by its red colour with nitric acid.

Oleaceæ.

1.—GLYCERINUM.

Glycerinum. — Glycerine, $C_3H_8O_3$. — A sweet principle obtained from fats and fixed oils, and containing a small percentage of water.

Characters.—A clear, colourless fluid, oily to the touch, without odour, of a sweet taste ; freely soluble in water and in alcohol. When decomposed by heat it evolves intensely irritating vapours of *Acrolein.* Specific gravity 1·25. Takes fire at a red heat, and burns with a blue flame. Possesses a remarkable power of dissolving arsenious anhydride, carbolic acid, borax, and many alkaloids. It decomposes permanganate and bichromate of potash. Heated with starch, it forms a "plasma." When glycerine is acted upon by strong acids, an oily, poisonous, explosive liquid is produced, termed *Nitro-Glycerine.* *Dose,* 1 to 2 drachms.

Officinal Preparations.—The Glycerina.

1. Glycerinum Acidi Carbolici.—Glycerine of Carbolic Acid (carbolic acid, 1 oz. ; glycerine, 4 fl. oz.).

2. Glycerinum Acidi Gallici.—Glycerine of Gallic Acid (gallic acid, 1 oz. ; glycerine, 4 fl. oz.).

3. Glycerinum Acidi Tannici. — Glycerine of Tannic Acid (tannic acid, 1 oz. ; glycerine, 4 fl. oz.).

4. Glycerinum Amyli. —Glycerine of Starch (starch, 1 oz.; glycerine, 8 fl. oz.).

5. Glycerinum Boracis.—Glycerine of Borax (borax, in powder, 1 oz. ; glycerine, 4 fl. oz.). Glycerine is also used in Linimentum Potassii Iodidi cum Sapone.

Therapeutics. — Used as an adjunct to lotions in skin diseases. Has been proposed as a substitute for sugar in the treatment of diabetes mellitus ; and has been employed as a substitute for cod-liver oil, but without much benefit.

2. FRAXINUS ORNUS.

Manna.—Manna.—A Concrete Saccharine Exudation from the stem of Fraxinus Ornus. Obtained by making incisions in the stems of the trees, which are cultivated for the purpose, chiefly in Calabria and Sicily.

Characters.—In stalactitiform pieces from one to six inches in length, and one to two inches in width, uneven, porous, and friable, curved on one side, of a yellowish-white colour, with a faintly nauseous odour and a sweetish taste. It consists principally of mannite, $C_3H_7O_3$, together with sugar and extractive matter. The glaucous colour of manna is due to *Fraxin.* *Dose,* 60 grains to 1 ounce.

Therapeutics.—A very mild laxative, suitable for children ; it is occasionally given as an agreeable adjunct to some purgative draughts.

3. OLEA EUROPÆA.

Olivæ Oleum.—The oil expressed in the south of Europe from the ripe fruit of Olea Europæa.

Characters.—Pale yellow, with scarcely any odour, and a bland oleaginous taste ; congeals partially at about 36° Fah. Consists of about 72 per cent. of a fluid portion, *Oleine,* or *Oleate of Glyceryl,* $C_3H_5 3C_{18}H_{33}O_2$, and 28 per cent. of a solid portion, which is a mixture of *Palmitin,* $C_3H_5C_{16}H_{31}O_2$, and *Stearin,* $C_3H_5 3C_{18}H_{35}O_2$.

Combines with alkalies to form soaps, and is converted by nitrate of mercury into *Elaidin,* a solid substance.

Olive oil is contained in Charta Epispastica, Cataplasma Lini, Enema Magnesiæ Sulphatis, and some Emplastra, Linimenta, and Unguenta.

Sapo Animalis.—Curd Soap.—A soap made with soda, and a purified animal fat consisting principally of stearin ; white, or with a very light greyish tint, dry, and nearly inodorous; used in the preparation of Pilula Scammonii Composita, and Suppositoria; Acidi Carbolici cum Sapone; Morphiæ cum Sapone; Acidi Tannici cum Sapone.

Curd soap may advantageously be substituted for the hard soap made with olive oil in preparing the Linimentum Potassii Iodidi cum Sapone.

Sapo Durus.—HARD SOAP.—Soap made with olive oil and Soda; greyish-white, dry and inodorous; used in Emplastra Resinæ and Saponis, Extractum Colocynthidis Compositum, Linimentum Potassii Iodidi cum Sapone, Linimentum Saponis, and in many Pilulæ.

Sapo Mollis.—SOFT SOAP.—Soap made with olive oil and Potash; yellowish-green, inodorous, of a gelatinous consistence. Contained in Linimentum Terebinthinæ.

Therapeutics.—Soap acts as an antacid, but is liable to disagree with the stomach, since the fatty acids may become liberated. It has no particular value as an internal remedy, but is employed as an adjunct to other drugs, and for the formation of pills.

Sapotaceæ.

ISONANDRA GUTTA.

Gutta-Percha.—GUTTA-PERCHA.—The concrete juice of Isonandra Gutta.

Characters.—In tough flexible pieces, of a light-brown or chocolate colour. Soluble, or nearly so, in chloroform.

Commercial gutta-percha consists of three distinct portions, pure *Gutta*, a milk-white solid ($C_{20}H_{32}$), a crystalline resin ($C_{20}H_{32}O_2$), and an amorphous resin ($C_{20}H_{32}O$).

Officinal Preparation.—LIQUOR GUTTA-PERCHA.—Solution of Gutta-Percha (gutta-percha, in thin slices, 1 oz.; chloroform, 8 fl. oz.; carbonate of lead, in fine powder, 1 oz.).

Employed in Charta Sinapis.

Use.—Chiefly used for it physical properties for making splints.

Scrophulariaceæ.

DIGITALIS PURPUREA. THE PURPLE FOX-GLOVE.

Digitalis Folia.—DIGITALIS LEAVES.—The dried LEAVES of Digitalis Purpurea. Collected from wild indigenous plants, when about two-thirds of the flowers are expanded.

Characters.—Ovate-lanceolate, shortly petiolate, rugose, downy, paler on the under surface, crenate, almost colourless, taste bitter and acrid. *Dose, in powder,* ½ to 1½ grain.

Officinal Preparations.—INFUSUM DIGITALIS.—Infusion of Digitalis (digitalis leaves, dried, 30 gr.; boiling distilled water, 10 fl. oz.). *Dose*, 2 to 4 fluid drachms.

TINCTURA DIGITALIS. — Tincture of Digitalis (digitalis leaves, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, 10 to 30 minims.

The digitalis leaves contain two active principles, *Digitalein* and

Digitalinum.—DIGITALIN.—A solution of this substance in hydrochloric acid is of a faint yellow colour, but rapidly becomes green. It is prepared from digitalis leaf, in coarse powder, 40 oz.; rectified spirit, distilled water, acetic acid, purified animal charcoal, solution of ammonia, tannic acid, oxide of lead, in fine powder, pure ether, of each a sufficiency.

Dose, $\frac{1}{60}$ to $\frac{1}{30}$ of a grain.

Therapeutics.—In small doses digitalis induces a rise of the blood pressure in the arteries, and a contraction of the systemic arterioles; the heart contracting more powerfully and slowly. By poisonous doses, the heart's action is rendered quick and irregular. Lastly, the heart stops beating, with its ventricles firmly contracted.

Medicinally administered, the most notable effect is slowing of the pulse. If the dose be increased, dangerous symptoms may arise, viz., vomiting, purging and faintness; patients under the full influence of digitalis should always assume the horizontal position, since when sitting or standing the above symptoms may arise.

Digitalis may not inaptly be termed The *Pendulum of the Heart,* since it diminishes increased action of that organ, and assists its driving power, when such power is deficient. It is most useful in cases of mitral disease; in hypertrophy with dilatation of the heart, irregular pulse and low arterial tension. It should be used with caution when the vascular system is atheromatous and the heart's tissue fatty.

Digitalis is used as a *diuretic* in dropsy, especially when associated with heart disease; but it should never be employed in the dropsy of chronic Bright's disease.

It is valuable in the treatment of hæmorrhage, especially from the lungs, and has been used in delirium tremens for inducing sleep, and also in acute mania.

Digitalis is said to be *cumulative* in its action, *i.e.*, during its use alarming symptoms may arise, and without any previous increase of dose.

Adulterations.—The leaves of Verbascum Thapsus and other plants.

Solanaceæ.

1. CAPSICUM FASTIGIATUM.

Capsici Fructus.—CAPSICUM FRUIT.—The dried ripe fruit of Capsicum Fastigiatum. Imported from Zanzibar, and distinguished in commerce as Guinea Pepper and Pod Pepper—chillies.

Characters. — Pod membranous, from five to eight lines long, two lines broad, straight, conical, pointed, smooth, shining, but somewhat corrugated, orange-red, intensely hot in taste.

Contains an acrid, volatile, crystalline alkaloid, *Capsicin.*

Dose, in powder, ½ to 1 grain in pills.

Officinal Preparation. — TINCTURA CAPSICI.—Tincture of Capsicum (capsicum fruit, bruised, ¾ oz.; rectified spirit, 1 oct). *Dose,* 10 to 20 minims.

Therapeutics.—A powerful topical stimulant, chiefly used as a condiment (cayenne pepper), but sometimes given in dyspepsia, diarrhœa, and excessive prostration; it is used as a gargle in scarlatinal and other forms of sore throat; externally it may be employed as a rubefacient.

2. SOLANUM DULCAMARA. THE BITTER-SWEET.

Dulcamara.—DULCAMARA.—The dried young branches of Solanum Dulcamara. From indigenous plants which have shed their leaves.

Characters.—Light, hollow, cylindrical, about the thickness of a goose-quill, bitter, and subsequently sweetish to the taste.

Contains, in very small amount, an alkaloid, *Solania,* probably combined with malic acid; and a sweetish-bitter extract, *Dulcamarine* or *Picro-Glycion.*

Officinal Preparation.—INFUSUM DULCAMARÆ. — Infusion of Dulcamara (dulcamara, bruised, 1 oz.; boiling distilled water, 10 fl. oz.). *Dose,* 1 to 2 fluid ounces.

Therapeutics.—The efficacy of this drug is questionable. It is said to be alterative, and diaphoretic, and has been given in chronic skin diseases, as psoriasis, and also in syphilis.

Styraceæ.

STYRAX BENZOIN.

Benzoinum.—BENZOIN.—A balsamic RESIN obtained from Styrax Benzoin. It is procured by making incisions into the bark of the tree, and allowing the liquid that exudes to concrete by exposure to the air. Imported from Siam and Sumatra.

Characters.—In lumps, consisting of agglutinated tears, or of a brownish mottled mass with or without white tears imbedded in it; has little taste, but an agreeable odour; gives off, when heated, fumes of benzoic acid; is soluble in rectified spirit and in solution of potash.

Officinal Preparations. — *Acidum Benzoicum. — Benzoic Acid. *Dose*, 10 to 15 grains.

Tinctura Benzoini Composita. — Compound Tincture of Benzoin (benzoin, in coarse powder, 2 oz.; prepared storax, 1½ oz.; balsam of tolu, ½ oz.; socotrine aloes, 160 gr.; rectified spirit, 1 oct.). *Dose*, ½ to 1 fluid drachm. Friar's Balsam

Benzoin is also contained in Adeps Benzoatus; in Suppositoria: Acidi Tannici; Hydrargyri; Morphiæ; and Plumbi Composita; in Unguenta: Gallæ; Plumbi Acetatis; Sulphuris; and Zinci.

Therapeutics. — A stimulating expectorant, at one time employed in chronic bronchitic affections. Externally it is applied to ulcers and wounds in the form of the tincture (Friar's Balsam).

Valerianaceæ.

VALERIANA OFFICINALIS.

Valerianæ Radix.—Valerian Root.—The dried root of Valeriana Officinalis. From plants indigenous to and also cultivated in Britain; collected in autumn, wild plants being preferred.

Characters.—A short yellowish-white rhizome, with numerous fibrous roots about two or three inches long; of a bitter taste and penetrating odour, agreeable in the recent root, becoming fetid by keeping; yielding volatile oil and valerianic acid when distilled with water.

Dose, in powder, 10 to 20 grains.

Officinal Preparations. — Infusum Valerianæ.—Infusion of Valerian (valerian root, bruised, 120 gr.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

Tinctura Valerianæ. — Tincture of Valerian (valerian root, in coarse powder, 2½ oz.; proof spirit, 1 oct.). *Dose*, 1 to 2 fluid drachms.

Tinctura Valerianæ Ammoniata.—Ammoniated Tincture of Valerian (valerian root, in coarse powder, 2½ oz.; aromatic spirit of ammonia, 1 oct.). *Dose*, ½ to 1 fluid drachm.

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* See Part I.

Therapeutics.—A powerful stimulant and antispasmodic; useful in hysteria, chorea, epilepsy, and hypochondriasis, and as an adjunct to tonics. Its antispasmodic powers are very inferior to assafœtida.

Valerianas Sodæ.—VALERIANATE OF SODA (amylic alcohol (fousel oil) 4 fl. oz.; bichromate of potash, 9 oz.; sulphuric acid, 6½ fl. oz.; solution of soda, a sufficiency; water, ½ cong.). By the action of sulphuric acid upon the bichromate of potash *Chromic Acid* is formed, which substance, by its oxidising agency, converts the amylic alcohol into *Valerianic Acid*, and this combines with the *Soda* to form Valerianate of Soda.

Dose, 1 to 5 grains.

Therapeutics.—Appears to resemble valerian in its action. Introduced into the British Pharmacopœia for making the Valerianate of Zinc.

VALERIANAS ZINCI.—Valerianate of Zinc (sulphate of zinc, 5¼ oz.; valerianate of soda, 5 oz.; distilled water, a sufficiency). *Dose*, 1 to 3 grains.

Therapeutics.—A nervine tonic and antispasmodic; given in cases where the combined action of the metal and valerian is desirable, viz., in hysteria, chorea, epilepsy, and neuralgic affections.

SUB-CLASS IV.—APETALÆ.

Aristolochiæ.

ARISTOLOCHIA SERPENTARIA.

Serpentariæ Radix. — SERPENTARY ROOT. — The dried RHIZOME of Aristolochia Serpentaria. From the southern parts of North America.

Characters.—A small roundish rhizome, with a tuft of numerous slender rootlets, about three inches long, yellowish, of an agreeable camphoraceous odour, and a warm bitter camphoraceous taste. Contains a volatile oil, resin, tannin, sugar, and mucilage.

