The examinational directory ; or, student's guide to pass and competitive examinations on the basis of the system of the University of London / by a graduate in first-class honours of the University [Rev. H. Killick].

THE LONDON EXAMINATIONAL DIRECTORY

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OR,

STUDENT'S GUIDE

TO PASS AND COMPETITIVE EXAMINATIONS

ON

THE BASIS OF THE SYSTEM OF THE UNIVERSITY OF LONDON.

BY

A GRADUATE IN FIRST-CLASS HONOURS OF THE UNIVERSITY.

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INTRODUCTION.

It is a common saying that "there is no royal road to learning," and this is true enough in the sense that ultimately it is only by individual effort that our intellectual acquirements can be made our own; but it is not true if it be understood to mean that there is not a vast difference in the difficulty of diverse modes of doing this. A not inconsiderable experience has convinced the compiler of this work that failure in examination is quite as frequently, at least in the higher examinations, the result of mistaken *method*, as of deficient capacity or want of application. This view is borne out, too, by the published statistics of the London University; at the second B.A. examination of the last three years we find that the average of failures exceeds one-half that of the total number of candidates, and when, with this somewhat remarkable fact, we take into consideration the circumstance that all of these have

already succeeded in passing two tolerably strict examinations, no other conclusion seems possible.

The main design then of this small handbook is to point out the course of reading and the method of study best adapted to secure a competent knowledge of the subjects of which it treats, with a special reference to the requirements of those who purpose presenting themselves for examination at the London University. Its object is not to *teach* the different subjects, but to point out, as clearly and concisely as we are able, what we believe to be the *best methods of learning* them. Without too close adherence to any particular plan, we have aimed at producing a compendium which shall be really useful to the candidate, and in addition therefore to the general consideration of the several branches of the examination syllabus, various special points have been more or less fully discussed, some on account of their intrinsic utility, and some with the view of assisting the student to a clear comprehension of the subject, while our principal design has been throughout to select such specialities as afford *the best exemplifications* of the methods which may most advantageously be employed. It may possibly appear to advanced students, that certain portions of the book might be omitted as

unnecessarily elementary; but we have constantly endeavoured to keep in view the requirements of that large and increasing class of private students, who, being unable to command the advantages of direct oral instruction, are compelled to rely mainly on their own resources.

A few observations, which apply more or less to the entire series of examinations, may perhaps be most appropriately introduced here, and we leave them to the consideration of the reader, with such modifications as his experience or special circumstances may suggest. In the programme for each examination it will be noticed that certain subjects are *permanent*, while others are *varied* from time to time. In the majority of cases it will be found advantageous to dispose first of the permanent portions of the syllabus for each examination, and afterwards take up the special requirements of the year. Amongst other reasons for this, it is sufficient to remind the candidate that if for any reason he decides to defer presenting himself, his labour is not so far lost. We believe, also, that generally speaking, at least for most students, it is by far the best plan to concentrate attention upon a single subject at a time, till it is pretty well mastered, rather than to devote successive short periods to

different subjects; with many minds there is a disinclination to *commence* anything new, and time and mental inertia are lost—just as in a reciprocating motion in a machine—in reverting to a fresh subject of study. We would not, however, insist too strongly on this point; each individual must determine for himself the practice which he finds most beneficial.

There is some art in what may be designated the management of an examination paper. Many men reduce the value of their work by a want of coolness and deliberation, which are as valuable here as under most other trying circumstances. Without tolerable self-possession answers are often imperfectly or confusedly given, or questions are misunderstood (an exceedingly common occurrence), or even overlooked altogether. We would in general recommend the candidate to commence by a *careful* and deliberate perusal of the entire paper; and except he finds himself able to deal satisfactorily with the whole, or nearly the whole, to begin with these questions which he can quickly or certainly answer, and having disposed of these, to afterwards take up any which seem likely to cause greater difficulty or occupy a longer time. It is hardly, perhaps, necessary to insist upon legibility

of the writing and distinct numbering, and separation of the answers; but if the candidate reflect upon the extra difficulty thrown upon the examiners (who often have to inspect some hundreds of papers in a few days), by neglect in these respects, and that anything which cannot be read is necessarily at once passed over, and is lost to him, he will not, perhaps, consider the reminder superfluous. Moreover, it should never be forgotten that at London a competent knowledge of *all* the subjects of examination is absolutely essential; a deficiency in one respect cannot be supplemented by unusual excellence in some other,—to fail in one single subject is to fail totally. The design of the pass examination is to secure a certain moderate and *uniform* standard of knowledge—uniform, at least, in so far as not to descend below a certain minimum; and we doubt not that failure is often the result of undue attention to some, perhaps favourite, subject of study, to the comparative neglect of other equally essential parts of the examination.

Since the London examiners are usually men of eminence in their several departments, it very commonly happens that they are the authors of works of repute in the subjects in which they

examine. Candidates should not forget to ascertain from time to time the existence of such books, which, other things being equal, it would generally be advisable to use. They should also keep a careful eye upon the examination papers, as they are published in successive years, to detect any intimations of a change in the style or range of the questions in any of the branches.

It is not impossible but that some may *prima facie* conclude that this book belongs to a class to which attaches a large amount of prejudice—(often very respectable certainly, but commonly unusually unreflecting)—the books which teach by inculcation of methods of "cramming." We speak of "cramming," because it is a well understood and expressive word, for which it is impossible to find any good substitute. That there *may* be such a process we do not deny; indeed, it is indisputable—(how far the present work is open to the charge of promoting and recommending superficial and unsatisfactory methods of study, the author leaves entirely to the judgment of his readers)—but there is no question but that its frequency and importance have been ridiculously and indeed injuriously overrated; and most of those who are continually warning their readers or pupils against it, would be puzzled to define exactly

what they mean. A few words on the subject, inasmuch as it really involves a discussion of methods of study in general, may not be out of place here. It must be remembered that a student reading for examination must *somehow* get up his subjects to the requisite point, and the question at issue simply is as to the mode in which this is to be done. Now, independently of passing the examination, the ends of study are twofold—first, the acquisition of a certain amount of positive knowledge; and secondly, the improvement of the mind as an instrument of acquisition. Now it requires no discussion to show that the former end is best answered by the easiest and quickest methods of acquisition; and as regards the second, rapidity and facility being signs of perfection, are *pro tanto* more likely to afford good mental training than more laborious processes. In fact, cramming, *i.e.*, the mere exercise of the memory in "getting up" a subject, without aiming to obtain a full mental grasp of it, is now reduced to very small and unimportant limits—such as the looking up of a few historical dates, or a few chemical figures, just previous to examination, to be forgotten almost as soon as it is over. The good old-fashioned days when the "coach" or the "grinder," was accustomed to

instruct his pupils to give such and such an answer if Mr A. asks the question, while some other reply was registered to satisfy Mr B., have gone by; and though there is now a constant tendency to more and more simplify and facilitate the acquisition of knowledge, we believe this to be wholly to the student's advantage, and that the horror with which some of the old school look upon "analyses," translations, and manuals, to be altogether a mistake. The one requisite is, that the student should thoroughly understand and grasp his subject; and if his "analysis" enable him to do as much of this in an hour as he would have done in a day without it, it is evidently so much clear gain; while as regards subjects which are and must ever be mere matters of memory, dates, arbitrary numbers, &c., such aids are often simply invaluable. This much the author thought necessary to premise by way of explanation on this point, as numerous recommendations based upon these principles will be found scattered through this work.

It only remains to remark, in conclusion, that we have not considered it necessary to refer specially to the course of reading for the various honours. Those who are sufficiently advanced to be prepared to carry the study of special subjects

to a high point will necessarily have arrived at a system of their own, and will not need the kind of assistance which it is the design of this manual to supply.

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MATRICULATION.

The main design of this examination is to test the acquirements of the candidate in those branches of study which are commonly recognised as essential elements in a good general education; it is intended to prove the possession of that amount of miscellaneous knowledge which is not only in itself an evidence of a certain amount of general capacity, but is moreover presumed to be necessary to enable the student to pursue higher and more special studies with any real advantage or success. Its range of subjects is therefore somewhat extensive, while the standard in each is not higher than is necessary to secure these ends. It is thus, as it were, the portal of the University, through which all must pass who wish to be enrolled in the body of its graduates, or to obtain any of the honours or more substantial rewards which the University has to offer. It is, moreover, recognised as one amongst the preliminary examinations

which, by recent regulations, it is necessary for a student to pass before he can commence either a legal or medical education; and indeed, as regards those who intend to pursue law or medicine as a profession, it offers special advantages,—in the former, in the reduction of the period of articles to four years to those who pass not lower than the first division; and to the student of medicine it throws open all the advantages which the deservedly unrivalled reputation of the medical degrees of the University brings with it. Though it is unquestionable that the older universities, in instituting "middle-class examinations," have conferred an immense benefit upon the public by raising the standard of instruction in middle-class schools, and in affording a ready and tolerably satisfactory means of discriminating between the good and the bad amongst them, yet the advantage which *those who pass such examinations* derive from them is mainly indirect; they are not what all examinations of this kind ought to be, a step to something beyond —they end in themselves, and open no path to higher honours or rewards. We cannot omit suggesting to those who have to decide such matters—if in any case the choice between the alternatives lies open—that these considerations should determine in favour of matriculating, notwithstanding the somewhat greater difficulties to be overcome.

With reference to the special details of preparation, it appears to be the simplest plan to take the various subjects *seriatim*, as given in the examina-

tion programme; and though under this arrangement certain of them will come under notice more than once, yet we shall endeavour to avoid repetition as much as possible.

ARITHMETIC AND ALGEBRA.

The required *Arithmetic* includes the ordinary rules, vulgar and decimal fractions, with extraction of the square root; the *Algebra*, the ordinary simple rules, proportion, the progressions and simple equations. Together they form the subject of a single paper, which usually commences with the arithmetical questions, of which the manipulation of fractions forms an important part; the remainder of the arithmetic generally consisting of one or two examples in interest, discount, or rule of three, the multiplication or division of decimals, and extraction of the square root. The only points which seem to call for special remark are—

The rationale of the ordinary operations of multiplication and division. These will be found in any modern arithmetic, and will cause no difficulty, particularly if the student bear in mind the principle upon which numeration proceeds, so as to be able to separate a number into its principal constituents. Thus 1868 is equal to $1000 + 800 + 60 + 8$.

The mode of performing division where decimals are concerned. The following process will be found upon the whole the easiest:—Get rid of the decimal values by multiplying both divisor and dividend by

the same power of 10; the proper multiplier being easily found by inspection, for it will evidently consist of 1, followed by as many cyphers as there are decimal figures in that number of the two which does not contain the least number of decimals. This process will not of course alter the value of the quotient, since both divisor and dividend are multiplied by the same quantity. All that need be remembered is to place the decimal point in the quotient *simultaneously* with the annexation of the first cypher, which it is necessary to add on to the dividend in order to carry on the dividing process. An example will make this clear:

Divide ·00013 by ·002.

Getting rid of the decimals by multiplying both by 100,000, we have to divide 13 by 200:

```
200)13000(·065
    1200
    ----
    1000
    1000
    ====
```

In this case it is necessary to commence the operation by annexing a cypher to the dividend, and hence we place simultaneously the decimal point in the quotient.

In pointing for extraction of square root take this universal rule: Place the first line over the decimal point (either where it actually is or would be), and divide into periods of two figures *from this line*, in both directions, thus—

2'81'45' '28'·14'50' '·28'14'5.

It will be found much better to use lines, as here indicated, than the ordinary dots, which leave the period doubtful; and observe caution in pointing correctly, especially where decimals are concerned.

We may just observe that the definition of a decimal may be most accurately worded thus: A decimal is a mode of expressing numerical quantities less than unity, by extending to the right of the unit's place the ordinary principle of numeration, viz. the principle of local values.

In the *Algebraical Simplifications*, some examples of which are always given, the student should bear in mind the ordinary criteria of the divisibility of $x^u + y^u$ or $x^u - y^u$ by $x+y$ or $x-y$ (see Colenso's "Algebra"). If upon inspection no common factor can be detected, or no obvious mode of simplification, the processes indicated by the algebraical symbols should be performed, when the reduction will often become at once obvious. It is particularly, however, in questions of this kind that a certain "knack," derivable from what may be termed algebraical experience, is valuable, and no general principles can be laid down to ensure the solution of these questions in every case. We may, however, notice an easy method of factorising expressions of the form x^2+Ax+B, where A and B are whole numbers, positive or negative. Resolve B into all possible pairs of factors, and then examine whether the sum or difference of the members of any one of these pairs will give A; if so, by adjusting the signs, we can

generally resolve the expression. Thus, to resolve $x^2-7x+12$ (Matric. 1866) take 12, and split it into all possible pairs of factors, viz. 1×12, 2×6, 3×4. Now, it is evident that the sum of the last pair will give 7, and hence, by a trial or two for signs, we find the expression to be equal to $(x-3)$ $(x-4)$. Similarly $x^2+5x-24=(x-3)$ $(x+8)$.

Algebraical Proportion.

Nearly all the questions given under this head can be solved in one or other of the following ways:—

First Class of Cases.—Having given the equality of two simple ratios (as $\frac{a}{b}=\frac{c}{d}$) to prove the equality of more complex expressions,—where antecedents are similarly involved with antecedents, and consequents with consequents.

(Two expressions are similar as regards *corresponding* letters—antecedents or numerators being correspondent to antecedents, consequents to consequents—when one expression is an exact reproduction of the other in *signs*, *indices*, and *coefficients*, but has the correspondent, and not the same letters.)

The required process of proof is conducted thus:—Arrange the complex ratios so that the similar quantities may form the numerator and the denominator of the same fractions. *Take now each of these two equal fractions separately*, and in the first prove (by the aid of the given equal simple ratios) its numerator divided by some value equal to its deno-

minator divided by some other value. Leaving the first fraction for the present, treat the second in a precisely similar manner,—proving its numerator divided by the same quantity as the divisor of numerator of first fraction, equal to its denominator divided by the same quantity as the divisor of the denominator of first fraction.