Officinal Preparations.—INFUSUM SERPENTARIÆ.—Infusion of Serpentary (serpentary root, bruised, ¼ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA SERPENTARIÆ. — Tincture of Serpentary (serpentary root, in coarse powder, 2½ oz.; proof spirit, 1 oct.). *Dose*, ½ to 2 fluid drachms.

Serpentary root is also contained in Tinctura Cinchonæ Composita.

Therapeutics.—Stimulant, tonic, diaphoretic and diuretic; occasionally used in dyspepsia, low febrile conditions, and in chronic rheumatism. It may be exhibited when guaiacum is not well borne, since this latter is said occasionally to disturb the bowels.

Cannabinaceæ.

1. CANNABIS SATIVA.

Cannabis Indica.—INDIAN HEMP.—The dried flowering tops of the female plants of Cannabis Sativa. For medicinal use, that which is grown in India, and from which the resin has not been removed, is alone to be employed.

Characters.—Tops consisting of one or more alternate branches, bearing the remains of the flowers and smaller leaves, and a few ripe fruits, pressed together in masses which are about two inches long, harsh, of a dusky-green colour, and a characteristic odour.

Contains a resin (*Cannabin*), and a volatile oil.

Officinal Preparations.—EXTRACTUM CANNABIS INDICÆ.—Extract of Indian Hemp (Indian hemp, in coarse powder, 1 lb.; rectified spirit, 4 oct.). *Dose,* ¼ to 1 grain.

TINCTURA CANNABIS INDICÆ.—Tincture of Indian Hemp (extract of Indian hemp, 1 oz.; rectified spirit, 1 oct.); 22 grains of extract in one fluid ounce, nearly.

Dose, 5 to 20 minims.

Therapeutics.—Cannabis Indica produces a kind of intoxication, accompanied by exhilaration and hallucinations of the senses, generally said to be of a pleasing nature, and followed by sleep and stupor. The anodyne and soporific effects are said to be followed by less unpleasant after-effects than those of opium; no loss of appetite or constipation is induced. On account of its antispasmodic and anodyne powers, Indian Hemp is given in various forms of neuralgia, in whooping cough, asthma, tetanus and hydrophobia.

The urine of patients under the influence of the drug acquires an odour similar to that of the Tonquin bean.

A tolerance of opium appears to establish in the system a similar capability of resisting the action of Cannabis Indica.

Incompatibles.—When the tincture is added to water, a turbidity takes place from the resin being precipitated; it is therefore desirable to rub it up with mucilage, to suspend it, or to add a few drops of an alkaline solution, such as the aromatic spirit of ammonia.

2. HUMULUS LUPULUS. THE HOP.

Lupulus.—Hop.—The dried strobiles of the female plant of Humulus Lupulus. Cultivated in England.

Characters.—Strobiles of a greenish-yellow colour, with minute yellow grains (Lupulin) adherent to the base of the scales; odour aromatic, taste bitter. *Lupulin*, the active principle, contains a bitter principle, *Humulin* or *Lupulite.*

Officinal Preparations.—EXTRACTUM LUPULI.—Extract of Hop (hop, 1lb.; rectified spirit, 1½ oct.; distilled water, 1 cong.). *Dose*, 5 to 15 grains.

INFUSUM LUPULI.—Infusion of Hop (hop, ½ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

TINCTURA LUPULI.—Tincture of Hop (hop, 2½ oz.: proof spirit, 1 oct.). *Dose*, ½ to 2 fluid drachms.

Therapeutics.—Stomachic, tonic, and somewhat narcotic; given in dyspepsia, in chordee; and to diminish the tendency to nocturnal emissions.

Coniferæ or Pinaceæ.

1. JUNIPERUS COMMUNIS. THE COMMON JUNIPER.

Juniperi Oleum.—OIL OF JUNIPER.—The OIL distilled in Britain from the unripe fruit of Juniperus Communis.

Characters.—Colourless or pale greenish-yellow, of a sweetish odour and warm aromatic taste. The juniper "berries" are of the size of black currants, of a deep purple colour, with a glaucous bloom. They contain three angular seeds, having a turpentine odour.

Officinal Preparation.—SPIRITUS JUNIPERI.—Spirit of Juniper (oil of juniper, 1 fl. oz.; rectified spirit, 49 fl. oz.).

Dose, ½ to 1 fluid drachm. Contained in Mistura Creosoti.

Therapeutics.—A powerful stimulant, acting especially on the kidneys. Chiefly used for its diuretic action in different forms of dropsies. Is contained in Gin and Hollands.

2. LARIX EUROPÆA. THE COMMON LARCH.

Laricis Cortex.—LARCH BARK.—The BARK, deprived of its outer layer, of Larix Europæa.

Characters.—In flat pieces, from three to six inches long, and from two to four inches wide; the inner surface is fibrous and yellow, and the outer surface, when denuded of epidermis, is reddish; the epidermis is greyish, spotted with lichens and beaded with resinous exudation; the odour faintly terebinthinate. Contains, in addition to turpentine, sugar, gum, and tannic acid, a volatile substance, *Larixin* or *Larixinic Acid*, $C_{10}H_{10}O_5$, a solution of which, with persalts of iron, turns to a purple colour.

Officinal Preparation. — TINCTURA LARICIS.—Tincture of Larch (larch bark, in coarse powder, 2½ oz. ; rectified spirit, 1 oct.). *Dose*, 20 to 30 minims.

Therapeutics.—Similar in action to other balsamic and terebinthinate remedies, but less apt to interfere with digestion, and more pleasant to the taste. It is stimulant, expectorant, and astringent ; given in purpura and intestinal hæmorrhage, also in chronic bronchitis and cystitis.

3.—ABIES EXCELSA. THE SPRUCE FIR.

Pix Burgundica.—BURGUNDY PITCH.—A RESINOUS EXUDATION from the stem of the Abies Excelsa. Melted and strained ; imported from Switzerland.

Characters.—Hard and brittle, yet gradually taking the form of the vessel in which it is kept ; opaque, varying in colour, but generally dull reddish-brown ; of a peculiar, somewhat empyreumatic, perfumed odour, and aromatic taste, without bitterness ; free from vesicles ; gives off no water when heated.

Officinal Preparation.—EMPLASTRUM PICIS.—Pitch Plaster (Burgundy pitch, 26 oz. ; common frankincense, 13 oz. ; resin, 4½ oz. ; yellow wax, 4½ oz. ; expressed oil of nutmeg, 1 oz. ; olive oil, 2 fl. oz. ; water, 2 fl. oz.).

Burgundy Pitch is also contained in Emplastrum Ferri.

Therapeutics.—Externally a slight stimulant to the skin.

4.—PINUS SYLVESTRIS. THE COMMON PINE.

Pix Liquida.—TAR.—A BITUMINOUS LIQUID obtained from the wood of Pinus Sylvestris and other pines by destructive distillation.

Characters.—Thick, viscid, brownish-black, with a well-known peculiar odour. Tar contains *Colophonic Acid*, and an empyreumatic oil, from which are obtained creosote, paraffin, etc. Pitch is the altered resin, which results from the distillation of tar.

Officinal Preparation.—UNGUENTUM PICIS LIQUIDÆ.—Ointment of Tar (tar, 5 oz. ; yellow wax, 2 oz.).

Therapeutics.—An internal and external stimulant ; exceedingly useful in chronic skin diseases, as psoriasis, eczema, and pityriasis. Given internally in bronchitic affections. Sometimes causes a black deposit in the urine. The vapour of tar is advantageously employed in phthisis and chronic bronchitis.

5.—PINUS ——? ABIES ——?

Resina.—RESIN. — The RESIDUE of the distillation of the turpentines from various species of Pinus and Abies.

Characters.—Translucent, yellowish, brittle, pulverisable, fracture shining; odour and taste faintly terebinthinate. It is easily fusible, and burns with a dense yellow flame and much smoke. It is coloured red by sulphuric acid. Contains three isomeric acids, *Pinic, Sylvic,* and *Pimaric* ($H,C_{20}H_{29}O_2$).

Officinal Preparations. — EMPLASTRUM RESINÆ. — Resin Plaster (resin, 4 oz. ; lead plaster, 2 lb. ; hard soap, 2 oz.).

UNGUENTUM RESINÆ.—Ointment of Resin (resin, in coarse powder, 8 oz. ; yellow wax, 4 oz. ; simple ointment, 16 oz.).

Resin is also contained in Charta Epispastica and Unguentum Terebinthinæ, in Emplastra ; Belladonnæ ; Calefaciens ; Opii ; Picis ; Saponis ; and Plumbi Iodidi.

Therapeutics.—Used as external stimulant applications.

6.—JUNIPERUS SABINA.

Sabinæ Cacumina.—SAVIN TOPS.—The fresh and dried TOPS of Juniperus Sabina. Collected in spring, from plants cultivated in Britain.

Characters.—Twigs densely covered with minute imbricated appressed leaves in four rows; odour strong, peculiar, and unpleasant ; taste acrid, bitter, resinous, disagreeable.

Dose, in powder, 4 to 10 grains.

Officinal Preparations. — TINCTURA SABINÆ. — Tincture of Savin (savin tops, dried and coarsely powdered, 2½ oz. ; proof spirit, 1 oct.). *Dose,* 20 minims to 1 fluid drachm.

UNGUENTUM SABINÆ. — Ointment of Savin (fresh savin tops, bruised, 8 oz. ; yellow wax, 3 oz. ; prepared lard, 16 oz.).

Oleum Sabinæ.—OIL OF SAVIN.—The OIL distilled in Britain from fresh savin, Juniperus Sabina. *Dose,* 1 to 5 minims.

Therapeutics.—An irritant, both internally and externally ; apparently acts powerfully upon the uterus as an emmenagogue. Is used externally as an ointment, to keep up discharge from a blistered surface ; and is sometimes given internally in cases of amenorrhœa when unaccompanied by congestion of the pelvic organs. In large doses it may produce abortion, and its administration is attended with great danger.

7.—ABIES BALSAMEA. BALM OF GILEAD FIR.

Terebinthina Canadensis. — CANADA BALSAM. — The TURPENTINE obtained by incision from the stem of Abies Balsamea. From Canada.

Characters.—A pale-yellow ductile oleo-resin, of the consistence of thin honey, with a peculiar agreeable odour, and a slightly bitter, feebly acrid taste ; by exposure drying very slowly into a transparent adhesive varnish ; solidifying when mixed with a sixth of its weight of magnesia.

Dose, 20 to 30 grains.

Contained in Charta Epispastica and Collodium Flexile.

8.—PINUS ; PALUSTRIS, TÆDA, PINASTER.

Terebinthinæ Oleum.—OIL OF TURPENTINE.—The OIL distilled from the oleo-resin (turpentine) obtained from Pinus Palustris, Pinus Tæda, and sometimes Pinus Pinaster.

Characters. — Limpid, colourless, with a strong peculiar odour, and pungent and bitter taste. It is inflammable ; dissolves caoutchouc, sulphur, phosphorus, fats and resins ; and with hydrochloric acid forms two artificial camphors, $C_{10}H_{16}HCl$ and $C_{10}H_{16}2HCl$. With water it forms three hydrates, viz., *Terpinol*, $(C_{10}H_{16})_2H_2O$, *Terpine*, $C_{10}H_{16},2H_2O$, and *Terpine Hydrate*, $C_{10}H_{16},3H_2O$.

Dose, 10 minims to 4 fluid drachms.

Officinal Preparations.—CONFECTIO TEREBINTHINÆ.—Confection of Turpentine (oil of turpentine, 1 fl. oz. ; liquorice root, in powder, 1 oz. ; clarified honey, 2 oz.).

Dose, 60 to 120 grains.

ENEMA TEREBINTHINÆ.—Enema of Turpentine (oil of turpentine, 1 fl. oz. ; mucilage of starch, 15 fl. oz.).

LINIMENTUM TEREBINTHINÆ. — Liniment of Turpentine (soft soap, 2 oz. ; camphor, 1 oz. ; oil of turpentine, 16 fl. oz.).

LINIMENTUM TEREBINTHINÆ ACETICUM.—Liniment of Turpentine and Acetic Acid (oil of turpentine, acetic acid, liniment of camphor, of each 1 fl. oz.).

UNGUENTUM TEREBINTHINÆ. — Ointment of Turpentine (oil of turpentine, 1 fl. oz. ; resin, in coarse powder, 60 gr. ; yellow wax, ½ oz. ; prepared lard, ½ oz.).

Use.—An external stimulant application. + astringent in Hæmorrhag

9.—PINUS TÆDA. THE FRANKINCENSE PINE.
PINUS PALUSTRIS. THE SWAMP PINE.

Thus Americanum.— COMMON FRANKINCENSE.—The concrete TURPENTINE of Pinus Tæda, and Pinus Palustris. From the Southern States of North America.

Characters.—A softish, bright-yellow opaque solid, resinous, but tough, having the odour of American turpentine.

Contained in Emplastrum Picis.

Cupuliferæ.

1.–QUERCUS INFECTORIA. THE DYER'S OAK.

Galla.—GALLS.—EXCRESCENCES on Quercus Infectoria caused by the punctures and deposited ova of an insect, the Diplolepis Gallæ Tinctoriæ.

Characters.—Hard, heavy globular bodies, varying in size from half an inch to three-fourths of an inch in diameter, tuberculated on the surface, the tubercles and intervening spaces smooth; of a blueish-green colour on the surface, yellowish-white within, with a small central cavity; intensely astringent. Contains *Tannic Acid*, *Gallic Acid*, *Ellagic Acid*, and gummy extractive matters and salts.

Officinal Preparations.—*ACIDUM GALLICUM.—Gallic Acid. *Dose*, 2 to 10 grains.

*ACIDUM TANNICUM.—Tannic Acid. *Dose*, 2 to 10 grains.

TINCTURA GALLÆ.—Tincture of Galls (galls, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

UNGUENTUM GALLÆ.—Ointment of Galls (galls, in fine powder, 80 gr.; benzoated lard, 1 oz.).

UNGUENTUM GALLÆ CUM OPIO.—Ointment of Galls and Opium (ointment of galls, 1 oz.; opium, in powder, 32 gr.).

Therapeutics.—The efficacy of gall nuts is due to the tannic and gallic acids contained in them. The action of these acids has been already described.*

2.–QUERCUS PEDUNCULATA.

Quercus Cortex.—OAK BARK.—The dried BARK of the small branches and young stems of Quercus Pedunculata. Collected in spring, from trees growing in Britain.

Characters.—Covered with a greyish shining epidermis, cinnamon-coloured on the inner surface, fibrous, brittle, and strongly astringent. Contains *Tannic* and *Gallic Acids;* also *Pectin* and *Querci-tannic Acid*, which differs from tannic acid in not yielding gallic acid when oxidised. The amount of tannic acid varies much according to the age of the branches from which the bark is taken.