By dividing the equality thus obtained from the first fraction by that obtained from the second, we shall arrive at the desired equality, or one from which it may immediately be deduced.

This process will be understood after a study of the annexed examples from the matriculation papers. The first is a simple case, which may be proved by an easier method, but it is adopted here to exhibit the principle of the proceeding; the second is somewhat more complex.

EXAMPLE 1.

If $\frac{a}{b}=\frac{c}{d}$ prove $\frac{a+b}{a-b}=\frac{c+d}{c-d}$.

Arranging the similar expressions in the same fractions, we have to prove

$$\frac{a+b}{c+d}=\frac{a-b}{c-d}.$$

Taking first fraction separately, we wish to prove, by aid of $\frac{a}{b}=\frac{c}{d}$, $\frac{a+b}{A}=\frac{c+d}{B}$,

where A and B represent some values to be determined.

Comparing corresponding terms in two numerators we have (1.) $\frac{a}{a}=\frac{c}{c}$;

(2.) $\frac{b}{a}=\frac{d}{c}\therefore\frac{a}{b}=\frac{c}{d}$.

Adding (1.) and (2.)

$$\frac{a+b}{a}=\frac{c+d}{c} \quad \ldots\ldots\ldots \text{I.}$$

Taking second fraction we wish to prove

$$\frac{a-b}{A}=\frac{c-d}{B},$$

where A is shown to be $= a$, and $B = c$. Now,

(1.) $\frac{a}{a}=\frac{c}{c}$,

(2.) $-\frac{b}{a}=-\frac{d}{c}$ because $\frac{a}{b}=\frac{c}{d}$.

Adding (1.) and (2.)

$$\frac{a-b}{a}=\frac{c-d}{c} \quad \ldots\ldots\ldots\ldots \text{II.}$$

Therefore dividing I. by II. we get

$$\frac{a+b}{a-b}=\frac{c+d}{c-d}$$ Q.E.D.

It will be observed from this example that since we determine the denominators in operating on first fraction, it is often advantageous to commence with the simpler of the two.

EXAMPLE 2. (London, 1860.)

If $\frac{a}{b}=\frac{c}{d}$ prove that

$$\frac{a^3+3a^2b+b^3}{c^3+3c^2d+d^3}=\frac{a^3+b^3}{c^3+d^3}.$$

Here the fractions are already properly arranged, so, commencing with the simpler, we wish to show

$$\frac{a^3+b^3}{A}=\frac{c^3+d^3}{B};$$

where we must find A and B as before. Now,

(1.) $\frac{a^3}{b^3}=\frac{c^3}{d^3}\therefore\frac{a}{b}=\frac{c}{d}$;

(2.) $\frac{b^3}{b^3}=\frac{d^3}{d^3}$.

Adding (1.) and (2.)

$$\frac{a^3+b^3}{b^3}=\frac{c^3+d^3}{d^3} \quad \ldots\ldots\ldots \text{I.}$$

Taking other fraction, we wish to show

$$\frac{a^3+3a^2b+b^3}{A}=\frac{c^3+3c^2d+d^3}{B};$$

where A and B are b^3 and d^3 respectively. Now, taking corresponding terms in both, we get,

(1.) $\frac{a^3}{b^3}=\frac{c^3}{d^3}$;

(2.) $\frac{3a^2b}{b^3}=\frac{3c^2d}{d^3}\left(\therefore\frac{a}{b}=\frac{c}{d}\therefore\frac{3a^2}{b^2}=\frac{3c^2}{d^2}\therefore\frac{3a^2}{b^2}\times\frac{b}{b}=\frac{3c^2}{d^2}\times\frac{d}{d};\right)$

(3.) $\frac{b^3}{b^3}=\frac{d^3}{d^3}$.

Adding (1.) (2.) (3.)

$$\frac{a^3+3a^2b+b^3}{b^3}=\frac{c^3+3c^2d+d^3}{d^3} \quad \ldots\ldots \text{II.}$$

Dividing I. by II. and alternating gives the required equality.

A *Second Class* of cases in algebraical proportion is resolvable by the aid of the following principle :—

If we have any number of equal ratios

$$\left(\frac{a}{b}=\frac{c}{d}=\frac{e}{f}=\&c.\right)$$

then,

$$\left.\begin{array}{l}\text{Any one of these}\\ \text{fractions}\end{array}\right\}=\frac{\text{Sum of any multiples of numerators}}{\text{Sum of same multiples of corresponding denominators}};$$

or,
$$\frac{a}{b}=\&c.=\frac{ma+uc+pe+\&c.}{mb+ud+pf+\&c.},$$

where m, u, and p, are any values whatever. This formula is easily proved thus :—

Let
$$r=\frac{a}{b}=\frac{c}{d}=\&c.$$

then
$$r=\frac{ma}{mb} \text{ or } ma=mb.r$$

$$r=\frac{uc}{ud} \text{ or } uc=ud.r$$

$$r=\frac{pe}{pf} \text{ or } pe=pf.r$$

Adding, we get

$$ma+uc+pe=(mb+ud+pf)r$$

$$\therefore r \text{ or } \frac{a}{b}\ \&c.=\frac{ma+uc+pe}{mb+ud+pf}.$$

The form of the question will often indicate whether this formula can be employed; if, for instance, more than two equal ratios or fractions be given. The following examples of its application may be usefully examined :—

EXAMPLE 1. (Matric., 1860.)

If $\frac{a}{b}=\frac{c}{d}$ prove that

$$\frac{(a^2+2c^2)^{\frac{1}{2}}}{(b^2+2d^2)^{\frac{1}{2}}}=\frac{a}{b}.$$

Squaring both sides to get rid of root, we have to prove

$$\frac{a^2+2c^2}{b^2+2d^2}=\frac{a^2}{b^2};$$

since $$\frac{a}{b}=\frac{c}{d} \therefore \frac{a^2}{b^2}=\frac{c^2}{d^2};$$

and by formula

$$\frac{1.a^2+2.c^2}{1.b^2+2d^2}=\frac{a^2}{b^2}, \text{ \&c.} \quad \text{Q.E.D.}$$

EXAMPLE 2. (Matric., 1866.)

If $$\frac{a}{b}=\frac{c}{d},$$

prove that $$\frac{a^2+c^2}{ab+cd}=\frac{ab+cd}{b^2+d^2};$$

by formula $$\frac{a.a+c.c}{a.b+c.d}=\frac{a}{b};$$

also $$\frac{b.a+d.c}{b.b+d.d}=\frac{a}{b}.$$

$\therefore$ The two expressions are equal.

EXAMPLE 3. (Matric., 1866.)

If $$\frac{a}{b}=\frac{b}{c}=\frac{c}{d},$$

prove $$\sqrt{ab}+\sqrt{bc}+\sqrt{cd}=\sqrt{a+b+c}\sqrt{b+c+d};$$

by formula $$\frac{a}{b}=\frac{b}{c}=\frac{c}{d}=\frac{a+b+c}{b+c+d};$$

or, $$\frac{\sqrt{a}}{\sqrt{b}}=\frac{\sqrt{b}}{\sqrt{c}}=\frac{\sqrt{c}}{\sqrt{d}}=\frac{\sqrt{a+b+c}}{\sqrt{b+c+d}} \quad \ldots \quad \text{I.}$$

by formula applied to the three left hand members of I.

$$\frac{\sqrt{a}}{\sqrt{b}}=\frac{\sqrt{a}.\sqrt{b}+\sqrt{b}.\sqrt{c}+\sqrt{c}.\sqrt{d}}{b+c+d} \quad \ldots \quad \text{II.}$$

Putting the right hand members of I. and II. equal, gives us almost directly the desired equality.

EXAMPLE 4. (Matric., 1866.) Formula not used.

If $$\frac{a}{b}=\frac{b}{c}=\frac{c}{d},$$

prove $$\frac{a^3}{b^3}=\frac{a}{d}.$$

(1.) $ac=b^2$

(2.) $bd=c^2$

Dividing (1.) by (2.)

$$\frac{a}{d}\cdot\frac{c}{b}=\frac{b^2}{c^2}$$

$$\therefore\frac{a}{d}=\frac{b^2}{c^2}\times\frac{b}{c}=\frac{b^3}{c^3}=\frac{a^3}{b^3}.$$ Q.E.D.

EXAMPLE 5. (London, 1860.)

If $$\frac{a}{b}=\frac{c}{d}=\frac{e}{f},$$

prove that each of these fractions is equal to

$$\frac{\left(\frac{a^2c^2}{e^2}+\frac{a^2e^2}{c^2}+\frac{c^2e^2}{a^2}\right)^{\frac{1}{2}}}{\left(\frac{b^2d^2}{f^2}+\frac{b^2f^2}{d^2}+\frac{d^2f^2}{b^2}\right)^{\frac{1}{2}}};$$

or to $$\frac{a^3df+c^3bf+e^3bd}{b^3ce+d^3ae+f^3ac}.$$

Taking first expression, and squaring to get rid of root, we wish to prove that the multiples of the corresponding terms in numerator and denominator are equal, namely,

$$\frac{c^2}{e^2}=\frac{d^2}{f^2} \text{ and } \frac{a^2}{c^2}=\frac{b^2}{d^2}, \text{ \&c.;}$$

which follow from the given equalities; from this

it results that the square of the original expression is equal to

$$\frac{a^2}{b^2}=\frac{c^2}{d^2}=\frac{e^2}{f^2};$$

and taking root of both sides we complete required proof. In the second fraction we have to show from the given equalities that $a^2df=b^2ce$, &c.; the full process we omit that the reader may test his comprehension of the principle. It will be gathered from some of these examples that it is sometimes necessary to modify the original given equalities by involution, multiplying, and so forth.*

With the fundamental propositions of proportion, alternation, inversion, equality of product of extremes and product of means, duplicate and triplicate ratio, &c., the student will, of course, make himself thoroughly familiar.

In reference to the Progressions it is only necessary to remark that the processes by which the formulæ are arrived at should be studied, and the formulæ themselves carefully committed to memory.

In conclusion, we may mention that in a little work, of which Mr Kimber is the author, published by Longmans, a collection is brought together of all the questions in arithmetic and algebra which have been proposed at matriculation since the foundation of the University, with the solutions fully worked out. It is impossible that the candidate who intends to present himself for that examina-

* See also Appendix, p. 173.

tion could have a better selection of examples for practice.

EUCLID.

The first four books are required for matriculation; and an entire paper, including two or three propositions out of each book, and three or four geometrical exercises or deductions, is given in the subject. It will naturally be supposed that it would not be easy to propound any very important novelty in the mode of learning or teaching a subject which has been before the world in nearly the same form for more than two thousand years; yet we believe that the student will derive essential advantage from attention to one or two suggestions,—the first of which is to master the *order* of the propositions. This, which might, upon a superficial view, seem a mere superfluity, is in reality essential, not only to a satisfactory treatment of the separate propositions, but to a thorough comprehension of the whole as a logical unity, as the finest example we possess of a system of purely deductive inference. The difficulty in doing so is trifling, especially if the student observe the analogies amongst different propositions, and the natural subdivisions of the individual books. Thus, suppose we enunciate the 5th and 6th of the first book thus :—

5th. If two sides of a triangle are equal, the opposite angles are equal.

6th. If two angles of a triangle are equal, the opposite sides are equal.

And compare them respectively with the

18th. If two sides of a triangle are unequal, the greater angle is opposite the greater side.

19th. If two angles of a triangle are unequal, the greater side is opposite greater angle.

An analogy is at once noticed which much facilitates the recall of the position of the propositions in the system. A precisely similar relation may be traced between the 4th, 8th, 24th, and 25th, and many such analogies between groups of propositions may be observed with a little trouble. It may be noticed that the 32d completes and includes the 16th and 17th, that the 43d is a proposition interpolated between others with which it is not directly connected, and so on. It is unnecessary to point out the natural subdivisions; they are obvious at first sight, particularly in the first book.

The principal defect in geometrical instruction, as ordinarily conducted, we believe to lie in this, that the propositions are taught solely in reference to particular diagrams, which have been for the most part exactly copied from each other by the different editors of Euclid's Elements. The consequence of this is, that the learner is often utterly incapable of going through an easy and familiar proposition, if the construction to which he has been accustomed be changed; and though judicious instructors generally aim, more or less, at the counteraction of this

evil, yet it would unquestionably be the better plan, and that which we would strongly recommend to private students, to generalise the propositions once for all, that is, so to express them as to render them applicable to any and every modification possible in the construction. A student who has thoroughly mastered a proposition would find no difficulty in generalising its expression in this way, and we are assured that by so doing an accuracy and certainty is given to his knowledge such as can be attained by no other means. To illustrate our meaning, and to aid those who choose to attempt the experiment, we append an example :—

Euclid I. 2. From a given point to draw a straight line equal to a given finite straight line.

Construction.—

1. Join given point with either extremity of given line.
2. On either side of this joining line, as *base*, describe an equilateral triangle, and produce its two sides. (If the point is given *in* the line, it is already joined with both extremities, and we may select either part as the "joining line.")
3. With its joined extremity as centre, and the given line itself as radius, describe a circle.
4. With apex of equilateral triangle as centre (*apex* being opposite *base*), and the side of it, produced through joined extremity (of given line) and limited by first circle, as radius, describe a second circle.

Proof.—From the two radii of second circle take the sides of the equilateral triangle, and the two remainders are equal; but one of these is equal to given straight line (being radii of first circle), while the other is drawn from given point. This last line is therefore equal to given line. Q.E.F.

It is often useful to express the constructions or proofs in a condensed form, thus—

I. 24.—Take that triangle which has the lesser angle, and of the two sides which contain that angle take the one which is not greater than the other; with this not greater side, at the same end with, and on the side of, the lesser angle, make an angle equal to the greater.

I. 26.—Select in one of the triangles a side which, with given side and one of the given angles, will make a case of I. 4, and prove this selected side equal to corresponding side in second triangle by a *reductio ad absurdum*.

The 12th and 13th propositions of the Second Book sometimes cause some difficulty, we therefore append the generalised proofs in brief:—

Euclid II. 12. Proof.—Apply Euclid II. 4 to produced side, and add square of perpendicular.

II. 13.—Apply II. 7 to side upon which perpendicular falls (towards acute angle, *i.e.* so

that the part whose square we consider may be towards acute angle), and add in square of perpendicular.

In I. 48, at given angular point, draw, outside the triangle, a straight line *perpendicular to* one of the containing sides, and *equal to* the other. We notice this proposition, because an error is often committed by *producing* one of these sides, instead of drawing a line at right angles.

In Book III. two important principles are—

1. That the straight line bisecting any chord of a circle at right angles, passes through the centre; and
2. That a straight line drawn at right angles to a tangent at the point of contact also passes through the centre.

With the converse propositions:

By the former we can easily solve—"given a segment, to describe the circle of which it is a segment," by simply drawing in the given segment any two non-parallel chords, and bisecting them at right angles, the centre of the required circle must obviously be at the intersection of these bisectors.

By the aid of these principles most of the problems relative to the inscription and circumscription of rectilineal figures and circles may be solved.

In Book IV. the tenth proposition is somewhat complicated in the details of its construction and proof; it should therefore be carefully examined.

MECHANICAL AND NATURAL PHILOSOPHY.

The University authorities generally decline, for obvious reasons, to recommend particular books to students in the subjects of their examinations; but in the present case they suggest to the candidate the attendance on a course of experimental lectures, and probably such would be the best plan, particularly if the lectures were delivered with special reference to the London programme. Those, however, who cannot conveniently command such instruction will find all they require in the "Elements of Natural Philosophy," by the Rev. Samuel Newth, and the candidate who has fairly got up this little manual may present himself for this part of the examination with confidence. Owing to its studied conciseness it is, however, a somewhat difficult book to the mere beginner, and we should recommend such to pass over, in the first reading, those portions which cause much difficulty, reserving them to be reconsidered upon a second perusal. Since this book includes all the subjects required under this head, it will only be necessary to add a few remarks on certain portions of it.

In some, if not all the editions, the complication of the triangle of forces is increased by the introduction of non-essential particulars into the enunciation. If the student has access to the last edition of the treatise on "Mechanics, Hydrostatics," &c., by the same author (a somewhat similar, but more

advanced work), he will find in it a much simpler demonstration of the proposition.

The reader should not overlook the proposition which asserts that "the sum of the moments of any two concurrent parallel forces, about a point in a plane without them, is equal to the moment of their resultant about that point"—since an obvious extension of this proposition constitutes the principle upon which very many of the problems relative to the centre of gravity may be solved (see 2d B.A. "Mechanics").

The three classes of *Levers* may easily be remembered by bearing in mind that *the fulcrum*, *the weight*, and *the power* is respectively in the middle, in the first, second, and third kinds.

With regard to pulleys, we may observe that the third system is the same as the first turned upside down, the fixed pulley in the latter being of course omitted as unnecessary. Observe, too, that in the first and second systems, the number of *moveable* pulleys is alone taken into account, while in the third system the *total* number is reckoned. The conditions of equilibrium in each kind may be formularised thus, P being power, W weight, n number of pulleys, as just explained—

(1.) $P=\frac{W}{2^n}$; (2.) $P=\frac{W}{n}$; (3.) $P=\frac{W}{2^n-1}$. *

* For *the most advantageous arrangement*, when weight of pulleys is reckoned,—in first system, the heavier the pulley the nearer the weight; in third, the nearer the power.

In the *screw-press* (screw with lever) notice that no change is made in mechanical advantage by altering diameter of the screw, the distance between power and centre, and distance between threads of screw remaining unaltered.

Second Law of Motion may often be more easily applied if we enunciate it thus: If two motion-producing forces act upon a body *simultaneously*, the body at the end of any given time will be found at the same spot as if they had acted upon it successively and separately for that time.

Third Law of Motion.—Since weight measures mass, we may apply this law, as if it said "ratio of pressure to weight." If a body, say of 1 lb. weight, falls freely, it is clear that the pressure of 1 lb. moves a mass or weight of 1 lb. The force of gravity is such, that in this case it generates during one second a velocity of 32·2 feet; that is, when pressure = weight, accelerating force is 32·2; if $\frac{\text{pressure}}{\text{weight}} = \frac{1}{2}$, then accelerating force would be 16·1 (*i.e.* when $\frac{1}{2}$ lb. moves weight of 1 lb.), and so on.

Accelerating Forces.—The student should take care to keep quite distinct the three classes of cases of vertical movement which may occur under this head:—

1. When body simply *falls freely*:—

$$v = gt$$
$$s = \tfrac{1}{2}gt^2$$
$$v^2 = 2gs$$

2. When body is *projected downwards*, with vertical velocity V:—

$$v = V + gt$$
$$s = Vt + \tfrac{1}{2}gt^2$$
$$v^2 = V^2 + 2gs$$

3. When body is *projected upwards*:—

$$v = V - gt$$
$$s = Vt - \tfrac{1}{2}gt^2$$
$$v^2 = V^2 - 2gs$$

But in this last case we have two additional formulæ :—

Total upward space *i.e.* greatest height reached. $= \dfrac{V^2}{2g}$.

Total upward time $= \dfrac{V}{g}$.

We may notice here, though it does not strictly belong to the matriculation subjects, that if, instead of falling or being projected *vertically* into the air, the body fall down or be projected up or down *an inclined plane* (i.e. *directly* up or down, not obliquely, or, as it were, across the plane), we have three cases precisely analogous to the above, the formulæ being also exactly the same, with this single modification, that instead of gravity, we must use an accelerating force represented by $\frac{gh}{l}$, where $g = 32{\cdot}2$; h = height of plane; and l length of it; in other words, for g we must write $\frac{gh}{l}$.

Specific Gravity.—The problem of finding the specific gravity of a substance mostly comes to this

—to find the weight of an equal bulk of water. The hydrostatic balance does this by means of the principle that a body wholly immersed in a fluid loses a weight the same as that of an equal volume of the fluid.

Optics.—The most important point is the formulæ for the conjugate foci in mirrors and lenses. If we denote by D the distance from the lens or mirror of the incident focus (*i.e.* of luminous point or object), by d the distance from the same of the conjugate focus, and by f the focal length of the mirror or lens, we have the following formulæ :—

For Mirrors (Spherical).

$$\text{Focal distance} = \frac{\text{radius}}{2}.$$

$$\frac{1}{d} + \frac{1}{D} = \frac{1}{f}.$$

For Lenses.

$$\frac{1}{d} - \frac{1}{D} = \frac{1}{f}.$$

Remembering that positive distances are those reckoned from mirror or lens in direction of incident focus. These formulæ give the "geometrical focus" of a reflected or refracted pencil,—*i.e.* the focus of those rays of the pencil which pass near the axis.

Problems on the position and magnitude of *images* are solved by the above formulæ. First find position of image,—*i.e.* its distance from mirror or lens, by means of these,—then its magnitude compared with

that of object is directly as their respective distances from the mirror or lens.

The image in *convex* mirrors is always virtual, erect, diminished (ved); in *concave* mirrors it is virtual, erect, and magnified (vem), if object be between mirror and principal focus; real, inverted, and magnified between focus and centre (rim), and real, inverted, and diminished if object be beyond centre (rid).

If object be in principal focus, rays are reflected parallel, and image is theoretically at an infinite distance; if object be at centre of curvature of mirror, then object and image coincide.

For the method of finding *practically* the principal foci of mirrors or lenses, see "Optics," 2d B.A.

If two plane mirrors be situated at an angle, and an object be placed between them, the number of images formed is one less than the quotient which results from dividing 360° by the number of degrees in the angle between the mirrors. Thus, if the mirrors be at right angles, the number of images is three; if at angle of 45°, the number is seven; and so on. If the mirrors are opposite and parallel, the number of images is theoretically infinite.

In reference to the phenomena of *Sound*, it is only here necessary to remind the learner that the note from a closed organ-pipe is an octave lower than if the pipe be open. *Sound* is now, however, excluded from matriculation subjects.

CHEMISTRY.

The Chemical Programme of the Matriculation includes (*a*) The Elementary Phenomena of Heat; (*b*) The General Principles of Chemical Philosophy; and (*c*), The Fundamental Points in the Chemistry of the Non-metallic Elements. In the "Educational Course" of Messrs Chambers of Edinburgh, there is published an excellent manual of Chemistry by Professor Wilson, and one which—notwithstanding that it belongs to the class of books which aim at popularising science—a class which the student would mostly do well to avoid—we can strongly recommend in the preparation for this part of the examination. It contains a clear exposition of the atomic theory, and of those fundamental laws of chemical combination which spring from it,—a thorough comprehension of which, together with the system of chemical notation, is absolutely necessary before the student can make one step of real progress in the acquisition of the science. Speaking wholly in reference to the requirements of the London examiners at matriculation, it is perhaps least satisfactory in its treatment of the phenomena of heat. As regards both the principles of chemical philosophy, and the general chemistry of the non-metallic elements, we have, however, no hesitation in saying that the student who has made himself familiar with those portions of this volume which relate to those subjects, may not only safely present

himself for this part of the examination, but will, moreover, have obtained a good basis knowledge of the science of chemistry. This being the case, it would scarcely be worth while to notice other books on this subject; but since Professor Fownes' Manual is in the hands of many students, we may observe that though the author has been pre-eminently successful in producing a text-book for those who have mastered the first principles of the science, yet his work is scarcely adapted to beginners in the study, for whom these instructions are chiefly intended. There is, moreover, a work on "Chemistry and Chemical Analysis," published in the cheap series of elementary books compiled under the auspices of the National Commissioners of Education in Ireland; it is, however, anything but what an elementary work ought to be, and we cannot recommend it to the student. If the candidate have the opportunity of obtaining practical instruction, or of attendance upon a course of experimental lectures, he should by no means omit to avail himself of it; or if he cannot do this, he should at least perform for himself the experiments which demonstrate the modes of preparing, and the characteristic reactions, of the chief chemical elements and their most important compounds, and which he will find indicated in Dr Wilson's book. Not to waste time in urging a point which is universally recognised, we may simply observe, that some amount of practical working is absolutely essential if the

student would acquire any real knowledge of this, the most useful, and in some respects the most fascinating, of all the sciences.

We shall next proceed to consider a few details which seem to call for special remark. Under the head of *Heat* we may notice—

That the centigrade thermometer is gradually superseding the awkward scale of Fahrenheit. Questions are often proposed involving the reduction of one of these modes of graduation to the other. This is very easily done in all cases, if the student remember that the freezing-point of water is 0° on the centigrade, and 32° on the Fahr. scale; while the interval between that and the boiling-point is 100° in the former, 180° in the latter. Since these degrees cover the same space, it is evident that 5 degrees centigrade are exactly equivalent to 9 of Fahrenheit. By bearing this fact in mind, and making the necessary allowance for the difference in the point of commencement of the graduation, no difficulty can be experienced in the reduction by means of a simple proportion.*

It is necessary to understand the difference between the temperature or intensity of heat manifested by, and the quantity of heat presumed to be in, a body. The former is measured by the *thermometer*, the latter by instruments termed *calorimeters*. The difference in question may be illustrated thus: Suppose we have two equal and perfectly

* See Appendix on Reduction of Thermometric Scales.

uniform sources of heat, let a pound of water be placed over one, and a pound of mercury over the other. Now, we may suppose that each will receive from the sources the same *quantity* of heat in the same time; but if, after the expiration of a short interval, we immerse a thermometer in both liquids, we shall find the mercury to have a much higher temperature than the water. The most general law which has been arrived at on the subject may be stated thus: *An atom of each of a number of bodies of similar chemical constitution requires the same quantity of heat to produce the same thermometric effect.* Thus the weight of an atom of iron being 56, and that of an atom of silver 108, the quantity of heat which would raise 56 parts of iron to a given temperature, would raise 108 parts of silver to the same point in the thermometric scale.

The quantity of heat imparted to a body, is estimated either by its effects in raising the temperature of bodies in contact with it, while its heat is given off, or by observing *the time* which it takes to give off its contained heat; in other words, by observing the time which it takes to cool down through a certain range of temperature. The details will be found under the head of Calorimetry in any treatise on heat.

The reader will find it a convenient aid to the memory to regard a liquid as a combination of a solid with a certain quantity of heat, and a gas as a liquid combined with a further proportion.

We may conclude the consideration of the phenomena of heat by a reference to the law of expansion of gases by heat. On the scale of Fahrenheit's thermometer the *coefficient of expansion* is given as $\frac{1}{460}$ (= ·002174). In order to fully understand this, let the reader imagine a tube of uniform diameter, and of indefinite length, closed at one end, in which an air-tight piston moves up and down. Let the sectional area of this tube be supposed to be 1 square inch, and let it be filled up to the 460th inch with air or gas of any kind, at 0° Fahr. It is clear that the tube would contain 460 cubic inches of air; now, if the temperature be raised, we should find that the 460 cubic inches of gas would expand 1 cubic inch (in other words, the piston would move along the tube 1 inch) for every degree of Fahr.,—becoming 461 at 1°, 492 at 32°, and so on. Similarly when the coefficient is given on the centigrade scale (·00366) it intimates that a gas expands $\frac{366}{100,000}$ of its bulk at 0° cent. for every degree of that scale.*

In studying the general principles of chemical philosophy a thorough comprehension of that simple doctrine, the atomic theory, will be found a key to all else. The student should understand clearly the difference between chemical union and mechanical mixture; in the former we have *an actual union of atoms*, in definite numbers, and according to a definite and invariable arrangement in each compound;

* See Appendix on Temperature—Reduction of Gases.

it will only take place between certain substances and under certain conditions ; the properties of the compound are usually totally different from the aggregate or average of the properties of the components ; and finally, it is often accompanied by the manifestation of some other form of correlated force, —light, heat, or electricity. On the other hand, a mere mechanical mixture forms a contrast in all these respects.