Officinal Preparation.—DECOCTUM QUERCUS.—Decoction of Oak Bark (oak bark, bruised, 1¼ oz.; distilled water, 1 oct.).

Therapeutics.—Rarely used except as an external astringent. The decoction is useful as a lotion, gargle, or injection, in leucorrhœa, in relaxed sore throat. Given internally when tannic acid is indicated.

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* Part I.—Appendix.

Euphorbiaceæ.

1.—CROTON ELUTERIA. THE CASCARILLA.

Cascarillæ Cortex. — Cascarilla Bark. — The bark of Croton Eluteria. From the Bahama Islands.

Characters.—In quills, two or three inches in length, and from two to five lines in diameter, dull-brown but more or less coated with white crustaceous lichens ; breaks with a short resinous fracture ; is warm and bitter to the taste ; and emits a fragrant odour when burned. Contains a neutral bitter principle (*Cascarillin*), some tannic acid, colouring matter, and a volatile oil.

Officinal Preparations. — Infusum Cascarillæ. — Infusion of Cascarilla (cascarilla bark, in coarse powder, 1 oz. ; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 2 fluid ounces.

Tinctura Cascarillæ.—Tincture of Cascarilla (cascarilla bark, bruised, 2½ oz. ; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Therapeutics.—An aromatic stomachic and tonic, and probably a stimulating expectorant. Given in dyspepsia, in some forms of chronic bronchitis, and in recovery from acute diseases.

2.—CROTON TIGLIUM.

Crotonis Oleum. — Croton Oil.—The oil expressed from the seeds of Croton Tiglium.

Characters.—Slightly viscid ; colour brownish-yellow, taste acrid, odour faintly nauseous. Contains *Tiglinic* and *Crotonic Acids*. The seeds are of a dull cinnamon-brown colour, about half an inch long and a quarter of an inch broad, and resemble castor oil seeds, but are rougher, and not marbled on their surface.

Doses, 1 or 2 drops placed on the tongue ; or formed into a pill with crumb of bread ; as an adjunct, $\frac{1}{12}$ of a drop and upwards.

Officinal Preparation.—Linimentum Crotonis.—Liniment of Croton Oil (croton oil, 1 fl. oz. ; oil of cajuput, 3½ fl. oz. ; rectified spirit, 3½ fl. oz.).

Therapeutics.—An intensely irritant, drastic purgative, frequently causing vomiting and nausea ; given in obstinate constipation and cerebral affections, as apoplexy. In very minute quantities it may be used as an ordinary purgative.

Externally the oil gives rise to pustulation ; and is a valuable counter-irritant when diluted with soap liniment or olive-oil.

Adulteration.— Other fixed oils, as castor oil, might be added. These would be difficult to detect.

3.—ROTTLERA TINCTORIA.

Kamala.—KAMALA.—A POWDER which consists of minute glands that cover the capsules of Rottlera Tinctoria. Imported from India.

Characters.—A fine granular mobile powder, of a brick-red colour; it is with difficulty mixed with water, but when boiled with alcohol the greater part is dissolved, forming a red solution. Ether dissolves most of it, the residue consisting principally of tufted hairs. It should be free from sand or earthy impurities. Consists of a resin, *Rottlerin*, with tannic acid, gum and volatile oil.

Dose, 30 grains to ¼ ounce, in thick gruel or honey.

Therapeutics.—A powerful vermifuge; much used in India for the treatment of tapeworm. It generally purges freely.

4.—RICINUS COMMUNIS. THE CASTOR OIL PLANT.

Ricini Oleum.—CASTOR OIL.—The OIL expressed from the seeds of Ricinus Communis. Imported chiefly from Calcutta.

Characters.—Viscid, colourless, or pale straw-yellow, having a slightly nauseous odour and a somewhat acrid taste. Contains three oily acids, *Ricinic*, *Ricin-Oleic*, and *Ricin-Stearic*, united with glycerine. The seeds are about the size of small beans, oval, compressed, obtuse at the ends, shining and smooth on the surface, of a light-ash colour, marbled with veins and dark spots.

Dose, 1 fluid drachm to 1 fluid ounce. It is often given, floating in some fluid, in the form of an emulsion, with some aromatic, or in gelatine or membranous capsules.

Castor oil is used in the preparation of Collodium Flexile, Linimentum Sinapis Compositum, and Pilula Hydrargyri Subchloridi Composita.

Therapeutics.—A quick, but mild purgative, causing little disturbance of the system more than the evacuation of the bowels. Given to delicate persons, and in gastritis, enteritis, dysentery, cystitis.

Adulterations.—Other fixed oils, difficult to detect.

Lauraceæ.

1.—CAMPHORA OFFICINARUM.

Camphora. — CAMPHOR ($C_{10}H_{16}O$).—A CONCRETE VOLATILE OIL obtained from the wood of Camphora Officinarum. Imported in the crude state from China and Japan, and purified by sublimation in this country.

Characters.—White, translucent, tough, and crystalline; has a powerful penetrating odour and a pungent taste, followed by a sensation of cold; floats on water, volatilises slowly at ordinary temperatures; is slightly soluble in water, but readily so in rectified spirit and ether. Sublimes entirely when heated.

When heated with nitric acid, camphor is oxidised to *Camphoric Acid* ($C_{10}H_{16}O_4$), and *Camphoretic Acid* ($C_{10}H_{14}O_7$). When heated in alcohol with caustic potash it is converted into *Camphic Acid* ($HC_{10}H_{15}O_2$), and *Camphol*, or Borneo Camphor ($C_{10}H_{18}O$). *Dose*, 1 to 10 grains.

Officinal Preparations. — AQUA CAMPHORÆ. — Camphor Water (camphor, broken into pieces, ½ oz.; distilled water, 1 cong.). *Dose*, 1 to 2 fluid ounces.

LINIMENTUM CAMPHORÆ.—Liniment of Camphor (camphor, 1 oz.; olive oil, 4 fl. oz.).

Used in Linimenta; Chloroformi; Hydrargyri; Terebinthinæ Aceticum.

LINIMENTUM CAMPHORÆ COMPOSITUM. — Compound Liniment of Camphor (camphor, 2½ oz.; oil of lavender, 1 fl. dr.; strong solution of ammonia, 5 fl. oz.; rectified spirit, 15 fl. oz.).

SPIRITUS CAMPHORÆ.—Spirit of Camphor (camphor, 1 oz.; rectified spirit, 9 fl. oz.).

Dose, 10 to 30 minims suspended in water by means of mucilage.

TINCTURA CAMPHORÆ COMPOSITA.—Compound Tincture of Camphor (opium, in coarse powder, 40 gr.; benzoic acid, 40 gr.; camphor, 30 gr.; oil of anise, ½ fl. dr.; proof spirit, 1 oct.). 1 grain of opium in ½ fluid ounce.

Dose, 15 minims to 1 fluid drachm.

Camphor is contained in Unguentum Hydrargyri Compositum and Unguentum Plumbi Subacetatis Compositum, and in several liniments.

Therapeutics.—Poisonous to the lowest forms of vegetable and animal life; acts like a narcotic poison upon insects and many animals. When applied in substance it is an irritant to mucous membranes and raw surfaces. When camphor is administered in very large doses, *i.e.*, 30—100 grains to the human subject, dangerous symptoms may arise, viz., giddiness, vomiting, coldness of the extremities, muscular debility, feeble pulse, unconsciousness, and even death. Medicinally employed, it is stimulant and antispasmodic. It has apparently some antipyretic influence. It may be given in choleraic diarrhœa and adynamic fevers; in some spasmodic affections, as pertussis, epilepsy and chorea; in hysteria, in chordee; as a calmative in disorders associated with sexual excitement. Externally it is applied as a stimulant to stiff and painful parts.

Adulterations.—Borneo Camphor, from a plant of the order Guttiferæ (Dryobalanops Camphora).

An artificial camphor can be made by passing hydrochloric acid gas through the volatile oil of camphor.

2.—CINNAMOMUM ZEYLANICUM.

Cinnamomi Cortex. — CINNAMON BARK.—The inner BARK of shoots from the truncated stocks of Cinnamomum Zeylanicum. Imported from Ceylon, and distinguished in commerce as Ceylon Cinnamon.

Characters.—About one-fifth of a line thick, in closely-rolled quills, which are about four lines in diameter, containing several small quills within them, light yellowish-brown, with a fragrant odour and warm sweet aromatic taste; breaks with a splintery fracture.

Officinal Preparations. — AQUA CINNAMOMI. — Cinnamon Water (cinnamon bark, bruised, 20 oz.; water, 2 cong. Distil one gallon). *Dose,* 1 to 2 fluid ounces.

PULVIS CINNAMOMI COMPOSITUS. — Compound Powder of Cinnamon (cinnamon bark, in powder, cardamom seeds, in powder, ginger, in powder, of each 1 oz.).

Dose, 3 to 10 grains.

Contained in Pilula Aloes et Ferri and Pilula Cambogiæ Composita.

TINCTURA CINNAMOMI.—Tincture of Cinnamon (cinnamon bark, in coarse powder, 2½ oz.; proof spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Cinnamon bark is also contained in Acidum Sulphuricum Aromaticum, Tinctura Cardamomi Composita, Tinctura Lavandulæ Composita, and other preparations.

Cinnamomi Oleum.—OIL OF CINNAMON.—The OIL distilled from Cinnamon Bark.

Characters.—Yellowish when recent, gradually becoming red, from the formation (by oxidation) of a resinous matter and *Cinnamic Acid* ($HC_9H_7O_2$), having the odour and taste of cinnamon. Sinks in water. Contains *Cinnamyl Hydride.* (C_9H_7OH), and a small quantity of a hydrocarbon ($C_{10}H_{16}$).

Therapeutics.—Stimulant, aromatic and carminative; somewhat astringent; used as an adjunct in diarrhœa.

The oil may be given in flatulence, and as a corrigent to purgatives.

Adulterations.—The bark of Chinese Cinnamon (from Cinnamomum Cassia), known by its greater roughness and thickness, and its less aromatic odour and taste.

3.—NECTANDRA RODIÆI. THE GREENHEART TREE.

Nectandræ Cortex.—BEBEERU BARK.—The BARK of Nectandra Rodiæi. Imported from British Guiana.

Characters.—In large, flat heavy pieces, from one to two feet long, from two to six inches broad, and about a quarter of an inch thick. External colour greyish-brown, internal dark cinnamon-brown. Taste strongly and persistently bitter, with considerable astringency. Contains Tannic Acid and two alkaloids, *Beberia* ($C_{19}H_{21}NO_3$), and *Nectandria* ($C_{20}H_{23}NO_4$).

Officinal Preparation.—BEBERIÆ SULPHAS.—Sulphate of Beberia, $C_{35}H_{40}N_2O_6,H_2SO_4$. The sulphate of an alkaloid prepared from Bebeeru Bark (bebeeru bark, in coarse powder, 1 lb.; sulphuric acid, ½ fl. oz.; slaked lime, ¾ oz. or a sufficiency; solution of ammonia, a sufficiency; rectified spirit, 16 fl. oz. or a sufficiency; diluted sulphuric acid, a sufficiency; water, 1 cong.; distilled water, a sufficiency).

Characters.—In dark-brown, thin translucent scales, yellow when in powder, with a strong bitter taste. Its watery solution gives with caustic soda a *yellowish-white* precipitate of Beberia. *Dose*, 1 to 10 grains.

Therapeutics.—The bark is seldom given. The sulphate of beberia has been used as a substitute for quinine; it somewhat resembles the cinchona alkaloids, and it is stated to be useful in periodic headaches. It may act as a tonic, but is a very imperfect substitute for quinine. Cases of ague, which have yielded rapidly to the action of quinine, have been unaffected by sulphate of beberia in doses large enough to produce gastric disturbance.

4.—SASSAFRAS OFFICINALE.

Sassafras Radix.—SASSAFRAS ROOT.—The dried ROOT of Sassafras Officinale. From North America.

Characters.—In branched pieces, sometimes eight inches in diameter at the crown; bark externally greyish-brown, internally rusty-brown, of an agreeable odour, and a peculiar aromatic warm taste; wood light, porous, greyish-yellow, more feeble in odour and taste than the bark; also in chips.

Contains tannic acid, red colouring matter, and a volatile oil consisting of a hydrocarbon, *Safren* ($C_{10}H_{16}$), sassafras camphor or *Sassafrol* ($C_{10}H_{10}O_2$), and an isomer, *Safrol*.

Sassafras Root is contained in Decoctum Sarsæ Compositum.

Therapeutics.—Diaphoretic and stimulant, seldom given alone; may be used in skin diseases, syphilis and chronic rheumatism. The volatile oil (Oleum Sassafras) may be given in doses of 1 to 5 minims.

Liquidambaraceæ.

LIQUIDAMBAR ORIENTALE.

Styrax Præparatus.—PREPARED STORAX.—A BALSAM obtained from the bark of Liquidambar Orientale. Purified by means of rectified spirit and straining.

Characters.—A semi-transparent brownish-yellow semi-fluid resin, of the consistence of thick honey, with a strong agreeable fragrance and aromatic bland taste; boiled with solution of bichromate of potash and sulphuric acid, it evolves the odour of bitter almonds. Heated in a test-tube in a vapour-bath it becomes more liquid, but gives off no moisture.

Contains a volatile oil, (*Styrol*), *Cinnamic Acid*, *Styracin*, and resin. *Dose*, 5 to 20 grains.

Prepared Storax is contained in Tinctura Benzoini Composita.

Therapeutics.—Stimulant to the mucous membranes, and a stimulating application to ulcers.

Moraceæ.

1.—FICUS CARICA. THE FIG.

Ficus.—FIG.—The dried FRUIT (Syconus) of Ficus Carica. Imported from Smyrna.

Figs contain chiefly saccharine and mucilaginous matters. They are used in preparing Confectio Sennæ.

Dose, ad libitum.

Therapeutics.—Nutritive, laxative, and demulcent.

2.—MORUS NIGRA. THE MULBERRY.

Mori Succus.—MULBERRY JUICE.—The JUICE of the ripe fruit of Morus Nigra.

Characters.—Of a dark violet colour, with a faint odour, and an acidulous sweet taste.

Officinal Preparation.—SYRUPUS MORI.—Syrup of Mulberries (mulberry juice, 1 oct. ; refined sugar, 2 lb. ; rectified spirit, 2½ fl. oz.). *Dose*, 1 fluid drachm.

Therapeutics.—Mulberry juice is given as a refrigerant in fevers. The syrup is frequently used as a colouring agent.

Myristicaceæ.

MYRISTICA OFFICINALIS. THE NUTMEG.

Myristica.—NUTMEG.—The KERNEL of the seed of Myristica Officinalis. Cultivated extensively in the Banda Islands of the Malayan Archipelago.

Characters.—Oval or nearly round, about an inch in length, marked externally with reticulated furrows, internally greyish-red, with dark-brownish veins. It has a strong peculiar odour, and a bitter aromatic taste.

Dose, in powder, 5 to 15 grains.

Nutmeg is an ingredient of Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Spiritus Armoraciæ Compositus, and Tinctura Lavandulæ Composita.

Myristicæ Oleum.—VOLATILE OIL OF NUTMEG.—The OIL distilled in Britain from Nutmeg.

Characters.—Colourless or straw-yellow, having the odour and taste of nutmegs.

Contains an oxygenated oil, *Myristicol*, isomeric with *Carvol*. *Dose*, 1 to 5 minims.

Officinal Preparation. — SPIRITUS MYRISTICÆ. — Spirit of Nutmeg (volatile oil of nutmeg, 1 fl. oz. ; rectified spirit, 49 fl. oz.). *Dose*, ½ to 1 fluid drachm. Contained in Mistura Ferri Composita.

Volatile oil of nutmeg is also contained in Pilula Aloes Socotrinæ, and Spiritus Ammoniæ Aromaticus.

Myristicæ Oleum Expressum.—EXPRESSED OIL OF NUTMEG. —A CONCRETE OIL obtained by means of expression and heat from nutmegs.

Characters.—Of an orange colour, firm consistence, and fragrant odour like that of nutmeg. Commonly known as "Butter of Nutmeg." Contains the volatile oil and fatty acids, amongst them *Myristicin* ($C_{48}H_{86}O_6$), united with Glycerine.

Used in the preparation of Emplastrum Calefaciens and Emplastrum Picis.

Therapeutics.—A gentle aromatic stimulant and carminative. In large doses nutmeg is stated to possess marked narcotic properties, causing drowsiness, even passing into complete insensibility. It is more generally used as a flavouring agent than as a medicine. The expressed oil, when applied externally, acts as a topical stimulant, and has been used in chronic rheumatism.

Piperaceæ.

1.—CUBEBA OFFICINALIS. THE CUBEB PEPPER.

Cubeba.—CUBEBS. —The dried unripe FRUIT of Cubeba Officinalis. Cultivated in Java.

Characters.—The size of black pepper, globular, wrinkled, blackish, supported on a stalk or tail of rather more than its own length; has a warm camphoraceous taste and characteristic odour. Contains a volatile oil ($C_{30}H_{48}$), an inert substance (*Cubebin*), and *Cubebic Acid.*

Dose, in powder, 30 to 120 grains.

Officinal Preparations.—TINCTURA CUBEBÆ.—Tincture of Cubebs (cubebs, in powder, 2½ oz.; rectified spirit, 1 oct.).

Dose, ½ to 2 fluid drachms.

Cubebæ Oleum. — OIL OF CUBEBS. — The OIL distilled in Britain from Cubebs.

Characters.—Colourless or pale greenish-yellow, having the peculiar odour and taste of cubebs.

Therapeutics.—Used for its stimulant action upon the urethral, vesical and other mucous membranes, from the surfaces of which it appears to have the power of arresting morbid discharge. Used in gonorrhœa and obstinate coryza.

2.—ARTANTHE ELONGATA. THE MATICO PLANT.

Maticæ Folia. — MATICO LEAVES. — The dried LEAVES of Artanthe Elongata (Piper Angustifolium). Imported from Peru.

Characters.—From two to eight inches long, veined and tesselated on the upper surface, downy beneath, with an aromatic, slightly astringent, warm taste, and an agreeable aromatic odour. Contains a trace of tannin, a volatile oil, and *Arthantic Acid.*

Dose of the powder, internally, 30 to 60 grains.

Officinal Preparations. — INFUSUM MATICÆ. — Infusion of Matico (matico leaves, cut small, ½ oz.; boiling distilled water, 10 fl. oz.). *Dose*, 1 to 4 fluid ounces.

Therapeutics.—Acts as a powerful styptic when the leaf* or powder is applied to bleeding surfaces, as leech bites. Given internally, it is said to be astringent to the genito-urinary mucous membrane and rectum. Similar in its action to that of cubebs and black pepper.

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* The styptic power is supposed to be due to the mechanical structu of the leaf.

3.—PIPER NIGRUM. BLACK PEPPER

Piper Nigrum.—BLACK PEPPER.—The dried unripe BERRIES of Piper Nigrum. Imported from the East Indies.

Characters.—Small, roundish, wrinkled; tegument brownish-black, containing a greyish-yellow globular seed; odour aromatic; taste pungent and bitterish. When decorticated forms WHITE PEPPER. Contains an *acrid resin*, a volatile oil, and *Piperin* ($C_{17}H_{19}NO_3$), isomeric with Morphia, and decomposed by nitric acid into *Piperic Acid* ($HC_{12}H_9O_4$) and the alkaloid *Piperedia* ($C_5H_{11}N$), or *Amyl Nitride.*

Dose, in powder, 5 to 20 grains.

Officinal Preparation.—CONFECTIO PIPERIS.—Confection of Pepper (black pepper, in fine powder, 2 oz.; caraway fruit, in fine powder, 3 oz.; clarified honey, 15 oz.).

Dose, 60 to 120 grains.

Pepper is also contained in Confectio Opii and Pulvis Opii Compositus.

Therapeutics.—Chiefly used as a condiment. Is a stimulant stomachic, and is valuable in hæmorrhoids and in gonorrhœa, on account of its influence upon the mucous membrane of the rectum and of the urethra. Pepper, or the oil, may be used externally as a rubefacient. The oil has been sometimes topically applied to relaxed sore throats.

Polygonaceæ.

RHEUM OFFICINALE?

Rhei Radix.—RHUBARB ROOT.—The dried ROOT, deprived of the bark, of Rheum Officinale, growing in Western China and Thibet. In this definition is included the Russian, the East Indian or Half-trimmed, and the Dutch-trimmed or Batavian Rhubarbs. Rhubarb is no longer brought overland through Russia, but is imported from Shanghai and Canton.

Characters.—The *Russian*, or so-called *Turkey* Rhubarb, occurs in trapezoidal, irregular-shaped, flat or cylindrical angular pieces, the cortex having been removed by slicing; yellow externally, not turned reddish-brown by boracic acid, showing the absence of turmeric; internally marked with fine waving greyish and reddish lines; finely gritty under the teeth, from the presence of raphides* of insoluble oxalate of lime; taste bitter, faintly astringent and aromatic, tinging the saliva bright yellow; odour peculiar; free from decay, pl

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* Needle-shaped or acicular crystals.

not worm-eaten. The pieces are frequently bored with a hole. The powder is bright buff-yellow.

The *East Indian* variety is not angular, but slightly rounded, with portions of the cortex adhering; externally red and veined, not covered with yellow powder like the preceding variety. It is also denser, less gritty, and the powder is of a redder hue.

The *Batavian* variety is in round or flattened pieces, angular, and drilled with a hole. Its origin is probably the same as the Russian.

Rhubarb contains starch, tannic and gallic acids, oxalate of lime, and an aperient principle now supposed to be *Chrysophanic Acid* ($C_{14}H_8O_4$), and to which the yellow colour is due. This acid also exists in great quantities in "Goa Powder."

Dose of powdered rhubarb, 1 to 5 grains, as a stomachic; 10 to 30 grains as a purgative.

Officinal Preparations.—EXTRACTUM RHEI.—Extract of Rhubarb (rhubarb root, sliced or bruised, 1 lb.; rectified spirit, 10 fl. oz.; distilled water, 5 oct.).

Dose, 5 to 15 grains.

INFUSUM RHEI.—Infusion of Rhubarb (rhubarb root, in thin slices, ¼ oz.; boiling distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

PILULA RHEI COMPOSITA.—Compound Rhubarb Pill (rhubarb root, in powder, 3 oz.; socotrine aloes, in powder, 2¼ oz.; myrrh, in powder, 1½ oz.; hard soap, in powder, 1½ oz.; oil of peppermint, 1½ fl. dr.; treacle, by weight, 4 oz.).

Dose, 5 to 10 grains.

PULVIS RHEI COMPOSITUS.—Compound Powder of Rhubarb (rhubarb root, in powder, 2 oz.; light magnesia, 6 oz.; ginger, in powder, 1 oz.). *Dose*, 20 to 60 grains.

SYRUPUS RHEI. — Syrup of Rhubarb (rhubarb root, in coarse powder, 2 oz.; coriander fruit, in coarse powder, 2 oz.; refined sugar, 24 oz.; rectified spirit, 8 fl. oz.; distilled water, 24 fl. oz.). *Dose*, 1 to 4 fluid drachms.

TINCTURA RHEI.—Tincture of Rhubarb (rhubarb root, in coarse powder, 2 oz.; cardamon seeds, freed from the pericarps, and bruised, ¼ oz.; coriander fruit, bruised, ¼ oz.; saffron, ¼ oz.; proof spirit, 1 oct.).

Dose, 1 to 2 fluid drachms, as a *stomachic;* 4 to 8 fluid drachms, as a *purgative.*

VINUM RHEI.—Wine of Rhubarb (rhubarb root, in coarse powder, 1½ oz.; canella bark, in coarse powder, 60 gr.; sherry, 1 oct.). *Dose*, 1 to 2 drachms.

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Therapeutics.—In small doses a slight aperient astringent and stomachic. The aperient action is generally followed by constipation. It causes no irritation of the alimentary canal. The perspiration, the milk, and the urine become coloured by rhubarb. It may be used in diarrhœa dependent upon irritating matter, which is thus expelled, and the subsequent astringency of the drug is very serviceable. It is also useful in cases of dyspepsia attended by constipation; but when given for habitual constipation, it should be combined with some other laxative. It is often usefully combined with magnesia or soda, especially when given to children, in the treatment of whose complaints it is notably valuable when combined with a mercurial alterative. Externally it has been applied to indolent ulcers.

Adulterations.—Extensively adulterated; inferior varieties, as the English, being substituted for the Russian, etc. Turmeric may be present, which is reddened by boracic acid. In English rhubarb oxalate of lime exists only in small quantities, and starch is generally in excess; the reverse is the case in the Chinese varieties.

Thymelaceæ.

DAPHNE MEZEREUM. DAPHNE LAUREOLA, THE SPURGE LAUREL.

Mezerei Cortex.—MEZEREON BARK.—The dried BARK of Daphne Mezereum or of Daphne Laureola.

Characters.—In strips or quilled pieces of various lengths, tough and pliable, olive-brown on the surface, white within, fibrous; odour faintly nauseous; taste hot and acrid. Contains an acrid resin, a volatile oil, and a crystalline substance, *Daphnin* ($C_{31}H_{34}O_{19}$), which, when boiled with dilute sulphuric acid, yields *Daphnetin* ($C_{19}H_{14}O_9$). Contained in Decoctum Sarsæ Compositum.

Officinal Preparation.—EXTRACTUM MEZEREI ÆTHEREUM.—Ethereal Extract of Mezereon (mezereon bark, cut small, 1 lb.; rectified spirit, 8 oct.; ether, 1 oct.). Contained in Linimentum Sinapis Compositum.

Therapeutics. — A powerful local irritant, and even vesicant. In large doses causes purging and vomiting; in small, it is a diaphoretic and diuretic. Has been used in syphilis, scrofula, chronic rheumatism, and skin diseases. It is seldom given internally in England, except in Decoctum Sarsæ Compositum. Used externally in the Linimentum Sinapis Compositum.

Ulmaceæ.

ULMUS CAMPESTRIS. THE BROAD-LEAVED ELM.

Ulmi Cortex. — ELM BARK. — The dried inner BARK of Ulmus Campestris. From trees indigenous to and cultivated in Britain.

Characters.—A tough brownish-yellow bark, about half a line thick, without smell; taste mucilaginous, slightly bitter and astringent. Its decoction is turned green by perchloride of iron, and precipitates a solution of gelatine; showing the presence of tannic acid.

Officinal Preparation.—DECOCTUM ULMI. — Decoction of Elm Bark (elm bark, cut in small pieces, 2½ oz.; distilled water, 1 oct). *Dose*, 2 to 4 fluid ounces.

Therapeutics.—Demulcent, slightly tonic and astringent; has been used in chronic skin affections, as psoriasis and lepra; is considered by some to be a valuable alterative. The decoction sometimes produces diaphoresis and diuresis.

CLASS II. ENDOGENÆ.

Graminaceæ.

1.—TRITICUM VULGARE. THE COMMON WHEAT.

Amylum.—STARCH ($C_6H_{10}O_5$).—The STARCH procured from the seeds of Triticum Vulgare.

Characters and Tests.—In white columnar masses. Microscopically consists of small transparent granules, with concentric rings surrounding the central hilum. Each granule consists of a thin external albuminous coat, which contains a substance termed Gelatinous Starch or Amiden. When starch is rubbed in a Wedgewood mortar with a little cold distilled water, it is neither acid nor alkaline to test paper, and the filtered liquid does not become blue on the addition of solution of iodine. Mixed with boiling water and cooled, it gives a deep blue colour with iodine. Boiling is necessary, in order that the contents of the granules may swell and burst their envelope. When heated for some time with dilute sulphuric acid, starch is converted first into its soluble isomer, *Dextrine*, and subsequently into *Glucose* (grape-sugar). It is changed by nitric acid into oxalic acid.

Officinal Preparations.—GLYCERINUM AMYLI. — Glycerine of Starch (starch, 1 oz.; glycerine, 8 fl. oz.).

MUCILAGO AMYLI.—Mucilage of Starch (starch, 120 gr.; distilled water, 10 fl. oz). Used in the following Enemata: Aloes; Magnesiæ Sulphatis; Opii; Terebinthinæ. Starch is also contained in Pulvis Tragacanthæ Compositus.

Therapeutics.—A mild nutritive demulcent; used in the form of the mucilage as a vehicle for enemata; combined with glycerine, it is useful as a sheathing in cases of chilblains and roughness of the skin.

Farina Tritici.—WHEATEN FLOUR.—The grain of wheat, Triticum Vulgare, ground and sifted. Consists of *starch* and *gluten*, together with gum, sugar, mucilage and water, and small quantities of phosphates of soda, lime and magnesia. If kneaded under a stream of water, the *starch* is washed away and the *gluten* is left as a tenacious, adhesive, greyish-white mass. Gluten thus prepared consists of *vegetable albumen,* insoluble in alcohol, and *vegetable fibrine,* soluble in alcohol. Contained in Cataplasma Fermenti.