An important extension of the atomic theory has been made in the case of gases, which may be most conveniently expressed in a *practical* form, thus,— the atoms of bodies in the gaseous state occupy the same space, or some simple multiple or part of that space (as $\frac{1}{2}$ or 2). This principle enables us to calculate the specific gravity of gases by the following easy rule:*—*Multiply the atomic weight of the gas by the specific gravity of hydrogen*, 69·3. The rationale of this rule is this, that hydrogen, which has a combining volume of 1, has also an atomic weight of 1, and a specific gravity of 69·3. An equivalent volume of another gas being the same, it is clear that its specific gravity will be immediately deducible by multiplying 69·3 by the relative weight of that same volume, *i.e.* by its atomic weight. We may

* The student should notice this rule, as questions often require a knowledge of the specific gravity of gases. Air is here taken as the standard, and reckoned as 1000. Practically, however, the student will find it far more convenient to take hydrogen (=1) as the standard, and refer all gaseous specific gravities to it.

observe, however, that *compound* gases have a combining volume of 2, and hence, in their case, we must *divide* the specific gravity obtained by the above rule, by 2. Wilson doubles the number for combining volumes, making that of simple gases 2, and of compounds 4; but we recommend the beginner to adopt the simpler system which we have made use of; it will therefore be only necessary to halve his combining volumes. The equivalent of oxygen must be taken as 16.

Under the head of the special chemistry of the elements and their simpler compounds, it is only necessary here to remark upon the foreign ingredients commonly met with in different kinds of water. These may be classed as (1) *The gaseous or liquid;* and (2) *The solid;* the former, including oxygen, nitrogen, carbonic acid, ammonia, and nitric or nitrous acids. These are derived from the atmosphere (especially carbonic acid, on account of its great solubility), and hence may be looked for in greatest abundance where the water is freely exposed or is much agitated in contact with air, as in the waters of running streams. Ammonia, and often nitrous acid, are found in rain-water, and with the common gases of the atmosphere constitute its only impurity, if carefully collected. The solid ingredients found in ordinary water are chiefly carbonate, sulphate and chloride of lime, of potash, and of soda. These are derived from the soil, and will therefore vary somewhat according to the district through

which the water has passed, or the nature of the strata in which the wells sunk to collect it are situated. Thus, in chalk districts we may expect an excess of lime salts; it is these which confer "hardness" upon water, and which form, when soap is added, an insoluble compound with its fatty acids. If the hardness is due to *carbonate* of lime, it is termed "temporary;" for it may be got rid of by boiling, which expels the free carbonic acid upon which the solubility of the carbonate depended—chalk being quite insoluble in *pure* water. On the other hand, this proceeding is of no avail if the hardness arises from the presence of *sulphate* of lime. Since its precipitation is not effected by boiling, it is then said to be "permanent," and a common resource is to convert the sulphate into carbonate by the careful addition of a proper quantity of carbonate of soda; and then upon the water being heated to the boiling point, the lime is precipitated as before; even after this, however, the water is left slightly contaminated with sulphate of soda.*

CLASSICS.

In this article, without attempting any special novelty, we shall lay before the reader the methods which some experience has suggested to us as the most satisfactory in the study of the classical languages. Those who have had the advantage of a

* Consult also Appendix—Works on Chemistry.

good school education will probably have arrived at a system of their own, and will require but little instruction on this head. With the self-taught student, however, the case is widely different; the necessity, and at the same time the difficulty of acquiring even a good elementary knowledge of Latin and Greek, is to such a formidable barrier to university honours; and the very multiplicity of the aids offered is to him, in some sense, a source of embarrassment. If, therefore, any of our suggestions should appear somewhat trivial to the advanced student, let him remember that they are chiefly intended for those who are endeavouring to overcome, unaided, the early difficulties in the acquisition of the classics.

Three papers in classics are given in matriculation:—

1. Latin translation, history, and geography.
2. Greek translation, grammar, history, and geography.
3. Latin grammar and Latin prose composition.

The first point for consideration is the selection of a good grammar, and in reference to this we would remind candidates that the Senate append a note to the regulations for matriculation to the effect that special stress is laid upon the accuracy of answers to the grammatical questions. Doubtless, for the general purposes of learners, no Latin or Greek grammar surpasses the smaller works

of which Dr Smith is the author or editor.* They are the only works of the kind readily accessible to the English student, in which the improved spirit of modern scholarship can be said to be fairly represented; and in their typographical and general arrangement they can hardly be excelled. Those who read without a tutor will derive great advantage from consulting, upon the principal points, any number of grammatical authorities to which they may have access, and selecting and combining into a systematic arrangement the most valuable items of information to be gathered from each. An example of the result of such a mode of proceeding is given in the appendix (Third Declension).

A thorough mastery of the inflections is absolutely necessary, and therefore the Senate, as we have noticed above, very properly make it an essential part of the examination. The difficulties of this acquisition cannot be ultimately evaded, and we believe that the best, is the old, method of getting them up, once for all, in the ordinary manner from the grammars. An idea has, however, of late years been extensively gaining ground that this method is essentially unscientific, and that the proper method of teaching or learning a foreign language is to imitate as nearly as possible the

* The "London" Latin and Greek grammars, published by Walton, are very good and cheap (only 1s. 6d. each).

natural process of acquisition of one's own mother tongue. Inflections are taught in widely separated scraps, and the vocabulary by frequent repetition of a few of the commonest words. Many school books have been compiled with a view of carrying out this notion (Bryce's Latin and Greek Reader, for example), but we believe that such attempts to smooth the path of the learner, at the utmost, only postpone a difficulty which must ultimately be fairly encountered and overcome. The subject is much too wide to admit of its discussion here, and we need only remark that, under ordinary circumstances, it is utterly impossible to imitate with any closeness the natural system by which we unconsciously and without effort learn our native tongue; and, moreover, if the system has any advantages, it is limited to the acquisition of a vocabulary, and is the worst possible for learning the accidence of a language.* Amongst special points in the Latin grammar, to which the candidate should direct his attention, are the genitive plurals of the third declension; the irregular comparatives and superlatives of adjectives and *adverbs;* the principal parts of the common verbs; the composition of verbs with prefixed prepositions; the use of the subjunctive mood, remembering, in particular, the great rule that it is used in objective sentences; the

* These remarks are intended to apply to the learning of inflections only; the best mode of acquiring a knowledge of the syntax is altogether another question.

different kinds of numerals, and their grammatical uses; with the Roman kalendar. In the Greek, the questions require a ready knowledge of the inflections of nouns, especially the irregulars of third declension; the declension and comparison of adjectives; and the principal parts of the commonest Greek verbs,—taking special note of such words as occur in the text of the authors given for the year.

For the simple sentences proposed to candidates for translation into Latin, the preparation of the more important parts of Arnold's "Latin Prose Composition," Part I., will suffice. We may remind the reader that, under the new arrangements, no *Greek* composition is given at matriculation. It must be confessed however that, in our opinion, no thoroughly satisfactory book for the tyro, in Latin composition, exists in our language. Arnold's books are often sadly wanting in perspicuity and condensation. Those, however, who are quite new to the study cannot do better than carefully get up an elementary work by the same author—"Henry's First Latin Book." This, as far as it goes, is much superior to Arnold's more elaborate treatises, and, indeed, is in many respects a model of what an elementary book should be. From it the student will easily acquire a familiarity with all the common syntactical constructions of the language. It is not unimportant to remark that a thorough comprehension of the logical analysis

of English sentences is one of the most valuable subsidiary aids which are at the command of the student in this branch of knowledge. It often enables him to generalise and discover the rationale of syntactical rules; the rules, for instance, for the construction of subordinate clauses in all their forms of the protasis and apodosis* in conditional assertions, and many other equally important points of syntax, would only be thoroughly intelligible to one who had mastered this process of logical dissection of sentences, and who was prepared to recognise analogy or identity of construction under superficial apparent diversity.

We may remark, in conclusion, that those who are a little more advanced in the study of Latin prose, will find Dr Smith's "Principia Latina," Parts IV. and V., perhaps superior to most other books. It is to be regretted, however, that Dr Smith has not included in his series of students' books treatises on Latin and Greek prose, adapted for students who have thoroughly mastered the elements of those languages, and which might supersede the confused and unsatisfactory works often employed in schools.

To pass to the consideration of the translation of the special authors given from year to year. The

* These terms relate to conditional sentences, that is, of the form, "If A is B, then C is D,"—the former clause being the protasis, or that which comes logically first, the latter clause is the apodosis.

main question for consideration, in reference to the preparation of translation, is as to how far it is advisable and really useful for the student to avail himself of the assistance of English translations or "keys." Our opinion on this point will be found to differ to some extent from that maintained by many educational authorities, but it has not been arrived at without experience of the practical working of different methods. Some instructors condemn the use of such aids altogether, maintaining that it reduces the process of translating to a mere question of memory, and that the knowledge so acquired, if it can properly be termed knowledge, is altogether delusive and unsatisfactory. The truth seems to be that here, as in many analogous cases, it is only the *abuse* of keys which is to be deprecated, and we believe, if employed in some such method as we shall suggest, their use effects a vast saving of time and labour which would otherwise be uselessly expended. The outline of the plan we would recommend is something of this kind—let the student procure the best text of his author, and the best translation which is at his command; the study of the original should be effected sentence by sentence, the reader doing his best to make out the translation, and, whether he succeed or not, he should compare his result with that contained in the key before him, to solve any doubt, and to be *assured* of his correctness. At the same time any words, phrases, or idiomatical

expressions, whose inflections, meanings, or syntax, are new to him, should be carefully noted and copied in manuscript.* Although this proceeding may at first sight seem tedious, yet, in the end, both time and labour are saved; the student has in his manuscript his author, in short, as it were, —he can quickly commit it to memory, or can at any moment refresh his knowledge, and go over the whole subject in an hour or two. Besides this incidental convenience, the knowledge thus obtained is definite and thorough, and thus prepared the candidate may present himself for examination with confidence. Employed in this manner, we believe the use of keys to be wholly advantageous.

The candidate will not, of course, omit to make himself familiar with the geography (looking out in a map the names mentioned) of the books read;† the *history* contained in them, with that of the period in which they were written, or to which they specially refer; together with the life of the author, with notices of his chief contemporaries.

We may mention, in conclusion, that translations of nearly every important classical author are published in Bohn's series, and are generally the best

* Of course the student is supposed to commit this manuscript to memory, at least so far as to be able to stand any examination upon it.

† And if he have time and opportunity, looking over the articles in Smith's Geographical Dictionary, and copying into his manuscript anything important therefrom.

which the student can procure. Before the examination, the candidate should carefully read the article on his author in Smith's Biographical Dictionary.

For the Grecian and Roman history, Dr Smith's smaller works will fully meet the requirements of this examination. Chepmell's "Short Course" (of English, Greek, and Roman history, Whittaker & Co.) will also be found an excellent compendium of the most important events, and is well suited for a review immediately previous to examination.

THE ENGLISH LANGUAGE.

It will generally be conceded, we think, that in no single respect, as far as ordinary school education is concerned, was there a more urgent demand for improvement than in the mode of teaching and studying the English language, which, till within a comparatively recent period, almost universally obtained, even in educational establishments of a superior class. Instructors themselves had rarely an adequate conception of their subject, and those even who were dissatisfied with the old routine were unable to depart from it, without almost wholly discarding the popular school-books, and relying upon their own knowledge and resources. Works professedly on English grammar and the science of the English language, from Lindley Murray to Allen and Cornwell, were, often notwithstanding

their size or pretensions, essentially superficial and unscientific. They frequently began and ended with a more or less elaborate discussion of the common definitions of the "Parts of Speech," without any attempt to penetrate the rationale, or to exhibit to the learner the philosophical basis of such distinctions; the general history of the origin and development of the language,—a point of fundamental importance,—was almost entirely ignored; their system of etymology consisted merely in long, unconnected lists of words derived from different sources; and their syntactical rules afforded no foundation for a sound or philosophical criticism. Grammar, in fact, was degraded into a mere set of rules and exceptions to be remembered, and no attempt was made to assign any reason for what was enunciated and taught in a wholly empirical manner. During the present century, however, the progress of almost every branch of scientific knowledge has been altogether unprecedented; many sciences may almost be said to have come into existence during this period, and others have emerged from the dim twilight of groping experiment and doubtful hypothesis into the clear sunshine of firmly-established general law. In this progress philological science has had its full share; and in place of the time-honoured system of a mere empirical treatment of language, the labours of Guest, Latham, and others, have rendered accessible to the student a thoroughly scientific exposition of the

history and principles of the English tongue. This advance has been reflected in the examination papers of the University of London; and even in an elementary course like that required to meet the necessities of matriculation, the student will find it essential to make himself acquainted with the fundamentals of the history and scientific principles of the language. In the general preparation for the single paper which includes this part of the matriculation, he will find it sufficient to read carefully Latham's "English Grammar for the use of Schools;" and certain portions of the "Handbook of the English Language," by the same author. The earlier portion of the latter work consists mainly of an elaborate examination of some of the different views which have been proposed as to the original locality occupied by the Teutonic or Anglo-Saxon invaders of Britain. Dr Latham's conclusion may be summed up in a single sentence,—The original area of that German population which became the Anglo-Saxons of England, lies between Rendsburg (lat. 54° 25′, long. 9° 40′) and Hanover; between Verden (lat. 52° 55′, long. 9° 12′) and Lüneberg, and between Bremenworde (lat. 53° 30′, long. 9° 9′) and Celle (lat. 52° 37′, long. 10° 5′.) In his preparation of this work, therefore, the student may omit the whole of Part I., except chaps. 1, 2, 14, 15, 16, 17; the remainder of the book should be carefully read, and it will be found practicable to compress its important points into

the compass of an analysis of moderate size. The Grammar above-mentioned forms the best introductory book. The Hand-book may be studied subsequently. Articles on teaching English, in *Athenæum* 1869, pp. 176, 209, 406, 505, 604, 636, 764, and 861, are worth looking through.

A Manual of the English language has been compiled by Dr Adams of University College. It contains a large mass of useful information; it has, however, the defect of mingling together, without obvious distinction, the important with that of secondary consequence, and in using it therefore the student should exercise his own discrimination; we may mention, however, that the earlier portions of the book are the best. The introduction, and the chapters on the numerals and pronouns, should be carefully studied; but the reader may, if he choose, omit the conjugations of the irregular verbs, and the entire chapter on the syntax. An excellent summary of the principal points in the history of the English language will be found in the introduction, by Dr Smith, to Marsh's "Lectures on English Language," published by Murray.

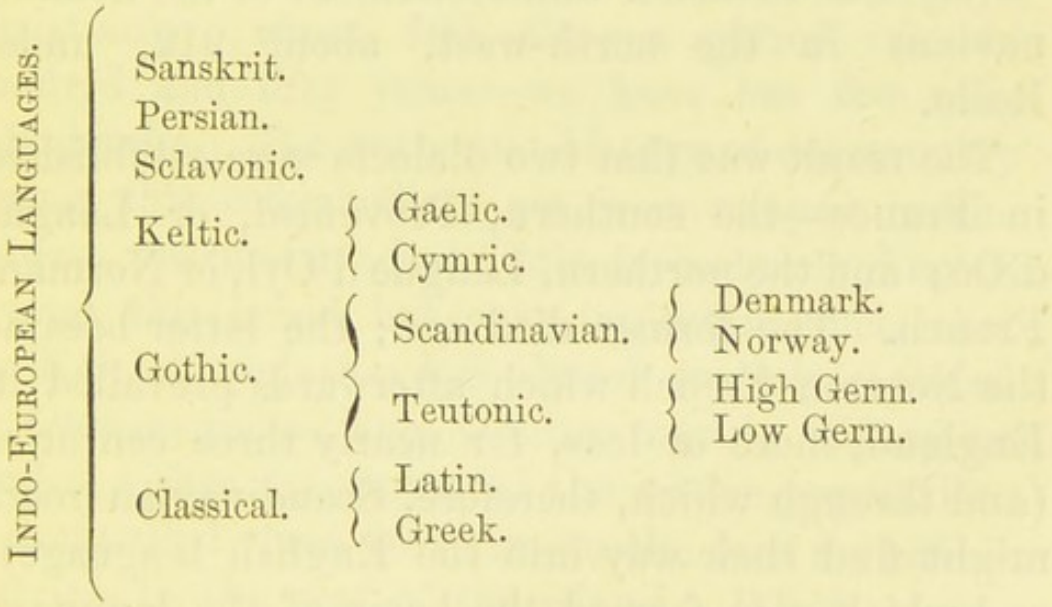
In the analysis of sentences, a part of the subject which a student should not overlook, it is not necessary to do more than refer him to a small tractate by Morell,—the "Essentials of English Grammar,"—in Part II. of which, though in an elementary form, he will find all that is really essential. If, however, the candidate choose to

pursue the subject somewhat more in detail, he may consult the second part of Mason's "English Grammar" (Walton & Maberly), in which it is more fully entered into. We have already noticed the importance of thorough comprehension of the logical structure and analysis of sentences as an element in the clear apprehension of the rules of classical composition.

Leaving the consideration of the special books, we will now proceed to glance at the chief *subdivisions* of the subject, which are tacitly recognised in the examination papers at matriculation. These are (1.) The general history of the language; (2.) Orthography, including the consideration of the constituent sounds, alphabet, &c.; (3.) Etymology, which is subdivided into inflection and derivation; (4.) Syntax, with the analysis and criticism of phrases or sentences; (5.) and Prosody, the laws of quantity, metre and poetic rhythm.

(1.) The consideration of the history of the English language should be commenced by a general view of the great group of languages of which it forms one member. This group, the Aryan or Indo-European (Arya, in Sanscrit = venerable, noble) —sometimes termed Japhetic, in contrast to Shemitic—includes those languages supposed to be derived from that primeval but extinct type (the Sanscrit being its best representative) once spoken by a people of *Central Asia*, partly pastoral, partly agricultural, who afterwards by emigration were

dispersed and became divided into distinct nationalities. One division of this early race turned southwards into Arya-varta, or Upper India, occupying the vast territory between the Himalaya and Vindhya mountains (the latter extending across the Indian peninsula from Guzerat to the Bay of Bengal). Another great division emigrated northward and westward into Europe; and in this way there sprung from one original stock a whole family of languages, which may be conveniently arranged thus :—



We are only here concerned with the last three. At an early period, say, about the era of the Roman occupation of Britain, the Kelts held the west of Europe—Britain, France, and Spain; the Teutonic tribes, the central parts; the Scandinavian, the north-central—the Danish and Norwegian peninsulas. The Teuton and Scandinavian pressed west-

ward, partly by gradual occupation, partly by the immigration of successive hordes, mixing with or displacing the Kelts still farther westward,—in Britain, for instance, driving them into Cornwall, Wales, Cumberland, and Ireland. In France the Romanised Keltic was greatly modified by two causes:—

(*a.*) The settlement of the Franks (Teutons) in the north and north-east of Gaul, in the fifth century; while the Visigoths and Burgundians fixed themselves in the south.

(*b.*) The invasion and settlement of the Scandinavians in the north-west, about 912, under Rollo.

The result was that two dialects were established in France—the southern, Provençal, or Langue d'Oc; and the northern, Langue d'Oyl, or Norman-French. The former died out; the latter became the Norman-French which afterwards prevailed in England, more or less, for nearly three centuries (and through which, therefore, Scandinavian roots might find their way into the English language), and which also formed the basis of the language of modern France.

In proceeding to notice the leading facts in the history of our tongue, we may take as our starting point the commencement of the Christian era, when we find in Britain a population speaking a Keltic language. The Roman conquest and occupation may be approximately regarded

as extending over a period of four hundred years, commencing about A.D. 50, and terminating A.D. 450. This occupation was, however, almost purely military,—there was at least nothing like a fusion of the conquering with the subject race; nor was any important change effected thereby in the language of the country. With the exception of a few words relating to military affairs, and chiefly found in the names of places, the long residence of the Roman legions in Britain has left no important trace in the English language.

From their departure till the introduction of Christianity, about 600 A.D.—a period of one hundred and fifty years—we have but few reliable details. The authentic history of our country during this intermediate era is enveloped in the deepest obscurity. But little is certainly known beyond this broad but very important fact, that the Keltic population was almost entirely replaced by *German* races, who, coming over in successive hordes, either exterminated the native population, or compelled them to retire to the less accessible districts in the west of the island. When, therefore, the light of Christianity, and with it that of authentic history, again dawned upon Britain, its inhabitants are Anglo-Saxons—its name England (or Angle-land). The precise locality which was the original home of the Anglo-Saxons (=Saxons of England, not Angles and Saxons) has been a subject of much dispute. The common view is

well known, and the result of Dr Latham's inquiry has been already given. They were probably *mixed* Germanic tribes, and not a people from any *one* district exclusively; and it may be regarded as certain that they belonged for the most part to the Low German area, *i.e.* the parts of Germany contiguous to, or not very distant from, the sea-coast. Both the race and their language were thus composite, the result of an amalgamation of several closely allied Teutonic families; so that Anglo-Saxon was never spoken as a homogeneous language on the Continent. Excepting those changes which naturally took place from the progress of time, in a language which, *for the great body of the people*, had neither literature nor writing to constitute a standard and confer stability, the Anglo-Saxon remained substantially the same till the Norman Conquest. No other single circumstance has had so important an influence on our tongue as the influx of Norman-French brought about by that event. Not only (*a*) did it contribute a large stock of words to the vocabulary, but (*b*) it radically modified the grammatical structure of the language, by promoting the change from an inflected or synthetical, to an uninflected or analytical form. This substitution of prepositions and auxiliary verbs for changes in the termination, seems to have been brought about by a concurrence of several causes: *First*, There is in all inflected languages an *inherent tendency* in this direction;

and this tendency operates with the greater force exactly in proportion as it is not counteracted by a generally diffused practice of writing and reading. At a certain period the Anglo-Saxon had a sufficiently copious literature; but even then the great body of the people were unable to make use of it, and the language as *spoken* had, previous to the Conquest, become less fixed and determinate in the use of inflections, while they were still retained in the *written tongue*. Subsequently, however, the Norman-French and Latin became almost exclusively the languages of literature, of law, of religion—of everything by which an easily accessible standard of orthography, inflection, and syntax is maintained, and the Anglo-Saxon was abandoned to the unlettered populace. From this time, therefore, the change in question advanced at a rapid rate, till almost every trace of inflection disappeared. A *second* cause which operated in the same direction was, as already noticed, the direct influence of Norman-French. Foreigners are impatient of an elaborate system of inflection which requires for its acquisition long and accurate practice, and are disposed to make short cuts to their meaning by omitting these niceties. The use of prepositions and auxiliaries, and certain changes in the syntax then follow as a necessary consequence. Such, in brief, are the chief influences which have operated in bringing about the most important and radical change which the Anglo-

Saxon underwent in its transition to English. Another remarkable era in the history of our language is coeval with the revival of the study of the classics, in the earlier part of the sixteenth century. The immediate effect of this was to introduce a class of words—coined directly from the Latin and Greek—which now constitutes a very prominent and essential element in the language of literature and of the educated classes. Contemporaneous with, or not long subsequent to, this revival of learning, flourished the most illustrious of England's authors, whose imperishable works have given the last touches to the perfection of the language in which they wrote, and, as in the parallel cases of Greece and Rome, shall hand it down to posterity, substantially unaltered to the end of time. To sum up, then, in a few words: The *basis* of the English language is Anglo-Saxon, modified chiefly (*a*) by a large immigration of a population speaking Norman-French (which introduced numerous words into its vocabulary, and aided in the suppression of its inflections,—the latter effect, however, long preceding the former); and (*b*) by the direct introduction of a multitude of derivatives and compounds from the classical languages.

After this general summary it will only be necessary to give briefly the history of some of the special elements which enter into the structure of our very composite tongue.

The Latin or classical elements may be arranged as follows :—

1. Latin of Roman period (A.D. 50–450), military terms, chiefly found in the names of places, as *Castra* (in Chester, &c.); *Colonia* (Lincoln, Colchester); *fossa; vallum*, and a few more.
2. Ecclesiastical words of classical origin, introduced by the monks and clergy, chiefly from A.D. 600 till after the Conquest,—as *monastery*, *bishop*, &c.
3. Words from Latin, coming through Norman-French. To the Latin words introduced during the two or three centuries subsequent to the Conquest, a French form was given. As examples, we may give the terminations, *tion* and *sion* (Latin *tio* and *sio*); *ty* (French *té*, Latin *tas*); *ance* and *ancy*, with the cognate adjectival endings in *ant* and *ent;* most words in *ment;* all in *tor*, *tory*, and *ure* (*or* through the French *eur*); all adjectives in *ary*, *ory*, *ic*, *ical*, *ive*, *ile*, *ible*, and most in *able;* and all verbs in *ate*, *act*, *ect*, *ict*, and *fy*. It must not, however, be supposed that all words terminating in these forms come to us from the Latin *through this medium*, the terminations were *originally* from the Norman-French, but many words have been introduced at a later period, and, in doing this, their inven-

tors have naturally assimilated them to forms already recognised in the language. In this way we have many words of Latin origin, but with French forms, which the French themselves never possessed.

4. Words from the Latin and Greek, coined and introduced after the revival of learning in the sixteenth century. These are in general easily distinguished from those of classes 2 and 3, by the absence of any change in the form of the original word beyond what is necessary to adapt it to the general analogy of the language.

With regard to the introduction of the Scandinavian words or forms, we may remark that roots from this source might come to us either *indirectly*, through the Scandinavian element in Norman-French, or *directly*, by means of the large colonies of Danes which settled in England under the Saxon kings, or through the extensive intercourse which for many years was kept up between Norway and the more northern parts of this country. As might be expected, therefore, it is in the north and north-east of the kingdom where traces of a Scandinavian element (especially in the names of places) are found to the greatest extent. It is very possible, too, that the original German invaders may have introduced words of Scandinavian origin.

(2.) The subject of *Orthography* is so fully treated

by Dr Latham, that it is not necessary to enter into any details here. The reader, however, in studying the fundamental *sounds* of the language, should take care not to confound them with the *letters* or *combinations of letters* which are used to represent them to the eye; thus, the sounds corresponding to the symbols *f* and *s* are not *ef* and *ess*, but, as in the commencement of the words, *fat* and *sit* respectively. It may be observed too, that, wherever the alternative is open, the English language almost invariably prefers the *flat* sounds.

(3.) *Etymology*, which constitutes that branch of the science of language which is concerned with "changes in the forms of words," is subdivided into *Accidence*, or the study of Inflections,—inflection being the change in the form of a word to indicate changes in its accessory meanings;—and *Derivation*, which treats of the origin of words, and the modification they undergo in passing from one language into another. Under this head the student should notice certain important general principles, amongst which we may mention—the "*Law of Accommodation*" (which, perhaps, belongs rather to orthography), that a sharp and flat mute cannot be pronounced together; the "*Law of the Suffix modification of the root vowel*," that the addition of a suffix to a root is often accompanied by a change in the characteristic vowel-sound of that root, as *break*, *broken*, *brother*, *brethren*, and so on.