Mica Panis.—CRUMB OF BREAD.—The soft part of bread made with wheaten flour. Contained in Cataplasma Carbonis.

Therapeutics.—Flour is used chiefly in the form of bread-crumbs for giving consistency to pills; it is also employed as a cataplasma.

2.—HORDEUM DISTICHON.

Hordeum Decorticatum.— PEARL BARLEY. — The husked SEEDS of Hordeum Distichon. Cultivated in Britain.

Characters. — White, rounded, retaining a trace of the longitudinal furrow. Consists of the seeds decorticated and rounded in a mill. Contains gluten, starch, gum and saccharine matters.

Officinal Preparation.—DECOCTUM HORDEI.—Decoction of Barley (pearl barley, 2 oz.; distilled water, 1½ oct.).

Dose, ad libitum.

Therapeutics.—The decoction is a mild nutritive and demulcent drink.

3.—SECALE CEREALE; THE COMMON RYE. SECALE CORNUTUM; THE SPURRED RYE.

Ergota.—ERGOT.—The sclerotium (compact mycelium or spawn), of a fungus, the Claviceps Purpurea, produced within the paleæ of the Secale Cereale. (Secale Cornutum).

Characters. — Subtriangular grains, curved, with a longitudinal furrow on the concave side, obtuse at the ends; from one-third of an inch to an inch and a half in length; of a violet-brown colour on the surface, pinkish within, solid, frangible, fracture short, colour faintly marked, but strong if the powder be triturated with solution of potash. The grains somewhat resemble the spur of a cock, hence the name "Spurred Rye."

Contains two bases, *Ergotine* and *Ecboline*, united with *Ergotic Acid*. The activity of the drug has been lately ascribed to *Sclerotic* or *Sclerotinic Acid*. Ergot also contains a fluid fixed oil, starch, gum, sugar and resin. It is liable to be fed upon by a species of acarus, which sometimes destroys the whole interior. *Dose, in powder*, 20 to 30 grains.

Officinal Preparations.—EXTRACTUM ERGOTÆ LIQUIDUM.—Liquid Extract of Ergot (ergot, in coarse powder, 1 lb.; ether, 1 oct., or a sufficiency; distilled water, 3½ oct.; rectified spirit, 8 fl. oz.). *Dose*, 10 to 30 minims.

INFUSUM ERGOTÆ.—Infusion of Ergot (ergot, in coarse powder, ¼ oz.; boiling distilled water, 10 fl. oz.).

Dose, 1 to 2 fluid ounces.

TINCTURA ERGOTÆ.—Tincture of Ergot (ergot, in coarse powder, 5 oz.; proof spirit, 1 oct.).

Dose, 10 minims to 1 fluid drachm.

Therapeutics.—It has been shown by experiments that ergot contracts the minute arteries by acting upon their muscular walls, and consequently increases the systemic blood-pressure. This action upon the arterioles is not prevented by previous division of the vaso-motor nerves. Injected into the jugular vein, it contracts the pulmonary arterioles, and thus suddenly diminishes the blood-pressure in the systemic arteries. Ergot acts in a peculiar manner upon the uterus, causing powerful contractions, especially when the patient is pregnant. If taken in small quantities for some length of time, as in bread made from ergotised grain, a species of gangrene, similar to senile gangrene, is produced; this effect is probably due to obstruction of the vessels by diminution of their calibre. Large doses may produce nausea, vomiting, delirium, and even death.

Ergot is usually employed to cause contraction of the uterus during labour, the contractions so produced differing from the natural ones in being continuous, and not alternating with relaxation. It is very valuable in menorrhagia, leucorrhœa, and in cases of amenorrhœa, dependent rather upon torpor of the uterus than upon anæmia. It is also useful in hæmorrhage after delivery. Lastly, ergot is an important remedy for arresting hæmorrhage from whatever cause produced, and it has been given in many other diseases, as in paraplegia.

4.—SACCHARUM OFFICINARUM. CANE SUGAR.

Saccharum Purificatum. — REFINED SUGAR ($C_{12}H_{22}O_{11}$).—Pure CANE SUGAR (Sucrose) prepared from the juice of the stem of Saccharum Officinarum. From plants cultivated in the West Indies and other tropical countries.

Characters.—Compact, crystalline, conical loaves, known in commerce as lump sugar. Is soluble in half its weight of cold water; much more soluble in hot water, forming a viscid syrup. The aqueous solution deviates the plane of polarisation to the right hand. When crystallised from a strong solution, oblique four-sided prisms of "sugar-candy" are formed. Heated to 365° Fahr., cane sugar melts, and, after sudden cooling, solidifies to "barley-sugar," an amorphous transparent substance.

Prolonged boiling converts Sucrose into Levulose (uncrystallisable fruit sugar); if the boiling be continued it is transformed into Glucose (grape sugar), $C_6H_{12}O_6$. Weak acids and fermentation effect a similar change. The following table shows the differences between Cane and Grape Sugar:

Cane SUCROSE. Sugar	GLUCOSE. = Grape-sugar
(1.) Charred by cold sulphuric acid.	(1.) Not charred by cold sulphuric acid.
(2.) Does not reduce an alkaline solution of a cupric salt.	(2.) Reduces an alkaline solution of a cupric salt.
(3.) Is not altered in colour by boiling with liquor potassæ.	(3.) Produces a brown coloration when boiled with liquor potassæ.
(4.) Less soluble in water.	(4.) More soluble in water.
(5.) Crystallises in 4-sided or 6-sided rhombic prisms.	(5.) Crystallises in square tables or cubes.

The sugars are termed carbo-hydrates, since they contain hydrogen and oxygen in the proportions to form water; the number of carbon atoms is six, or some multiple of this number. Starch, gum, and cellulose are also carbo-hydrates.

Officinal Preparation.—SYRUPUS.—Syrup (refined sugar, 5 lb.; distilled water, 2 oct.). *Dose,* ad libitum.

Used in forming the other syrups of the Pharmacopœia, and numerous other preparations.

Therapeutics.—Demulcent; useful, from its sweet taste, to disguise remedies the flavour of which is unpleasant.

Adulterations.—May contain sulphate of lime, and also lead in minute quantities. These may be harmless when sugar is employed medicinally, but not so when the substance is used in considerable quantities daily for domestic purposes.

Theriaca.—TREACLE.—The uncrystallised residue of the refining of sugar.

Characters.—A thick, brown, fermentable syrup, very sweet ; not crystallising by rest or evaporation. Fermentable with yeast, yielding rum by distillation.

Tests.—Nearly free from empyreumatic odour or flavour. Treacle is used in the preparation of the following Pilulæ : Assafœtidæ Composita ; Conii Composita ; Ipecacuanhæ cum Scilla ; Rhei Composita ; Scillæ Composita.

Therapeutics.—A slight laxative in doses of a teaspoonful and upwards ; often given in combination with sulphur.

Iridaceæ.

CROCUS SATIVUS.

Crocus.—SAFFRON.—The dried STIGMA and part of the STYLE of Crocus Sativus. Imported from Spain, France and Italy.

Characters.—Thread-like styles, each terminated by three long orange-brown stigmas, broadest at the summit ; has a powerful aromatic odour. Rubbed on the wet finger, it leaves an intense orange-yellow tint. When pressed between the folds of white filtering paper it leaves no oily stain. The colouring matter is due to *Polychroit* yielding, by decomposition, a volatile oil, and *Crocin*, a red colour, turned *blue* by sulphuric acid, *green* by nitric acid. "Hay Saffron" is the name given to the finest saffron dried loosely ; the inferior kind, "Cake Saffron," is dried under pressure.

Dose (dried), from 20 grains and upwards.

Officinal Preparation. — TINCTURA CROCI. — Tincture of Saffron (saffron, 1 oz. ; proof spirit, 1 oct.).

Dose, ½ drachm to 2 drachms.

Saffron is also contained in Decoctum Aloes Compositum, Pilula Aloes et Myrrhæ, Pulvis Cretæ Aromaticus, Tinctura Cinchonæ Composita, Tinctura Opii Ammoniata, and Tinctura Rhei.

Therapeutics. — Has a very slight stimulant action ; is chiefly used as a colouring agent.

Adulterations.—Safflower and marigold petals, and saffron petals are often present.

The safflower petals ground together constitute the so-called "Cake Saffron."

B.E.P.E.P.
S.PEPPET.D.M.

Liliaceæ.

1.—ALOE VULGARIS. ALOE —— ?

1. **Aloe Barbadensis.**—BARBADOES ALOES.—The INSPISSATED JUICE of the leaf of Aloe Vulgaris. Imported from Barbadoes.

Characters.—In yellowish-brown or dark-brown opaque masses; breaks with a dull conchoidal fracture; has a bitter nauseous taste, and a strong disagreeable odour; powder of a dull olive-green colour, more soluble than the socotrine variety; usually imported in gourds. *Dose,* 2 to 6 grains.

Officinal Preparations.—ENEMA ALOES.—Enema of Aloes (Barbadoes aloes, 40 gr.; carbonate of potash, 15 gr.; mucilage of starch, 10 fl. oz.).

EXTRACTUM ALOES BARBADENSIS.—Extract of Barbadoes Aloes (Barbadoes aloes, in small fragments, 1 lb.; boiling distilled water, 1 cong.). *Dose,* 2 to 6 grains.

PILULA ALOES BARBADENSIS.—Pill of Barbadoes Aloes (Barbadoes aloes, in powder, 2 oz.; hard soap, in powder, 1 oz.; oil of caraway, 1 fl. dr.; confection of roses, 1 oz.). *Dose,* 5 to 10 grains.

PILULA ALOES ET FERRI.—Pill of Aloes and Iron (sulphate of iron, 1½ oz.; Barbadoes aloes, in powder, 2 oz.; compound powder of cinnamon, 3 oz.; confection of roses, 4 oz.). *Dose,* 5 to 10 grains.

Barbadoes Aloes is also contained in Pilula Cambogiæ Composita; Pilula Colocynthidis Composita; and Pilula Colocynthidis et Hyoscyami.

2.—**Aloe Socotrina.**—SOCOTRINE ALOES.—The INSPISSATED JUICE of the leaf of one or more undetermined species of Aloe. Produced chiefly in Socotra, and shipped to Europe by way of Bombay.

Characters.—In reddish-brown masses, opaque, or translucent at the edges; breaks with an irregular or smooth and resinous fracture; has a bitter taste, and a strong, but fragrant, odour. *Dose,* 2 to 6 grains.

Officinal Preparations.—DECOCTUM ALOES COMPOSITUM.—Compound Decoction of Aloes (extract of socotrine aloes, 120 gr.; myrrh, 90 gr.; saffron, 90 gr.; carbonate of potash, 60 gr.; extract of liquorice, 1 oz.; compound tincture of cardamoms, 8 fl. oz.; distilled water, a sufficiency). *Dose,* ½ to 2 fluid ounces.

ENEMA ALOES.—Enema of Aloes (socotrine aloes, 40 gr.; carbonate of potash, 15 gr.; mucilage of starch, 10 fl. oz.).

EXTRACTUM ALOES SOCOTRINÆ.—Extract of Socotrine

Aloes (socotrine aloes, in small fragments, 1 lb.; boiling distilled water, 1 cong.). *Dose*, 2 to 6 grains.

Also contained in Extractum Colocynthidis Compositum.

PILULA ALOES ET ASSAFŒTIDÆ.—Pill of Aloes and Assafœtida (socotrine aloes, in powder, assafœtida, hard soap, confection of roses, of each, 1 oz.). *Dose*, 5 to 10 grains.

PILULA ALOES ET MYRRHÆ.—Pill of Aloes and Myrrha (socotrine aloes, 2 oz.; myrrh, 1 oz.; saffron, dried, ½ oz.; confection of roses, 2½ oz.). *Dose*, 5 to 10 grains.

PILULA ALOES SOCOTRINÆ.—Pill of Socotrine Aloes (socotrine aloes, in powder, 2 oz.; hard soap, in powder, 1 oz.; volatile oil of nutmeg, 1 fl. dr.; confection of roses, 1 oz.). *Dose*, 5 to 10 grains.

TINCTURA ALOES.—Tincture of Aloes (socotrine aloes, in coarse powder, ½ oz.; extract of liquorice, 1½ oz.; proof spirit, a sufficiency). *Dose*, 1 to 2 fluid drachms.

VINUM ALOES.—Wine of Aloes (socotrine aloes, 1½ oz.; cardamon seeds, freed from the pericarps, and bruised, 80 gr.; ginger, in coarse powder, 80 gr.; sherry, 2 oct.). *Dose*, 1 to 2 fluid drachms.

Socotrine Aloes is also contained in Pilula Rhei Composita, and Tinctura Benzoini Composita.

Both varieties of Aloes dissolve almost entirely in proof spirit, and during solution exhibit, under the microscope, numerous minute crystals. They both yield an active purgative principle, *Aloin* ($C_{34}H_{36}O_{14}H_2O$); also *Aloetic Acid*, striking olive-brown with persalts of iron. When aloes is acted upon by nitric acid, *Polychromic, Chrysammic,* and *Chrysolepic Acids* are formed.

Therapeutics.—Purgative, chiefly acting upon the lower part of the intestinal canal. The action of aloes is slow, and the secretions of the tube are but little increased. It is frequently emmenagogue. When small doses are given, tonic and stomachic effects are apparently induced upon the upper part of the canal. The preparations of aloes are employed in habitual constipation; they seldom produce subsequent confinement of the bowels. They may be given in chronic dyspepsia, in combination with stomachics and tonics, and they are often used as adjuncts to other purgatives, as scammony, colocynth and rhubarb. Aloes, combined with myrrh and iron, is constantly prescribed in amenorrhœa, connected with anæmia and defective action of the pelvic organs. The drug should be avoided when there is much tendency to hæmorrhoids, or when the abdominal organs are in a state of inflammation.

There is apparently but little difference between the action of Barbadoes and Socotrine aloes. Some physicians, however, consider that the extract of Barbadoes aloes is more efficacious than an equivalent quantity of the Socotrine.

Aloes frequently causes griping, especially when given alone.

2.—URGINEA SCILLA.

Scilla.—SQUILL.—The sliced and dried BULB of Urginea Scilla. From the Mediterranean coasts.