The "*Law of Convergence or Assimilation*," which expresses the tendency (very often exemplified in the history of the English language) of several similar, but not identical, terminations to converge to a single form. Many such favourite forms, which have absorbed several originally distinct endings, might be instanced; thus, the termination "*ing*" represents (*a*) the Anglo-Saxon "*ung*," as in farthung, farthing; (*b*) "*ing*," implying descent, as in Atheling; (*c*) "*an*," the termination of the infinitive mood, hence the origin of the infinitive in *ing*, as in "*Riding* (= *to ride*) *is pleasant;*" (*d*) "*anne*," the case-ending of the dative infinitive, which, with the prefix *to*, was equivalent to the Latin gerund in *do*,—*to lovanne* = amando = for, &c., loving; as in the phrase "the church-going bell" (= the bell for (church) going,) and analogous expressions; and finally (*e*) "*ende*" of the present participle, *lovende*, loving; as in "Parents, loving their offspring, provide for them." Amongst these forms the student should carefully distinguish the true infinitive in "*ing*" from the participle. We may remark also, that the use of the "*to*" before the simple infinitive, (as *to write* = scribere, ecrire), almost peculiar to English, has arisen from a confusion between the simple infinitive (which is, of course, grammatically a noun) and the dative infinitive; it belongs properly only to the latter, but has been also prefixed to the former from a want of discrimination between the two

forms, when the characteristic endings were obscured. Another example of this principle of convergence is presented in the termination *im* or *em* of the pronouns (him, them). This was originally the sign of the dative case, but it has absorbed all the other terminations of the oblique cases, except the genitive.

The same law will often also be found to afford a more or less complete explanation of certain words, pronounced and even spelled in the same way, yet in reality quite distinct—a class which the student should carefully notice. The word "the," for example, is either the softened form of the Anglo-Saxon demonstrative pronoun,—the; or the ablative case of se, seo, thæt = that (representing "*by that*"), as in—All the worse = The worse by all that. Similarly we have "thinks" from thincan —*to think*, and from thencan—*to seem* (as in methinks); *do* and *become* exemplify the same principle, each being in fact two words fused into a single form.

It will be found of great advantage,—indeed, almost indispensable,—to study the principal inflectional forms of the Anglo-Saxon, especially in the case of the pronouns (see Latham); and to compare Etymological forms, with the cognate endings in the other Indo-European languages (*e.g.* see Appendix—"Verb-endings").

The origin and meaning of the most common *affixes* constitute an important part of Etymology;

the prefixes are generally simple enough, but the suffixes present somewhat more difficulty. They will be found in Latham and Adams.

(4.) A sufficiently detailed account of the fundamentals of *Syntax* will be found in Dr Latham's Grammar and Handbook. This part of the examination includes the criticism of phrases and sentences, in discussing which the candidate should bear in mind that they are not necessarily incorrect, often they are only inelegantly or awkwardly expressed; sometimes they present examples of *ellipsis*, and require certain words to be supplied to complete the full construction; thus, the expression—"I like you better than he," may be expanded into "I like you better than he likes you." It is useful, however, to remember that questions relative to the forms of words, and to the construction of phrases or sentences, do not always admit of an *unqualified* answer; they may often be decided in different ways, according as we consider them (*a*) *logically*, (*b*) *historically*, or (*c*) in reference to the *usage* of authorities. In *the Logical* investigation we apply the principles of language to the analysis and determination of the proper construction; looking closely at the meaning intended to be conveyed, we ask what *ought*, *à priori*, to be the construction of the words made use of in conveying it. This mode of elucidation is often much assisted by a consideration of the analogies supplied by other languages. We ask "How would this sentence be

rendered in Latin, Greek, or French? Are there any parallel constructions in those languages?" Such a comparison will often be found exceedingly instructive. In the *Historical* inquiry, we investigate the usage at the earliest period at which the form in question can be traced; we go back, if necessary, to the Anglo-Saxon, or even to the more ancient Teutonic languages; and we further inquire what modification it has undergone, and why? *Usage* is of course determined by a reference to the practice of the best modern authorities, and of educated persons generally. A simple example will render further explanation unnecessary:—

Take these sentences:

Him excepted, none came.
He excepted, none came.

Which is to be preferred? *Logically* considered, "him excepted" is correct; it is a case of the "absolute construction," and primarily the idea contained in that construction, and which determines the case to be employed, is that of an instrument, or cause, or antecedent (as in, "Cæsar having arrived, the army conquered"), expressed in Latin by the ablative, in Anglo-Saxon by the dative-absolute. "Him" is the dative, and therefore *logically* preferable. Considered from the *Historical* point of view, the same considerations would bring us to a similar conclusion. On the other hand, good modern *usage* is in favour of "he," the

nominative; and often, indeed, more decidedly than in this particular example (in which there is a little complication from a tendency to view the expression as equivalent to "except him"). No one would think of saying, for instance, "*Him having arrived the army, &c.;* in such doubtful cases we must decide upon the balance of argument; generally, however, giving the precedence to well-established usage as the final arbiter. It is not, of course, suggested that every sentence proposed for criticism requires or admits of such an elaborate discussion; it is only intended that the candidate should have before him the general mode, leaving the application to his own judgment in any particular instance.

ENGLISH HISTORY.

The regulations of the University prescribe the general history of England to the end of the seventeenth century as the subject of this part of the examination, and two or three questions on modern geography are usually included in the paper.

The first essential in the study of English history is an accurate knowledge of the *genealogy and dates* of accession of the successive sovereigns. The best tables we have met with are to be found in a small manual by J. D. Beale, entitled a "Text-book of English and General History" (Bell and Daldy), —a book which, in several ways, will be found useful. It contains a concise account of the History

of Europe as contemporaneous with that of England, with an epitome of the British constitution, and of the government and social arrangements of the Anglo-Saxons. Similar genealogical tables are given in Dr Smith's smaller History of England; they are, however, somewhat too closely printed, but the work itself will answer well for getting up the general subject. In any case, we would strongly recommend the student to make use of but *one* set of such tables, for, otherwise, the important aid which the memory derives from the eye is worse than lost.* In preparing for matriculation, two points may be mentioned as worthy of special attention:—1. *The important battles*, and in particular, those which have taken place on English ground; their dates, results, and exact locality, the latter the student should accustom himself to mark on an outline map; and, 2. *The principal points in Constitutional History* (particularly the great charters of English liberty), together with the explanation of those phrases in which are often crystallised, as it were, the most remarkable events of English history,—such as "The Long Parliament," "Nonjurors," "Constitutions of Clarendon," "Statute of Provisors," and so forth. A list of examples of these may be collected from the "Calendars." If the learner experience any diffi-

* We would urge upon the student the importance of thoroughly mastering the Genealogical Table, as a general basis for his studies in English History.

culty in remembering *dates* in the ordinary form, he may adopt either the system of rhyming, which may be found at the end of Ince's "Outlines of English History," or, if he prefer it, may have recourse to a method of embodying them in words, which will be explained elsewhere.

The candidate should be able to fill in an outline map of England, with:—(*a.*) the Roman subdivisions, and the chief towns and roads (Watling Street, &c.) of that period; (*b.*) the kingdoms of the Heptarchy, the "Littus Saxonum," and the "Dane-lagh;" and (*c.*) an outline map of France, with the provinces. He should also make himself acquainted with the general history of English dominion in France.

The questions in modern geography have usually a reference to important historical localities. The candidate should be prepared, moreover, to mark on a blank map the principal towns, mountain ranges, and rivers of Europe, or at least of the United Kingdom. It is, perhaps, unnecessary to remark that the most rapid and effectual method of acquiring a tolerable range of geographical knowledge is that of frequent study of maps, with occasional practice in outline sketches.

THE FRENCH LANGUAGE.

The paper in FRENCH includes two or three extracts from works not previously announced, a few easy sentences to be translated *ad aperturam*, and

questions in the Accidence. With respect to the translation, we need only refer the reader to the remarks on the study of the classics, of which he can avail himself as far as he thinks them applicable to his own requirements. In preparing the Inflections, he should take special notice of *the irregular plurals of nouns*, and of those *nouns which have different plural forms with distinct significations*, *the irregular comparatives and superlatives of adjectives*, and *the gender* of the more common substantives. With respect to these last, he should bear in mind the useful rule which connects the gender of French nouns with that of their Latin originals,—all nouns masculine or neuter in Latin become masculine in French, while Latin feminines retain their gender unaltered.* The use of the *masculine* form of the adjectival pronoun before a vowel or unaspirated *h*, with feminine nouns, should not be forgotten. The conjugation of all the common irregular verbs, as well as that of the normal forms, should be thoroughly mastered; the questions often refer to the imperative and subjunctive moods, and to the construction of interrogative and negative sen-

* If the Student can find time to look over Max Müller's *Lectures on the Science of Language* (both volumes), he will find many most useful hints on French Grammar, and on the French language generally; amongst other things an explanation of the few apparent exceptions to this rule. So also he may rapidly review Brachet's *Historical Grammar of French Tongue*, translated by Mr Kitchen.

tences. The peculiarity in the conjugation of verbs in "*ger*" is not unfrequently alluded to.

Out of the almost innumerable host of French grammars, it would, perhaps, be impossible to determine which is absolutely the best; notwithstanding that the work has been somewhat severely criticised, we are inclined to think that Hamel's is as good as any; it has, at any rate, the great merit of being easily understood. We can, with confidence, however, recommend Cassell's Dictionary; a cheap abridgment is published at three shillings and sixpence, which will be found to answer any ordinary purpose. In conclusion, we may state that Messrs Sampson Low & Co., supply copies of the works of French authors, including those required for matriculation, and generally for a very moderate price.

FIRST B.A. AND B.Sc. EXAMINATIONS.

ARITHMETIC AND ALGEBRA.

THE syllabus of the first B.A. and B.Sc. examinations, in addition to the subjects of matriculation, includes *Algebraic Variation*, *Permutations and Combinations*, *Annuities*, *Quadratic Equations*, and the *Nature and Uses of Logarithms*. Of these we may notice:—

Quadratic Equations.—A case of not unfrequent occurrence is that of an equation containing a *surd*, which admits of a simple solution by a process of obtaining an expression outside the radical sign similar to that beneath it. Representing, then, the surd quantity by a new symbol, we readily obtain the required roots. Thus—

Find value of x from

$$8ax^2+14bx+6\sqrt{ax^2+14bx+21b}=14;$$

making quantity outside surd sign similar to that beneath it, by adding $21b$ to both sides, and putting m equal to surd quantity, we get

$$m^2+6m=14+21b$$

therefore

$$m=\pm\sqrt{23+21b}-3.$$

Substituting surd value for m, putting it equal to each root successively, we have two equations, which give the four roots required.

The following, also from the London Papers, are solved upon a similar principle, and are inserted as easy exercises for the student:—

(1.) $ax^2+\sqrt{ax^2-bx+c}=bx$;

(2.) $x^2-x+5\sqrt{2x^2-5x+6}=\frac{1}{2}(3x+33)$.

The theorems of Algebraical Proportion (Inversion, Composition, &c.) may sometimes be usefully employed in reducing equations to a simple form, particularly when we have an algebraical fraction for one side, and a known value for the other. Thus applying theorem—

If $$\frac{a}{b}=\frac{c}{d},$$

then $\frac{a+b}{a-b}=\frac{c+d}{c-d}$, to this equation:—

$$\frac{\sqrt{a}+\sqrt{a-x}}{\sqrt{a}-\sqrt{a-x}}=\frac{1}{a},$$

we get $$\frac{\sqrt{a}}{\sqrt{a-x}}=\frac{1+a}{1-a};$$

from which the solution is easily obtained.

If it should occur that any factor containing the unknown, enters into every term of an equation, one or more roots of that equation may be obtained by putting such common factor equal to 0, and solving.

Cases of quadratics sometimes occur *in which the roots actually found will not satisfy the given equation.* Thus, if it be of the form—

$$ax+\sqrt{bx+c}=d;$$

the solution obtained by the ordinary method *may* be that of a similar equation, but with a *minus* sign before the surd, and we cannot determine without trial to which of the two it actually refers. The source of the fallacy of course lies in the fact that the square of the surd has the same sign whether derived from a plus or minus quantity.

Those who desire to work rapidly will find it convenient to accustom themselves to the solving of quadratics by the use of the formula for the values of the roots, without going through the routine process of solution.

The candidate should not pass over the consideration of the various properties of the roots of quadratics, and the mode of constructing an equation when its roots are given. They are noticed in any ordinary treatise on Algebra, and those who possess Puckle's "Conic Sections" will find a note relative to the subject appended thereto.

Proportion.—In addition to the particulars noted under matriculation, the relation of the Algebraic to the Geometric test of proportionality should be thoroughly understood, not overlooking the case of the ratios of incommensurable quantities. It will be found in Todhunter's "Algebra."

Logarithms are sufficiently entered into in Colenso's "Trigonometry," and it is only necessary to introduce two or three remarks here. The student should take care to thoroughly master the mode of finding the characteristic in all cases;

and for practical utility, the nature and use of Co-logarithms, and of the column of Differences. We append a note on the "*Modulus*" and the "*Advantages of the Common System.*"

Modulus.—The term "modulus" is often used in a *restricted* sense, to indicate the constant multiplier by which we pass from the logarithms of the Napierian system to another,—generally the common. In a general sense, however, a modulus between *any* two systems in the constant multiplier, by which we reduce logarithms of the one kind to those of the other, and it may be deduced in the following manner (a and e being *any* bases whatever):—

Let N be a number whose logarithm to base a is known ($=m$), and we require its logarithm in any other base e.

Then $\log._a N = m \therefore N = a^m$,

and let $\log._e N = x \therefore N = e^x$,

$$\therefore a^m = e^x$$

or $$a = e^{\frac{x}{m}}$$

or $$\log._e a = \frac{x}{m} = \frac{\log._e N}{\log._a N};$$

or $$\log._a N \times \log._e a = \log._e N.$$

$\text{Log.}_e a$ is the modulus by which we pass from system a to system e, that is, it is the log. of the number representing given base to required base. If e represent base of Napierian system, or 2·71828, then

$$\log._{10} e = \cdot 434294819.$$

The number by which we multiply Napierian to reduce them to common logarithms, representing, in fact, what is commonly understood by "*the modulus.*"

Advantages of the Common System arise from its having the same base as that of the common system of numeration. They are :—

1. We can always find characteristic by an easy inspection.
2. The logarithms of all numbers having the same series of significant digits, irrespective of the position of the decimal point, have the same mantissa, and differ only in their characteristic and perhaps sign, according to position of decimal point. Any digits are "*significant*" except the ciphers which are adjacent to a decimal point.
3. This property enables us to find, at least approximately, the logarithms of numbers higher than those given in the Tables.

Of the ordinary algebras, Todhunter's or Colenso's is the best. Wood's treatise is larger and more expensive, but is excellent in its details; for examples for practice, we may refer to Mr Kimber's collection of all the papers on this subject hitherto given at the first B.A. examinations, with the solutions of the questions, similar to that already referred to under Matriculation.

The Euclid of this examination requires no

special observation. It includes the whole of the sixth, and the first twenty-one propositions of the eleventh books. The solid geometry now required may be worked up from the chief propositions in Euclid, books XI. and XII., and in Wormald's Solid Geometry, which last has been specially prepared for similar examinations, and is published by Groombridge.

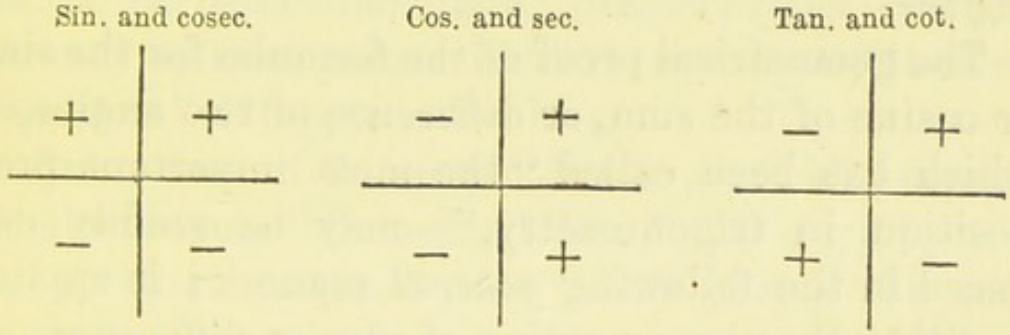
Trigonometry.—The candidate should work up the general subject from Colenso or Todhunter. A very good trigonometry (Hann's) is published in Weale's series, price one shilling. It is only necessary here to remark upon a few special points.

The *line* definitions should not be omitted; they are exceedingly useful in determining a large number of elementary formulæ, by a ready inspection; the ratio definitions, on the other hand, are best adapted for practical working.

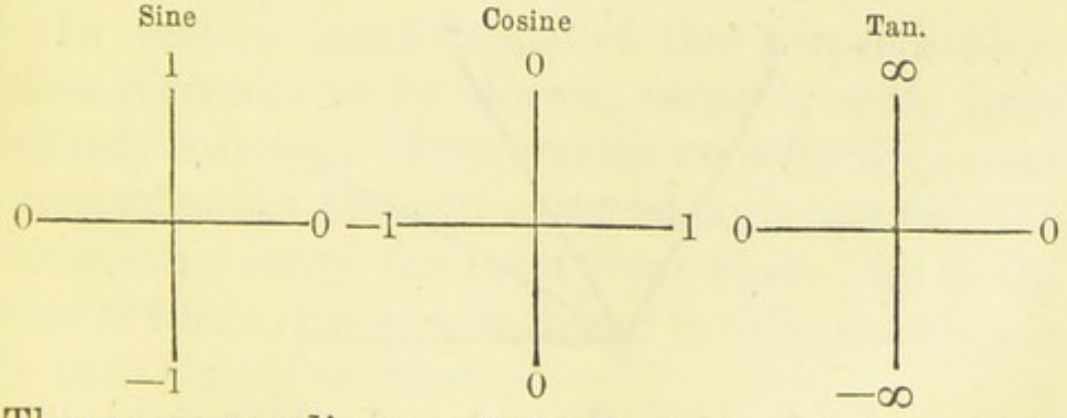
Occasionally we have noticed a little difficulty in understanding the forms which expressions for the circular measure of an angle or arc may assume. An arc of a circle (or an angle represented by such arc) is measured in two ways, either by stating what part it is of the entire circumference; in other words, the number of 360ths, or degrees which it contains; or by what is termed "circular measure,"—that is, giving the *length* of the arc —as if measured by a flexible tape,—the radius being generally the measuring line; thus an arc,

whose circular measure is $\frac{1}{2}$ or 3, is one whose actual length is $\frac{1}{2}$ or 3 times the radius. Any other line having length may, however, be used for the same purpose; thus the expression sin. (sin. 30°), indicates the sine of an arc which arc has a length equal to that of the sine of 30°;—in other words, the sine of an arc equal in length to $\frac{1}{2}$ the radius.

The pairs of reciprocals, *sine and cosec.; cosine and sect., tan. and cot.*, should be associated in the memory, and the signs of these functions in the different quadrants may easily be remembered by carrying in the eye these diagrams:—



The limits of the values by similar diagrams:—



The corresponding reciprocals being immediately deducible.

The particular numerical values of the sine (from which we easily get those of the other functions) of of 30°, 45°, and 60° are respectively—

$$\frac{\sqrt{1}}{2}, \frac{\sqrt{2}}{2}, \frac{\sqrt{3}}{2};$$

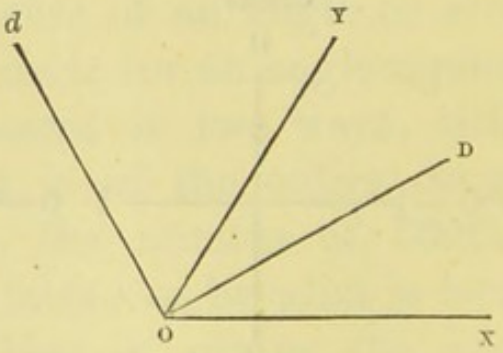
a form in which they are not likely to be confused. The following, too, are sometimes convenient:—

$$\sin 18° = \frac{\sqrt{5}-1}{4} \quad \sin 54° = \frac{\sqrt{5}+1}{4}$$

$$\sin 15° = \frac{\sqrt{3}-1}{2\sqrt{2}} \quad \sin 75° = \frac{\sqrt{3}+1}{2\sqrt{2}};$$

The candidate should carefully study the following:—

The geometrical proof of the formulæ for the sine or cosine of the sum, or difference of two angles,—which has been called "the most important proposition in trigonometry,"—may be readily deduced in the following *general* manner; it applies to either the sine or cosine of sum or difference:—



Take a fixed point O, and a fixed straight line OX, and with this make an angle $YOX = A$. Call

OX "fixed line 1," and OY "fixed line 2" (it is, of course, of no real consequence which of the lines, bounding angle A, we agree to call 1 or 2; but that which we call 2, becomes the line from which we measure B by revolving line).

From *position of fixed line* 2 (OY), suppose Od to revolve round O (in the positive direction, as Od, if we want the sum; in the negative, as OD, if we require the difference), till it makes an angle with OY equal to B.

To complete the necessary construction, we have to draw four perpendiculars, thus:—

Take a point P, in revolving line, and from P let fall perpendicular upon "*first fixed line*" (which we may call 1st perpendicular), and upon "*second fixed line*" (2d perpendicular).

From foot of 2d perpendicular, let fall perpendiculars upon "first fixed line" (3d perp.), and upon "first perpendicular" (4th perp.) In any of these cases *producing*, when necessary, the line upon which perpendicular is to fall.

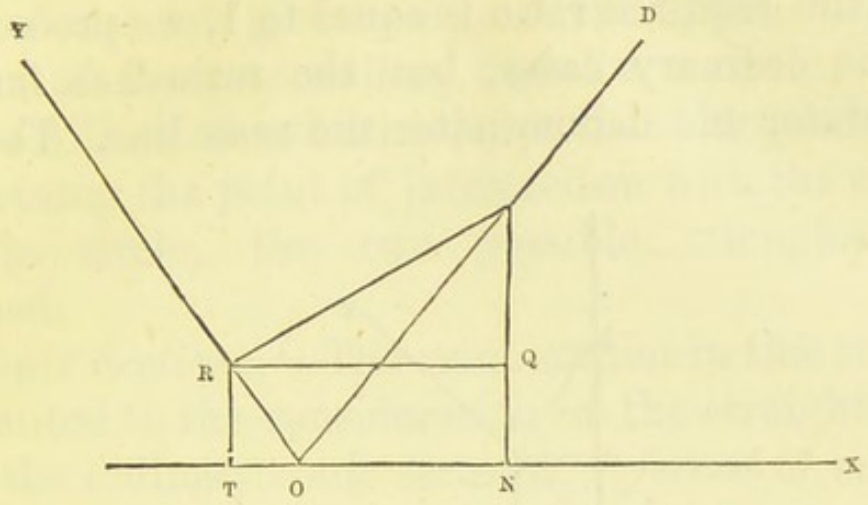
In certain cases, some of the perpendiculars thus directed to be drawn, coincide with lines already existing. This creates no difficulty,—the perpendiculars are still assumed to be drawn. In some other cases, the point *from* which, lies in the line *to* which, the perpendicular is to be drawn. It is then simply omitted.

Proof.—The sum or difference required will be the angle between the "first fixed line" and the

"revolving line;" *taking care to reckon the angle in the proper direction.* The ratio which represents its sin. or cos. will be evident on inspection. The side which forms the numerator of this ratio may be resolved into the sum or difference of two other lines; instead of one of which we commonly have to take an equal parallel line in the figure. Having thus obtained the sum or difference of two ratios, we take each separately; the two lines which represent the numerator and denominator of the first are sides of triangles, two of which will be found to have a common side, by means of which we may resolve this ratio into the product of two others; and similarly we may deal with second ratio.

The four fractions thus obtained are the ratios required. The necessary equalities of angles being generally proved by VI. 8 or I. 29, or from their belonging to two right-angled triangles, whose remaining angles are equal (∴ they leave a common remainder when taken from a right angle). It is necessary to bear in mind the usual principles of the signs of the sin. and cos. in the different quadrants. A single example will suffice.

To prove $\sin(A-B) = \sin A \cos B - \cos A \sin B$ when A is between 90° and 180°, and B not far from a right angle.



Here $YOX = A$; and OD revolving in negative direction from OY makes $YOD = B$. DOX is difference therefore. Completing construction as directed, we have

$$\sin(A-B) = \frac{PN}{PO} = \frac{PQ+QN}{PO} = \frac{PQ}{PO} + \frac{RT}{PO}$$

$$= \frac{PQ}{PR} \cdot \frac{PR}{PO} + \frac{RT}{RO} \cdot \frac{RO}{PO}$$

$$= \cos RPQ \sin B + \sin A \cos B ;$$

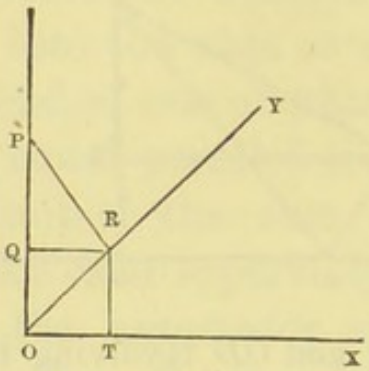
but $RPQ = QRO$ (VI. 8) $= ROT$ (I. 29),

and $\cos RPQ = \cos ROT = -\cos A$

$\therefore \sin(A-B) = \sin A \cos B - \cos A \sin B.$

The only case where the geometrical proof is inapplicable in this form, is where the sin. or cos. of the sum or difference in question is equal to 0. This case, however, is easily proved, by showing that both sides of the equation are equal to 0, and, therefore, equal to each other. It is chiefly necessary to remember the relation of the sign of a sin. or cos. of an angle, with the sign of the sin. or cos. of its complement, supplement, &c., for this proof

If the required ratio is equal to 1, we proceed as in the ordinary cases, but the ratio has for its numerator and denominator the *same* line. Thus—



Let $A+B = 90°$, with similar construction, we have :—

$$YOX = A, \text{ and } DOY = B$$

Then $$\sin (A+B) = \frac{PO}{PO}.$$

This is seen if we gradually increase an angle till it reaches indefinitely near to 90°,

$$\frac{PO}{PO} = \frac{PQ+QO}{PO} = \frac{RT}{PO} + \frac{PQ}{PO}$$

$$= \frac{RT}{RO} \cdot \frac{RO}{PO} + \frac{PQ}{PR} \cdot \frac{PR}{PO}$$

$$= \sin A \cos B + \cos QPR \sin B,$$

but $$QPR = A \text{ (VI. 8, and I. 29.)}$$

The "ambiguous case" in the solution of triangles occurs when,—having given two sides of a triangle and an angle not included, *the side opposite that angle is less than the other given side* (which, of course, includes the condition that the triangle is not right-angled). The ambiguity is easily shown geometrically thus:—With common junc-

tion of the two given sides as centre, and with the lesser of them as radius, describe a circle. This circle will cut the third side, or that side produced; by joining the point of intersection with the centre of the circle, the two possible triangles are formed.

Conic Sections.—The examination in this subject is limited to the consideration of the straight line, and the ordinary conic sections, *referred to rectangular* co-ordinates. The books usually read are Puckle's or Todhunter's "Treatises on the Conic Sections;" both are excellent works, covering very nearly the same ground, and there is really little to choose between them; but upon the whole, perhaps Todhunter's work is the best adapted to the candidate reading for the London degree. In the study of this branch of mathematics, we would recommend that the same symbols should be always used uniformly to denote the same things (thus, in the straight line, a and b may represent intercepts on axes, a the angle which straight line makes with axis of abscissa, θ the angle with axis of abscissa of a perpendicular, on line from origin, &c., &c.), and not, as is the usual practice, to indicate different lines or angles under different circumstances. Some confusion may be avoided by adopting this suggestion.