Characters.—Bulb pear-shaped, weighing from half a pound to ten pounds; outer scales membranous, brownish-red or white; inner scales thick, whitish, fleshy, juicy; taste mucilaginous, intensely and disagreeably bitter, somewhat acrid. The dried slices are white or yellowish-white, slightly translucent, scentless, disagreeably bitter, brittle and easily pulverisable if very dry, but, if exposed, readily recovering moisture and flexibility.

Contains an *acrid resin* and a very bitter principle, *Scillitin*, together with a trace of tannin and phosphate of lime. An aqueous infusion of squill is turned to deep purple by the ferric salts. *Dose, in powder*, 1 to 3 grains.

Officinal Preparations. — ACETUM SCILLÆ. — Vinegar of Squill (squill, bruised, 2½ oz.; diluted acetic acid, 1 oct.; proof spirit, 1½ fl. oz.). *Dose*, 15 to 40 minims.

OXYMEL SCILLÆ.—Oxymel of Squill (vinegar of squill, 1 oct.; clarified honey, 2 lb.). *Dose*, ½ to 1 fluid drachm.

PILULA SCILLÆ COMPOSITA.—Compound Squill Pill (squill, in powder, 1¼ oz.; ginger, in powder, ammoniacum, in powder, hard soap, in powder, of each 1 oz.; treacle, by weight, 2 oz., or a sufficiency.

SYRUPUS SCILLÆ.—Syrup of Squill (vinegar of squill, 1 oct.; refined sugar, 2½ lb.). *Dose*, ½ to 1 fluid drachm.

TINCTURA SCILLÆ.—Tincture of Squill (squill, bruised, 2½ oz.; proof spirit, 1 oct.). *Dose*, 10 to 30 minims.

Powdered squill is also contained in Pilula Ipecacuanhæ cum Scillâ.

Therapeutics.—In small doses squill acts as a stimulant, expectorant and diuretic; in larger doses it may produce vomiting and purging. It increases the secretion of the mucous membrane of the bronchi, and arrests the expectoration of mucus when viscid and abundant. It is contra-indicated in cases of an active inflammatory nature on account of its acrid and stimulating properties. As an expectorant, squill is often combined with ammoniacum and ipecacuanha.

O/sat.

Melanthaceæ.

1.—COLCHICUM AUTUMNALE. THE MEADOW SAFFRON.

1. **Colchici Cormus.**—The fresh CORM of Colchicum Autumnale; collected about the end of June; and the same, stripped of its coats, sliced transversely, and dried at a temperature not exceeding 150° Fahr.

Characters.—Fresh corm about the size of a chestnut, flattened where it has an undeveloped bud; furnished with an outer brown and an inner yellow coat; internally white, solid and fleshy; yielding, when cut, a milky acrid and bitter juice. Dried slices, about a line thick, moderately indented on one, rarely on both sides, firm, flat, whitish, amylaceous.

Dose, in powder, 2 to 8 grains.

Officinal Preparations.—EXTRACTUM COLCHICI.—Extract of Colchicum (from fresh colchicum corms, deprived of their coats, 7 lb.). *Dose*, $\frac{1}{2}$ grain to 2 grains.

EXTRACTUM COLCHICI ACETICUM.—Acetic Extract of Colchicum (fresh colchicum corms, deprived of their coats, 7 lb.; acetic acid, 6 fl. oz.). *Dose*, $\frac{1}{2}$ grain to 2 grains.

VINUM COLCHICI.—Wine of Colchicum (colchicum corm, sliced, dried, and bruised, 4 oz.; sherry, 1 oct.).

Dose, 10 to 30 minims.

Colchici Semina.—COLCHICUM SEEDS.—The fully ripe SEEDS of Colchicum Autumnale.

Characters.—About the size of white mustard seed, very hard, and of a reddish-brown colour.

Both the seeds and the corm contain gum, starch, fatty matter, *Cevadic Acid*, and a crystalline principle, *Colchicine*. This last substance was at one time said to be identical with veratria, but it does not excite sneezing. It is turned *deep violet* by nitric acid.

Officinal Preparation.—TINCTURA COLCHICI SEMINUM.—Tincture of Colchicum Seeds (colchicum seeds, bruised, $2\frac{1}{2}$ oz.; proof spirit, 1 oct.). *Dose*, 10 to 30 minims.

Therapeutics.—In medicinal doses, colchicum increases the action of some of the secreting organs; the fæces become more coloured, and the bile is apparently thrown out in larger quantities. The urine is also sometimes increased in quantity. The action of the heart is diminished, and in some persons the pulse becomes intermittent. Vomiting, purging, with intense prostration, may ensue from the exhibition of large doses.

Colchicum is regarded almost as a specific in acute attacks of gout, and it is extensively employed in all forms of this malady. It often affords relief in rheumatism and other inflammatory affections, probably from its especial controlling power over the heart's action, rather than from any specific effect. It is employed with advantage as a cholagogue, combined with other purgatives ; and it may be often substituted for mercurials.

2.—ASAGRÆA OFFICINALIS.

Sabadilla. — CEVADILLA.— The dried FRUIT of Asagræa Officinalis. Imported from Mexico.

Characters.—Fruit about half an inch long, consisting of three light-brown papyraceous follicles, each containing from one to three seeds, which are about a quarter of an inch long, blackish-brown, shining, slightly winged, possessing an intensely acrid bitter taste. Contains two acids, *Veratric* and *Cevadic*, and an active principle,

Veratria. — VERATRIA ($C_{32}H_{52}N_2O_8$). — An ALKALOID obtained from Cevadilla ; not quite pure. May be obtained thus : cevadilla, 2 lb. ; distilled water, rectified spirit, solution of ammonia, hydrochloric acid, of each a sufficiency ; purified animal charcoal, 60 gr.

Characters and Tests. — Pale-grey, amorphous, without smell, but, even in the most minute quantity, powerfully irritating the nostrils ; strongly and persistently bitter, and highly acrid ; insoluble in water, soluble in spirit, in ether, and in diluted acids, leaving traces of an insoluble brown resinous matter. Heated with access of air, it melts into a yellow liquid, and at length burns away, leaving no residue. An active poison. With nitric acid it forms a yellow solution, and with sulphuric acid acquires an *intense red* colour.

Dose, $\frac{1}{12}$ grain to $\frac{1}{6}$ grain. Must be used with great care if given internally.

Officinal Preparation. — UNGUENTUM VERATRIÆ. — Ointment of Veratria (veratria, 8 gr. ; prepared lard, 1 oz. ; olive oil, $\frac{1}{2}$ fl. dr.).

Therapeutics.—In contact with the nasal passages, veratria excites violent sneezing. Placed on the unbroken skin it causes a sensation of heat and pricking. Taken internally it produces diarrhœa, nausea and vomiting, and formication in the extremities ; the pulse becomes slow, weak, and at length irregular ; the temperature becomes lower, and muscular weakness, twitching, convulsions, collapse and death may ensue. Veratria exercises a peculiar action upon the heart : at first there is a transient quickening, said by Bezold to be due to stimulation of the motor ganglia ; then follows a retardation, from the vagi becoming influenced. The tetanoid spasms which are immediately produced by veratria upon the voluntary muscles are not arrested by severing the connection of the muscles with the spinal cord, as is the case with the spasms resulting from poisoning by strychnia. Medicinally, veratria has been used to reduce the temperature and pulse in acute sthenic febrile affections, as lobar pneumonia and erysipelas; it has also been given in gout and rheumatism. Externally the ointment has relieved pain in neuralgia and rheumatism of various kinds.

3.—VERATRUM VIRIDE. THE GREEN HELLEBORE.

Veratri Viridis Radix.—GREEN HELLEBORE ROOT.—The dried RHIZOME of Veratrum Viride. Collected in autumn in the United States and Canada.

Characters.—Thick and fleshy, giving off numerous pale-yellow radicles, which are marked with indentations; has a peculiar acrid taste, and produces a sensation of tingling about the fauces. Contains two alkaloids, *Viridia* and *Veratroidea*, the former soluble, the latter insoluble, in ether.

Dose, in powder, 1 to 3 grains or more.

Officinal Preparation. — TINCTURA VERATRI VIRIDIS.—Tincture of Green Hellebore (green hellebore root, in coarse powder, 4 oz.; rectified spirit, 1 oct.). *Dose*, 5 to 20 minims.

Therapeutics.—Said to be valuable in controlling the vascular system in inflammatory diseases, and especially in gout, rheumatic fever, and allied affections. Characteristic symptoms of its action are depression and slowness of the pulse. Experiments appear to show that *Viridia* is slightly, if at all, a topical irritant; it causes neither purging nor vomiting. *Veratroidea*, however, causes both these symptoms, and has a somewhat irritant local action. Neither of the alkaloids affects the brain.

Palmaceæ.

ARECA CATECHU. THE BETEL-NUT TREE.

Areca.—ARECA NUT.—The SEED of Areca Catechu. Imported from the East Indies.

Characters. — The seeds resemble horse chestnuts; are rusty-grey in colour, very hard, with a tesselated surface and well-marked hilum. When split open, the albumen is seen to be ruminated; the cut surface resembles that of a nutmeg.

Contains *Catechu-tannic* and *Gallic Acids*, together with gum, oily matter, and *Areca-red*, a reddish-brown substance, soluble in boiling water and alkaline liquids, and yielding oxalic acid when boiled with nitric acid.

Dose, in powder, 15 to 30 grains as an astringent; ½ to ¾ ounce as an anthelmintic.

Therapeutics. — Areca nut, mixed with quick-lime and Chavica leaves, forms Betel, the masticatory of the East. It is said to render the breath fragrant, to strengthen the gums and teeth; to act as a preservative against dysentery, and to possess certain narcotic and stimulant properties. It is certainly astringent, like kino and catechu, and may be employed as an anthelmintic to expel the tape-worm.

Smilaceæ.

SMILAX OFFICINALIS. SARSAPARILLA.

Sarsæ Radix.—JAMAICA SARSAPARILLA.—The dried ROOT of Smilax Officinalis. Native of Central America, imported from Jamaica.

Characters.—Roots not thicker than a goose-quill, generally many feet in length, reddish-brown, covered with rootlets, and folded in bundles about eighteen inches long, scentless; taste mucilaginous, feebly bitter, faintly acrid. Contains a volatile oil, together with a bitter crystallisable principle, *Sarsaparillin*, *Smilacin*, or *Parillinic Acid*, turning red with sulphuric acid.

Officinal Preparations. —DECOCTUM SARSÆ.—Decoction of Sarsaparilla (Jamaica sarsaparilla, cut transversely, 2½ oz.; boiling distilled water, 1½ oct.). *Dose*, 2 to 10 fluid ounces.

DECOCTUM SARSÆ COMPOSITUM.—Compound Decoction of Sarsaparilla (Jamaica sarsaparilla, cut transversely, 2½ oz.; sassafras root, in chips, guaiacum-wood turnings, fresh liquorice-root, bruised, of each ¼ oz.; mezereon bark, 60 gr.; boiling distilled water, 1½ oct.). *Dose*, 2 to 10 fluid ounces.

EXTRACTUM SARSÆ LIQUIDUM.—Liquid Extract of Sarsaparilla (Jamaica sarsaparilla, cut transversely, 1 lb.; distilled water, at 160° Fah., 14 oct.; rectified spirit, 1 fl. oz.).

Dose, 2 to 4 fluid drachms.

Therapeutics.—Supposed to be diaphoretic, diuretic, tonic, and alterative. It is largely used in the treatment of constitutional syphilis; but as it is usually given in combination with powerful remedies, it is a question how much influence the drug itself has really exercised.

Adulterations.—Inferior kinds of sarsaparilla; sometimes it is mixed with other substances, as Dulcamara, detected by their different structure.

Zingiberaceæ.

1.—ELETTARIA CARDAMOMUM. THE MALABAR CARDAMOM.

Cardamomum.—CARDAMOMS.—The dried CAPSULES of Elettaria Cardamomum. Cultivated in Malabar. The seeds are best kept in their pericarps, from which they should be separated when required for use, the pericarpial coats being rejected.

Characters.—Seeds obtusely angular, corrugated, reddish-brown, internally white, with a warm, aromatic, agreeable taste and odour, contained in ovate-oblong, triangular, pale-brown coriaceous ribbed pericarps. Yield a volatile oil, having the taste and odour of the seeds, and consisting of a liquid portion and a crystalline camphor isomeric with turpentine camphor ($C_{10}H_{16},3H_2O$). They also contain a fixed oil and an acrid resin. *Dose, in powder*, 5 to 20 grains.

Officinal Preparation.—TINCTURA CARDAMOMI COMPOSITA. —Compound Tincture of Cardamoms (cardamom seeds, freed from the pericarps and bruised, ¼ oz. ; caraway fruit, bruised, ¼ oz. ; raisins, freed from their seeds, 2 oz. ; cinnamon bark, bruised, ½ oz. ; cochineal, in powder, 60 gr. ; proof spirit, 1 oct.). *Dose,* ½ to 2 fluid drachms.

Contained in Decoctum Aloes Compositum, Mistura Ferri Aromatica, Mistura Sennæ Composita, and Tinctura Chloroformi Composita.

Cardamom is also contained in Extractum Colocynthidis Compositum, Pulvis Cinnamomi Compositus, Pulvis Cretæ Aromaticus, Tinctura Gentianæ Composita, Tinctura Rhei, and Vinum Aloes.

Therapeutics.—An agreeable aromatic stimulant, stomachic and carminative ; used as a condiment in the East. It is chiefly given as an adjunct to purgatives and other medicines, to prevent griping.

2.—CURCUMA LONGA. TURMERIC.

Curcuma.—TURMERIC.—The RHIZOME of Curcuma Longa.

Characters.—In short pieces, externally yellow, internally deep orange, having a peculiar odour. Contains a yellow colouring principle, *Curcumin*, turned deep reddish-brown by alkalies, but unaltered in tint by any acids except boracic acid.

Officinal Preparations.—TURMERIC PAPER.—Unsized white paper steeped in turmeric and dried by exposure to the air.

Turmeric Tincture.—(Turmeric, bruised, 1 oz.; rectified spirit, 6 fl. oz.).

Uses.—Not used as a remedy; is taken as a condiment in the form of curry powder, of which it is an ingredient. It is introduced into the British Pharmacopœia as a test for alkaline solutions, in contact with which its colour is changed to reddish-brown.

3.—ZINGIBER OFFICINALE. THE GINGER.

Zingiber.—Ginger.—The scraped and dried RHIZOME of Zingiber Officinale. From plants cultivated in the West Indies, India and other countries.

Characters.—Irregular lobed, decorticated pieces, three or four inches long, sub-compressed, yellowish-white, but not chalky on the surface, with a short mealy fracture, hot taste, and agreeable aroma. Powder yellowish-white.

Contains a *volatile oil* (C_5H_8), upon which its pungency depends, resinous matters and a large quantity of starch.

Dose, in powder, 10 to 20 grains and upwards.

Officinal Preparations. — Syrupus Zingiberis.—Syrup of Ginger (strong tincture of ginger, 6 fl. dr.; syrup, 19 fl. oz.).

Dose, 1 fluid drachm.

Tinctura Zingiberis.—Tincture of Ginger (ginger, in coarse powder, 2½ oz.; rectified spirit, 1 oct.).

Dose, 15 minims to 1 fluid drachm.

Tinctura Zingiberis Fortior.—Strong Tincture of Ginger (ginger, in fine powder, 10 oz.; rectified spirit, a sufficiency).

Dose, 5 to 20 minims.

Ginger forms an ingredient of many other officinal preparations.

Therapeutics. —An aromatic stimulant and carminative. Taken internally, produces an agreeable sensation of warmth at the epigastrium; it appears to assist digestion by giving a healthy tone to the stomach. Ginger is employed in dyspepsia, especially when accompanied by much flatulence, and as an adjunct to purgatives to prevent griping. It acts as a sialogogue when chewed, and may be used in relaxation of the tonsils and uvula.

CLASS III. ACOTYLEDONES.

Lichenes.

1.—CETRARIA ISLANDICA.

Cetraria.—Iceland Moss.—The entire lichen Cetraria Islandica. Native of the North of Europe.

Characters.—Foliaceous, lobed, crisp, cartilaginous, brownish-white, paler beneath; taste bitter and mucilaginous. A strong decoction gelatinises on cooling; the gelatinous matter is termed *Lichenin* or *Lichen-Starch* ($C_{12}H_{20}O_{10}$).

Cetraria also contains *Licheno-Stearic Acid* ($C_{14}H_{34}O_3$), *Fumaric Acid*, a little sugar, and a bitter crystallisable principle, *Cetraric Acid* ($C_{18}H_{16}O_8$).

Officinal Preparations.—Decoctum Cetrariæ.—Decoction of Iceland Moss (Iceland moss, 1 oz.; distilled water, 1 oct.). *Dose*, 1 to 2 fluid ounces.

Therapeutics.—The decoction is demulcent and slightly tonic.

2.—ROCCELLA TINCTORIA (?).

Lacmus.—Litmus.—A blue pigment prepared from various species of Roccella; occurs in small cakes, made up of a granular powder. The lichen is macerated for some time in water rendered alkaline by potash and lime, and mixed with urine; fermentation takes place, the mass becoming red and then blue; it is then removed, and reduced by sand and lime, etc., to a proper consistence. Has an odour of violets.

The blue colouring matter is due to *Orcein* ($C_7H_7NO_3$).

Officinal Preparations.—Tincture of Litmus.—(Litmus, in powder, 1 oz.; proof spirit, 10 fl. oz.). Diluted with water, it may be used as a test for the presence of acids.

Blue Litmus Paper.—Unsized white paper steeped in tincture of litmus and dried by exposure to the air. Used as a test for acids, or any acid liquid, by which the blue colour is changed to red.

Red Litmus Paper.—Unsized white paper steeped in tincture of litmus which has been previously reddened by the addition of a very minute quantity of sulphuric acid and dried by exposure to the air.

Red Litmus Paper indicates the presence of any substance having an alkaline reaction, which restores to the paper its original blue colour.

Filices.

ASPIDIUM FILIX MAS. THE MALE FERN.

Filix Mas.—MALE FERN.—The dried RHIZOME, with the bases of the foot-stalks and portions of the root fibres of Aspidium Filix Mas. Collected in summer.

Characters. — Tufted, scaly, greenish-brown; powder greenish-yellow, with a disagreeable odour, and a nauseous bitter, somewhat astringent taste.

Contains tannin, starch, a resin, a volatile oil, and a fixed green oil.

Ether dissolves the active principle, and the ethereal extract deposits a crystalline colourless substance, *Filicic Acid.* The green liquid portion contains *Glyceride of Filixolyn*, yielding, by saponification, *Filosmylic* and *Filoxylic Acids.*

Dose, in powder, 60 to 180 grains.

Officinal Preparation.—EXTRACTUM FILICIS LIQUIDUM.—Liquid Extract of Male Fern (male fern, in coarse powder, 2 lb.; ether, 4 oct., or a sufficiency). *Dose*, 15 to 30 minims.

Therapeutics.—Used as an anthelmintic, especially in the treatment of the tape-worm. It acts apparently by destroying the worm, and thus assisting its expulsion. It should be given during fasting, and followed after an interval by a mild purgative. The liquid extract is perhaps the most valuable anthelmintic known.

ANIMAL KINGDOM.

CLASS. MAMMALIA.

Cetacea.

PHYSETER MACROCEPHALUS. THE SPERM WHALE.

Cetaceum.—SPERMACETI.—Nearly pure Cetine, mixed with oil, from the head of Physeter Macrocephalus, inhabiting the Pacific and Indian Oceans. It is separated from the oil by filtration and pressure, and afterwards purified.

Characters and Tests.—Crystalline, pearly-white, glistening, translucent, with little taste or odour, reducible to powder by the addition of a little rectified spirit. Scarcely unctuous to the touch; does not melt under 100° Fahr.

Cetine, or *Palmitate of Cetyl* ($C_{16}H_{33},C_{16}H_{31}O_2$), yields, when saponified, *Hydrate of Cetyl*, or *Ethal* ($C_{16}H_{33}HO$).

Officinal Preparation. — UNGUENTUM CETACEI.—Ointment of Spermaceti (spermaceti, 5 oz.; white wax, 2 oz.; almond oil, 1 oct., or a sufficiency).

Spermaceti is also used in the preparation of Charta Epispastica.

Therapeutics.—An emollient application.

Pachydermata.

SUS SCROFA. THE HOG.

Adeps Præparatus.—PREPARED LARD.—The purified FAT of Sus Scrofa (the internal fat of the abdomen of the hog, perfectly fresh, 14 lb.).

The lard is purified by removing the peritoneum, thoroughly washing the broken-up masses of fat with a stream of running water, to dissolve and carry away any soluble matters, then straining and liquefying at a heat not exceeding 212°Fahr., in order to avoid decomposition, and again straining through flannel.

Characters and Tests.—A soft, white, fatty substance, melting at about 100° Fahr. Has no rancid odour; dissolves entirely in ether. Consists of a mixture of Stearin and Olein.

Officinal Preparations. — UNGUENTUM SIMPLEX.—Simple Ointment (white wax, 2 oz.; prepared lard, 3 oz.; almond oil, 3 fl. oz.). Lard is also used for preparing other unguenta.

Adeps Benzoatus. — BENZOATED LARD. — (Prepared lard, 1 lb.; benzoin, reduced to coarse powder, 160 gr.). Contained in Suppositoria: Acidi Tannici; Hydrargyri; Morphiæ; Plumbi Composita; and Unguenta: Gallæ; Plumbi Acetatis; Sulphuris and Zinci.

Therapeutics. — Emollient; sometimes added to poultices to prevent them becoming hard and dry.

Rodentia.

CASTOR FIBER. THE BEAVER.

Castoreum. — CASTOR. — The dried PREPUTIAL FOLLICLES and their SECRETION, obtained from Castor Fiber, and separated from the somewhat shorter and smaller oil-sacs which are frequently attached to them. From the Hudson's Bay Territory.

Characters.—Follicles in pairs, about three inches long, fig-shaped, firm, and heavy, brown or greyish-black; containing a dry, resinous reddish-brown or brown highly odorous secretion, *Castorine*, in great part soluble in rectified spirit, and in ether.

Castor also contains a volatile oil, *Uric, Phosphoric* and *Benzoic Acids,* combined with potash, lime, and soda; also carbonate of ammonia, *Carbolic Acid* and *Salicine.*

Dose, 5 to 10 grains.

Officinal Preparation.—TINCTURA CASTOREI.—Tincture of Castor (castor, in coarse powder, 1 oz.; rectified spirit, 1 oct.).

Dose, ½ to 1 fluid drachm.

Therapeutics. — Stimulant and antispasmodic; used in epilepsy and hysteria, and to rouse the system in cases of an adynamic type, as in typhoid pneumonia.

Ruminantia.

1.—BOS TAURUS. THE OX.

Fel Bovinum Purificatum.—PURIFIED OX BILE.—The purified GALL of Bos Taurus (fresh ox bile, 1 oct.; rectified spirit, 2 oct.). The bile and spirit are mixed by agitation in a bottle, and set aside until the sediment subsides. The clear solution is decanted, and evaporated in a porcelain dish by the heat of a water bath until it acquires a suitable consistence for forming pills.

Characters and Tests.—A yellowish-green substance, having a taste partly sweet and partly bitter; soluble in water and in spirit. A solution of one or two grains of it in about a fluid drachm of water, when treated, first with a drop of freshly made syrup consisting of one part of sugar and four of water, and then with sulphuric acid cautiously added until the precipitate at first formed is redissolved, gradually acquires a cherry-red colour, which changes in succession to carmine, purple, and violet.

This change of colour is produced by the liberation of cholic acid.

Bile consists chiefly of a fatty crystalline substance, *Cholesterine* ($C_{26}H_{44}O$), a base, *Choline,* and two peculiar acids, *Glycocholic* ($C_{26}H_{43}NO_6$), and *Taurocholic Acids* ($C_{26}H_{45}NSO_7$).

The principal colouring matter of the bile is *Bilirubin* ($C_{16}H_{18}N_2O_3$); by oxidation this substance yields *Biliverdin* ($C_{16}H_{20}N_2O_5$); a third pigment has been described, viz., *Bilifuscin* ($C_{10}H_{20}N_2O_4$).

The presence of these pigments may be shown by the addition of nitric acid, or some other oxidising agent, as tincture of iodine; bilirubin is then transformed to biliverdin, exhibiting a *green* colour, which eventually passes through *blue, violet, red,* and lastly *yellow.*

Dose, 5 to 10 grains or more, given in small gelatine capsules or formed into pills.

Therapeutics. — In ordinary medicinal doses dried bile appears to act as a slight laxative to the alimentary canal. It is said to be cholagogue, and is given in dyspepsia, especially when vomiting occurs after food. Its value as a remedy demands further investigation.

Lac.—MILK.—The fresh milk of the cow, Bos Taurus. Consists of caseine, fat or butter, milk-sugar, various salts (chiefly phosphates and chlorides), and water. About 12 per cent of solid matter, and at least 10 per cent of cream, should be afforded by good milk.

Casein is the nitrogenous constituent, and from it milk derives its chief nutritive property. This substance is coagulated by acetic acid, forming "Curds;" a similar effect is produced by other acids and rennet. "Whey" is the residue of milk from which the cream has been removed by standing, and the caseine by coagulation. Milk is used in the preparation of Mistura Scammonii.

Lactis Saccharum.—SUGAR OF MILK, $C_{12}H_{24}O_{12}$.—A CRYSTALLISED SUGAR (Lactose) obtained from the whey of milk by evaporation.

Characters.—Usually in cylindrical masses, two inches in diameter, with a cord or stick in the axis, or in fragments of cakes; greyish-white, crystalline on the surface, and in its texture, translucent, hard, scentless, faintly sweet, gritty when chewed. Slowly soluble in 6 parts of cold water, only slightly soluble in alcohol, and insoluble in ether. When boiled with diluted acid, grape-sugar yields *Galactose;* if left for some time in contact with yeast, it undergoes alcoholic fermentation; it also reduces cuprous oxide from an alkaline solution. Used in making Pulvis Elaterii Compositus.

Dose, ad libitum.

Therapeutics.—May be used for rubbing up powerful medicinal powders, as calomel, bismuth, hydrochlorate of morphia, etc. Milk-sugar, added to cow's milk, diluted with water, may be used as a substitute for the milk of the human female. It is less irritating to the mucous membranes than cane sugar, and might on that account be advantageously substituted for that last-named substance in the diet of infants.

2.—MOSCHUS MOSCHIFERUS. THE MUSK DEER.

Moschus.—MUSK.—The inspissated and dried SECRETION from the PREPUTIAL FOLLICLES of Moschus Moschiferus; native of the mountainous regions of Central Asia. Imported from China and India.

Characters.—In irregular, reddish-black, rather unctuous grains; having a strong, peculiar, very diffusible odour, and a bitter aromatic taste; contained in a round or slightly oval membranous sac, about two inches in diameter, covered on the outer side with stiff greyish hairs, arranged in a concentric manner around its central orifice. The peculiar odorous principle has not yet been isolated. *Dose*, 5 to 10 grains.

Therapeutics.—Stimulant and antispasmodic; it resembles castoreum in its action, and is suitable for the same class of cases.

Adulteration.—The drug is very high in price. The sac in which the musk is contained is consequently often emptied and filled with a mixture of dried blood, with more or less of true musk, and the sac carefully closed again. Sacs are sometimes made from the skin or scrotum of the animal, and filled with a mixture of sand, musk and dried blood.

3.—PEPSINA.

Pepsina.—PEPSINE.—A preparation of the mucous lining of a fresh and healthy stomach of the pig, sheep, or calf.

Characters and Tests.—A light yellowish-brown powder, having a faint, but not disagreeable, odour, and a slightly saline taste, without any indication of putrescence; very little soluble in water or spirit. Two grains of it with an ounce of distilled water, to which five minims of hydrochloric acid have been added, form a mixture in which 100 grains of hard-boiled white of egg, in thin shavings, will dissolve on their being digested together for about four hours at a temperature of 98° Fahr. *Dose*, 2 to 5 grains.

Therapeutics.—Stated to be a valuable remedy in dyspepsia. Has proved more efficacious when combined with diluted hydrochloric acid, since in the presence of peptones its action is reduced, and is renewed by adding more diluted acid. In combination with iron, pepsin may expedite recovery in cases of extreme anæmia, where the functions of the stomach have become deranged. Pepsin, with diluted acid, has been successfully employed in the treatment of spasmodic asthma.

Pepsin would appear to be especially serviceable in old persons who suffer from vomiting or regurgitations after each meal, and in whom the distressing symptoms apparently arise from simple debility of the stomach.

A few grains of the substance may be mixed with the food.

4.—OVIS ARIES. THE SHEEP.

Sevum Præparatum.—PREPARED SUET.—The INTERNAL FAT of the abdomen of Ovis Aries, purified by melting and straining.

Characters.—White, smooth, almost scentless; fusible at 103° Fahr. Composed almost exclusively of *Stearin*, with a little *Olein* and *Palmitin.* Used in preparing Emplastrum Cantharidis and Unguentum Hydrargyri.

Therapeutics.—Emollient, and used in preparing ointments and plasters; occasionally added to poultices.

CLASS. AVES (BIRDS).

Rasores (Gallinæ).

GALLUS BANCKIVA (DOMESTICUS). THE COMMON FOWL.

Ovi Albumen.—EGG ALBUMEN.—The LIQUID WHITE of the egg of Gallus Banckiva.

Characters.—Coagulated by ether, corrosive sublimate, and other metallic salts, by nitric, sulphuric, tannic, and hydrochloric acids, and by a temperature above 180° Fahr.; not precipitated by acetic acid, as is the case with caseine.

Ovi Vitellus.—YOLK OF EGG.—The YOLK of the egg of Gallus Banckiva.

Characters.—Consists of an albuminous principle, *Vitellin*, with olein, margarine, cholesterine, salts of lime, iron, and a yellow oil containing phosphoric acid. Used in preparing Spiritus Vini Gallici.

Therapeutics.—Used as an antidote in corrosive sublimate and sulphate of copper poisoning, forming in each case an inert albuminate of the metal. By dissolving alum in white of egg an astringent application may be formed. The albumen coagulates and is applied locally in this form. The yolk forms a nutritious light article of diet, and is useful in the form of egg-flip in cases of exhaustion, when solid food cannot be taken.

CLASS. PISCES (FISHES).

Teleostei (Anacanthini).

1.—ACIPENSER. THE STURGEON.

Isinglass.—ISINGLASS.—The SWIMMING BLADDER or sound of various species of Acipenser, prepared, cut into fine shreds and dried.

Characters.—A gelatinous tissue, which, when boiled, yields gelatine, a substance soluble in hot water, and forming a jelly on cooling; precipitated by tannic acid, but not by gallic acid. Tanno-gelatine forms the basis of leather, and is produced by the union of tannic acid with gelatine.

Officinal Preparation.—SOLUTION OF GELATINE.—(Isinglass, in shreds, 50 gr.; warm distilled water, 5 fl. oz.). Used to distinguish tannic from gallic acid, and to detect tannic acid in Decoctum Ulmi, with which it should give a precipitate.

2.—GADUS MORRHUA. THE COD.

Oleum Morrhuæ.—COD-LIVER OIL.—The OIL extracted from the fresh liver of Gadus Morrhua by the application of a heat not exceeding 180° Fahr.

Characters and Tests.—Pale-yellow, with a slight fishy odour, and bland fishy taste. A drop of sulphuric acid added to a few drops of the oil on a porcelain slab develops a violet colour, which soon passes to a yellowish or brownish-red. This test shows that the oil is obtained from the liver, but does not prove that it came from the codfish, since any liver-oil would give the same reaction, in consequence of the contained bile.

Contains glycerine, oleic, margaric, butyric and acetic acids, with a substance termed *Gaduin;* some quantities of iodine, with traces of bromine, chlorine, phosphorus, and salts are also present. *Dose*, 1 to 8 fluid drachms.

Therapeutics.—The exact manner in which cod-liver oil acts is as yet undetermined. Patients who have become emaciated from any cause, and whose blood is impoverished, frequently put on flesh under its exhibition; in some cases it appears to improve the richness of the blood. It often increases the weight, the increase exceeding many times the quantity of oil consumed. It has proved very serviceable in the treatment of phthisis, scrofula, and low forms of rheumatic and other inflammation. It is probable that it merely acts as an *oil*, but is superior to other oils on account of its more ready assimilation. Cod-liver oil is largely used in the treatment of phthisis and scrofula, in chronic rheumatism and neuralgia, in chronic skin diseases, and in cachectic conditions generally. It is sometimes rubbed into the surface with the idea of obtaining its constitutional effects.

CLASS. INSECTA.

Coleoptera.

CANTHARIS VESICATORIA. THE SPANISH FLY.

Cantharis. — CANTHARIDES. — Cantharis Vesicatoria. The BEETLE, dried; collected chiefly in Hungary.

Characters and Tests.—From eight to ten lines long, furnished with two wing-covers (elytræ) of a shining metallic-green colour, under which are two membranous transparent wings; odour strong and disagreeable; powder greyish-brown, containing shining green particles. Free from mites. The insects swarm upon trees about May and June, and are collected by shaking the branches and catching them in sheets. They are then thrown into boiling vinegar and afterwards dried. Contain fatty principles and oil, yellow and green colouring matters, and an active principle, *Cantharidine.*

Officinal Preparations. — ACETUM CANTHARIDIS.—Vinegar of Cantharides (cantharides, in powder, 2 oz.; glacial acetic acid, 2 fl. oz.; acetic acid, 18 fl. oz., or a sufficiency).

CHARTA EPISPASTICA.—Blistering Paper (white wax, 4 oz.; spermaceti, 1½ oz.; olive oil, 2 fl. oz.; resin, ¾ oz.; canada balsam, ¼ oz.; cantharides, in powder, 1 oz.; distilled water, 6 fl. oz.).

EMPLASTRUM CALEFACIENS.—Warm Plaster (cantharides, in coarse powder, expressed oil of nutmeg, yellow wax, resin, of each 4 oz.; soap plaster, 3¼ lb.; resin plaster, 2 lb.; boiling water, 1 oct.).

EMPLASTRUM CANTHARIDIS.— Cantharides Plaster (cantharides, in powder, 12 oz.; yellow wax, 7½ oz.; prepared suet, 7½ oz.; prepared lard, 6 oz.; resin, 3 oz.).

LIQUOR EPISPASTICUS.—Blistering Liquid (cantharides, in powder, 8 oz.; acetic acid, 4 fl. oz.; ether, a sufficiency).

TINCTURA CANTHARIDIS.—Tincture of Cantharides (cantharides, in coarse powder, ¼ oz.; proof spirit, 1 oct.).

Dose, 5 to 20 minims.

UNGUENTUM CANTHARIDIS. — Ointment of Cantharides (cantharides, 1 oz.; yellow wax, 1 oz.; olive oil, 6 fl. oz.).

Therapeutics.—Externally applied, a rubefacient and irritant: if the preparation be strong, producing vesication; the active principle sometimes becomes absorbed, and symptoms resulting from its internal administration ensue. Internally, in medicinal doses, the first symptom is diuresis, and the urine, upon examination, shows a trace of albumen; under the microscope a few blood discs may appear; further effects are strangury and hæmaturia, priapism, sometimes aphrodisiac effects, diminution and suppression of urine, and finally convulsions and death. The drug is supposed to influence the spinal cord. Externally the preparations of cantharides are more generally employed than any other vesicating agents. They are applied in pleurisy, pneumonia, pericarditis, and other internal inflammations, after the subsidence of the more urgent febrile symptoms; also to painful and diseased joints. Vesication is employed in congestion of the head; and over non-inflammatory painful parts, as in neuralgic affections; finally, in diseased conditions of the skin itself. Internally, the tincture may be given in affections of the spinal cord, as in chronic forms of paraplegia, and incontinence of urine from atony of the bladder; also in hydrocephalus and non-inflammatory forms of albuminuria; in skin affections, especially the squameæ: it has been occasionally employed in gleet and other mucous discharges.

Conditions in which the preparations of Cantharides must be omitted or used with caution.

1. Acute inflammation of the kidneys, since the cantharidine may become absorbed.
2. In young and very weak subjects vesication may be followed by sloughing, and prove dangerous.
3. In children, even when healthy, much caution must be observed in employing cantharides liniments to large surfaces; severe hæmaturia has resulted, and lasted for several days, from the application of the Liquor Epispasticus to the scalp in the treatment of ringworm.

Adulterations.—The "Golden Beetle" has been mixed with cantharides; and to increase the weight, artificial glass beads or tubes, coloured in imitation of the fly, have been added.

Hemiptera.

COCCUS CACTI. THE FEMALE COCHINEAL INSECT.

Coccus. — COCHINEAL. — The dried female insect, Coccus Cacti. Reared in Mexico and Teneriffe.

Characters.—Ovate, plano-convex, about two lines long, wrinkled, black or greyish-white; yields, when crushed, a puce-coloured powder. The greyish-white insect quickly becomes black when warmed before the fire. The colouring matter is due to *Carmine* or *Carminic acid* ($C_{14}H_{14}O_8$), which occurs as small purple-red grains, insoluble in ether, but soluble in water and in alcohol.

Officinal Preparation. — TINCTURA COCCI. — Tincture of Cochineal (cochineal, in powder, 2½ oz. ; proof spirit, 1 oct.). *Dose,* 30 minims to 1½ fluid drachms.

Cochineal, in powder, is also contained in Tinctura Cardamomi Composita and Tinctura Cinchonæ Composita.

Therapeutics.—Formerly much esteemed in the treatment of whooping cough. It is chiefly employed as a colouring agent, and is much used in the arts as a dye.

Adulterations.—Inferior cochineal is sometimes covered with bone-black to give it a black colour ; at other times it is covered with some white powder, as talc, carbonate of lead, or sulphate of baryta, in order to resemble the finer variety.

Hymenoptera.

APIS MELLIFICA. THE HIVE BEE.

Cera Alba.—WHITE WAX.—Yellow Wax, bleached by exposure to moisture, air, and light.

Characters.—Hard, nearly white, translucent. Not unctuous to the touch ; does not melt under 150° Fahr.

Officinal Preparation. — UNGUENTUM SIMPLEX. — Simple Ointment (white wax, 2 oz. ; prepared lard, 3 oz. ; almond oil, 3 fl. oz.).

White wax is also contained in Charta Epispastica ; Suppositoria: Acidi Tannici ; Hydrargyri ; Morphiæ ; Plumbi Composita ; and in Unguenta : Cetacei ; and Plumbi Subacetatis Compositum.

Cera Flava.—YELLOW WAX. — The prepared HONEY-COMB of Apis Mellifica.

Characters. — Firm, breaking with a granular fracture, yellowish, having an agreeable honey-like odour. Not unctuous to the touch ; does not melt under 140° Fahr. Entirely soluble in oil of turpentine.

Yellow wax is contained in Emplastra : Calefaciens ; Cantharidis ; Cerati Saponis ; Galbani ; Picis ; and in Unguenta : Cantharidis ; Hydrargyri Compositum ; Hydrargyri Oxidi Rubri ; Picis Liquidæ ; Resinæ ; Sabinæ ; Terebinthinæ.

Bees' Wax consists of *Cerotin* or *Cerotic Acid* ($HC_{27}H_{53}O_2$), soluble in boiling alcohol, *Myricin* or *Palmitate of Melissyl* ($C_{30}H_{61},2C_{16}H_{31}O_2$), insoluble in boiling alcohol, but deposited on cooling ; and *Cerolein,* a substance to which the tenacity, odour, and colour of the wax are due.

Mel.—HONEY. — A SACCHARINE CONCRETION deposited in the honey-comb by Apis Mellifica.

Characters and Tests.—When recently separated from the honey-comb, it is a viscid translucent liquid, of a brownish-yellow colour, which gradually becomes partially crystalline and opaque. It has a peculiar heavy odour, and a very sweet taste. Should contain no starch. Consists of three kinds of sugar, viz., Sucrose, Glucose, and Levulose, mixed with odorous, colouring, gummy, and waxy matters and water.

Dose, ad libitum.

Officinal Preparations.—MEL DEPURATUM.—Clarified Honey (honey, 5 lb., melted in a water-bath, and strained while hot through flannel, previously moistened with warm water).

Contained in Confectiones: Piperis; Scammonii; Terebinthinæ, and in

MEL BORACIS.—(Borax, in fine powder, 64 gr.; clarified honey, 1 oz.).

OXYMEL.—Oxymel (clarified honey, 40 oz.; acetic acid, 5 fl. oz.; distilled water, 5 fl. oz.).

Dose, 1 to 2 fluid drachms.

Contained also in Oxymel Scillæ.

Therapeutics.—Much the same as sugar in its action, but more laxative; usually employed as a vehicle for other medicines.

CLASS. ANNELIDA.

Hirudinea.

1.—SANGUISUGA MEDICINALIS. THE SPECKLED LEECH.

2.—SANGUISUGA OFFICINALIS. THE GREEN LEECH.

Hirudo.—THE LEECH.—Leeches are collected in Spain, France, Italy, and Hungary.

Characters.—Body elongated, two or three inches long, tapering to each end, plano-convex, wrinkled transversely; back olive-green, with six rusty-red longitudinal stripes.

The belly of the Speckled Leech is of a greenish-yellow colour, spotted with black; that of the Green Leech is olive-green, and not spotted.

Therapeutics.—Used for the local abstraction of blood when cupping is not considered advisable. A leech usually draws about one fluid drachm of blood. Care must be taken to prevent leeches entering the mouth, rectum, or uterus. Should a leech pass into the stomach, a dangerous result may be averted by injections of salt and water. Bleeding from leech bites may be arrested by pressure, by matico, or by the application of caustic or collodion. A suture is sometimes required.

FINIS OF PART II.

ADDENDA.

* HUMULUS LUPULUS.
Extractum Lupuli.
Infusum Lupuli.
Tinctura Lupuli.

Nat. Ord. † LOBELIACEÆ.

LOBELIA.
Tinctura Lobeliæ.
,, ,, *Ætherea.*

Therapeutics of GUM ACACIA (page 55).—A simple demulcent, used to relieve irritation of the mucous membranes, as of the fauces, pharynx, stomach, bladder and urethra ; it is also much employed for suspending some metallic powders, as oxide of zinc and subnitrate of bismuth, when administered in a liquid form.

Therapeutics of KOUSSO (page 59).—An anthelmintic, but it is doubtful whether it is superior to other remedies of the same class. Its cathartic power is very slight. It appears to destroy the worm, but requires a subsequent purgative to expel it. It is chiefly employed when the presence of the tapeworm is suspected. It frequently causes nausea and even vomiting.

Therapeutics of the CHERRY LAUREL (page 59).—The same as of diluted hydrocyanic or prussic acid.‡ The strength of the cherry laurel water (Aqua Laurocerasi) is very variable, and on this account its use is objectionable ; some physicians consider it an elegant method of administering hydrocyanic acid.

Urine which has been coloured *yellow* by the internal administration of Santonin (page 85), is changed to a *bright crimson* on the addition of liquor potassæ.

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* This substance belongs to the Nat. Ord. Cannabinaceæ, and should immediately follow Cannabis Indica (page xiii).

† This Natural Order should immediately precede the order Loganiaceæ (page xi).

‡ Part I.

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