The points to which the student should especially direct his attention are:—

First, The straight line and general equation

of first degree, the different forms of the equation, and the simpler propositions on the straight line (as for instance Sections I. and II. of Puckle).

Second, The equations to the circle, parabola, hyperbola, and ellipse, deduced from the characteristic property of each curve. These are given very fully in Todhunter's work; if the student make use of Mr Puckle's Manual, he may deduce them himself by a comparison of paragraph 162 with 101 and 102.

The equations to the tangent and normal to each of these curves. A simple method, for the tangent, will be found in either of the works mentioned; in Puckle, in paragraph 253;—the process given under the head of the several curves by this author, is somewhat more difficult.

Third, The interpretation of loci—that is, the determination of the lines or curves represented by a given equation. With brief but sufficient directions on this head, we shall conclude the consideration of this part of the examination. We may premise the observation, that the equation should be first reduced to its simplest form, by dividing by any common factor, squaring to get rid of any roots of the variables, &c., and that by an "*absolute*

term" is meant one which contains neither x nor y.

(*a.*) The equation of the first degree, in general, represents a straight line. *If it contain an absolute term*, the corresponding line does *not* pass through origin, and may be easily determined by making x and y successively equal to 0 in the equation; the value of y in the former case, and of x in the latter, then gives the intercepts on the axes, and we can at once draw the required line accordingly.

If the equation do not contain an absolute term, the line passes through origin, and we have first to find in which pair of quadrants it lies; this is done by noticing the *sign* of the value of $\frac{x}{y}$ deduced from equation; if plus, the line will be in the 1st and 3d, if minus, in the 2d and 4th. Secondly, to determine the exact position, the value of $\frac{x}{y}$ gives us the ratio of abscissa to ordinate of any point on required line, therefore, taking one of these of known magnitude, we at once have the other, and therefore a point through which the line passes, and this suffices to determine it, by joining origin.

(*b.*) Equations of second degree. The general equation has the form:—

$$Ax^2+Bxy+Cy^2+Dx+Ey+F=0\,;$$

or

$$y=\frac{-(Bx+E)+\sqrt{(B^2-4AC)x^2+2(BE-2CD)x+E^2-4CF}}{2C}\,;$$

This latter result should be carefully remembered, as upon it depends the solution of the point in question. Thus, if the constants in any such equation have such a value that :—

I. If B^2-4AC is negative, locus is an *ellipse*, but if also

(*a.*) $A=C$ and $\frac{B}{2A}=\cos\omega$—locus is *a circle.*

(*b.*) $(B^2-4AC)\ (E^2-4CF)-(BE-2CD)^2$ is positive, locus is *impossible,*

(*c.*) Do. do. do. is 0, locus is *a point.*

II. If B^2-4AC is positive, locus is hyperbola, but if also

(*d.*) Quantity under root is a complete square, locus is *two intersecting straight lines.*

III. If $B^2-4AC=0$ (*i.e.* if first three terms of general equation form a complete square) we take the next term as the test :—

(*e.*) If also $BE-2CD$ is positive or negative, locus is a *parabola,*

But if $BE-2CD=0$, we take again the next part of the radical quantity as the test. That is under these circumstances—

(*f.*) If E^2-4CF is positive, locus is *two parallel lines.*

(*g.*) If do. is 0, locus is *one straight line.*

(*h.*) If do. is negative, locus is *impossible.**

* If it should happen that the co-efficient of y^2, or C, is $=0$, then in above expressions we must substitute D for E, E for D, and A for C.

To make use of above results (which, though somewhat complicated in appearance, are sufficiently simple in practice), we write the given equation in the form of the general equation of the second degree, this gives us the value of the coefficients, A, B, &c., and we can at once then determine to which of the three great classes the corresponding locus belongs, by the value of B^2-4AC, and applying the further tests find accurately what it is. If, for instance, the equation were $3x-y^2=0$—writing in the form of the general equation we should find $A=0$, $B=0$, $C=-1$, $D=3$, $E=0$, $F=0$, and hence easily deduce the locus,—a parabola.

ENGLISH LITERATURE AND HISTORY.

This part of the examination includes—(*a.*) The English Language; (*b.*) English Literature—portions of the works of two or three eminent authors—announced from year to year; and (*c.*) English History. The *English Language* has been somewhat fully discussed in connection with matriculation, and it is not necessary to add anything here on the study of the subject generally; a similar course will meet the requirements of both examinations.

In the preparation of the authors, the candidate will find it of great advantage—if a poetical or dramatic work—to commit it to memory, as far as he conveniently can; if prose, to make a full and

accurate analysis. The points which are most frequently referred to in the questions, and to which, therefore, special attention should be directed, are :—

(*a.*) The meaning of every part, so that if necessary it may be given in paraphrase.

(*b.*) Obsolete or rare forms of words, their derivation, meaning, and history.

(*c.*) Special allusions to history, mythology, &c.

(*d.*) Phrases which have passed into current speech, or which are remarkable for beauty or vigour.

(*e.*) Any imitations of other authors, or any similarities of sentiment or illustration.

(*f.*) The lives of the authors, the date of their works, and circumstances under which they were written, with the most striking peculiarities and characteristics of their style.

Chambers's "Cyclopædia of English Literature" is the most convenient general work on the subject, and the information there given may form as it were the basis, to which may be added information from any other accessible sources.*

In the case of poets, Johnson's "Lives" should be consulted. Of manuals of English Literature,

* Annotated editions of authors given for examination, may usually be secured by writing to Thornton of Oxford, or Wheeler & Day, Cambridge.

we may notice, amongst the smaller works, Spalding's, a book which will answer the student's purpose, but is written in an uninteresting style. Those who desire more elaborate treatises, may employ Angus or Craik. In the volumes of Macaulay's collected "Essays," will be found elaborate critiques on several English writers, not unfrequently given, amongst which are Johnson, Bacon, and Milton. The student will scarcely omit the opportunity, occasionally thus afforded him, of combining a rich intellectual treat with the acquisition of special information for his examination.

In prosecuting the study of the authors, the candidate will find a good Etymological Dictionary almost indispensable, especially for those writers in which obsolete or antiquated forms occur. Amongst the less expensive we may mention Reid's "English Dictionary," and a similar, perhaps better, work published by Chambers for five shillings (Donald's "Etymological Dictionary"); but if the reader should chance to meet with Bailey's "Dictionary,"—an old work, published in Edinburgh, which may occasionally be picked up cheap at a second-hand book-stall,—he will find in it a very valuable collection of obsolete words, and difficult etymologies. Wright's "Dictionary of Obsolete and Provincial English" (Bell and Daldy) may be referred to. In a recent number of the *Edinburgh Review* (July 1869), is an article on

Shaksperian language and glossaries, which will direct the student of his plays. Craik also has published a work on the "English of Shakspere." A glossary of obsolete and rare words in Milton, is printed at the end of Donald's "English Dictionary" (Chambers).

The third subdivision includes English History, as at matriculation, to the end of the 17th century. It is only necessary to supplement what has previously been said, by recommending special attention to *constitutional* points. In addition to what is found in ordinary histories, the student should make himself acquainted with the most important parts of Creasy's "Constitutional History of England," or of Murray's shilling reprint of "Hallam's Constitutional History," and of Macaulay's essays thereon; and he will find it a not uninteresting occupation, and one which will amply repay him, if he carefully peruse certain chapters of Blackstone's "Commentaries" (Book I., "The King and his Title;" Book II., chap. iv. and v.; Book III., chap. iii., iv., xxii., xxiii.; Book IV., chap. viii., and the chapter on the "Rise and Progress of English Law"). There is a work in Weale's series, "Hamilton's Constitutional History," which contains a large mass of information on these points, but somewhat confusedly arranged; but if the student will be at the trouble of disentangling it, this book will answer his purpose very well. We may add, in conclusion, that

a careful perusal of the introduction to Macaulay's "History of England," should be by no means omitted, questions are often taken directly from it, and it contains an admirable summary of the gradual growth of our constitution. Craik's "English Literature" gives a full account of the Chroniclers and other authorities for the earlier periods of English history.

FRENCH AND GERMAN.

Translation from authors not previously announced, and re-translation of English passages into the language are the requirements of this part of the first B.A. examination. It is not necessary to do more here than to give a hint as to the mode of practising the re-translation where the aid of a tutor cannot be obtained. In such a case, the student should render passages from French authors into tolerably free and idiomatic English, put the translation aside for a month or two, and then re-translate from them into French or German, comparing his result with the original. The pronunciation of these languages, which, however, does not enter into any part of the examination, cannot possibly be acquired without oral instruction. Amongst works which, though not written directly on French Grammar, &c., it is very useful to look over, are Sir G. C. Lewis' "Romance Languages," Max Müller's two volumes

of "Lectures on the Science of Language," and Mr Kitchen's translation of Brachet's "Historical Grammar of the French Tongue." Works of this latter description are, of course, suggested to the student for rapid review only; and in this way he may quickly extract whatever is likely to be useful to him.

SECOND B.A. AND B.Sc. EXAMINATIONS.

MECHANICS AND HYDROSTATICS.

THESE, with Hydraulics and Pneumatics, form the subjects of the morning paper on Wednesday of the examination week. The first of the two divisions of Newth's "Elements of Mechanics," &c. (*i.e.* of his large work), is compiled with especial reference to the questions of that paper, and contains all the subjects therein required. It will, therefore, only be necessary here to introduce a few hints which may aid and supplement the study of that book.

For *motion on inclined planes* (motion of a body *directly* up or down the plane), we have three cases exactly corresponding to the three cases of vertical movement, under accelerating forces (see Matric., Nat. Phil.), and the three sets of formulæ are precisely the same, with this exception, that the accelerating force, instead of being g, or 32·2, is $\frac{gh}{l}$.

The student should not overlook the proposition respecting the descent of bodies down the chords of

a vertical circle, and should practise the deductions from it, since it is often referred to in examination questions.

Parabola of Projection.—It is often convenient in the solution of problems to be able to construct geometrically the parabola for any given angle and velocity. This is easily done thus :—Let h represent the space to which the body would rise if projected *vertically* upwards with given projectile velocity (that is, space due to projectile velocity); h' ($= h.\cos.^2 a$,) the space due to horizontal component (V. cos. a) of projectile velocity, and a the angle of projection. Find first horizontal range, bisect this, and from this point of bisection erect a perpendicular, and make it equal in length to h, through its extremity the directrix passes, which therefore, whatever be the angle of projection, is fixed for the same velocity—always being at a height of h above horizontal line passing through point of projection. From top of this perpendicular measure along it *towards horizontal line in question*, two parts successively, each equal to h'. The first will give position of vertex, the second of the focus on the perpendicular, and these points are therefore situated at a distance of h' and $2h'$, respectively, below directrix.

If the projectile force act *horizontally* forwards, the same construction will show that the vertex coincides with the point of projection, while the focus is placed at a distance of h below it.

If the body be projected *downwards*, we can determine the curve by the consideration, that *when a body is projected obliquely upwards it strikes the ground* (*that is, horizontal plane through point of projection*) *with the same velocity, and at the same angle at which it was projected.* In the case of *downward* projection, therefore, we may regard the body as moving in a path as the result of having been projected *upwards* (at same angle with horizontal plane, and at same velocity, but) from a point at a distance from the actual point of projection, equal to the horizontal range. Having thus reduced to a case of upward projection, we can determine directrix, focus, and vertex as before.

We may add that the same considerations show that if a body be projected *vertically* upwards, the parabola becomes a straight line, and the directrix, vertex, and focus coincide at its highest point.

The student should examine these different cases, and trace their results with diagrams. The directrix has this remarkable property, that the velocity of the body in the direction of the curve at any point (that is, in the line of a tangent at that point), is the same as the velocity which would be generated by falling from the directrix to that point.

Centre of Gravity.—The great majority of problems on the centre of gravity may be *easily* solved by the application of the following principle:—"The sum of the moments of any number of

parallel forces about a plane without them, is equal to the moment of their resultant about that plane;" which, in connection with this particular application of it, may be enunciated thus:—The sum of the products of the weights of *the parts* of a body into the respective distances of their centres of gravity from a given plane without them, is equal to the weight of *the whole*, multiplied by the distance of its centre of gravity from the same plane. This proposition is really the key to this class of problems, and we strongly recommend the reader to practise the solution of questions by its application. It should be remembered that all the parts must be outside and on the same side of the assumed plane; and that in general it is sufficient if we can determine the *proportionate areas* (*i.e.* weights) of the parts, without troubling to obtain the *actual* superfices from the given data. A simple example will make all clear.

From a given square, let one of the four equal triangles, formed by the intersection of the diagonals, be cut out: it is required to find position of centre of gravity of remainder.

Imagine the imperfect square situated horizontally and placed against a wall or other vertical plane, in such a way that the absent side would, if present, be in contact therewith. Let the distance between the centre of the square and the vertical plane, be represented by d (if the side of the square be given, then d may easily be found, if re-

quired by the form of the question), the area of each triangle by A, and the distance of centre of gravity of remainder also from assumed vertical plane be x. Then, since areas represent weights, the square being uniform, we have, by proposition :—

Weight of entire square $\times$ d = weight of omitted triangle $\times \frac{d}{3}$ + weight of remainder $\times$ x;

or $4A.d = A.\frac{d}{3} + 3A.x$;

or $4d = \frac{d}{3} + 3x$;

or $x = \frac{11}{9}d$;

but x is the distance of centre of gravity required *from assumed plane*,—subtracting d, we find that it is situated $\frac{2}{9}d$ from centre of square.

Strictly speaking, this process only gives us a line (since an infinite number of points may be at same distance from plane), in *some part of which* required centre of gravity is situated; but we can commonly immediately determine another line from the symmetry of the figure,—since if any figure be symmetrical about a given line (that is, if folded over on that line, the two parts would coincide), the centre of gravity must lie therein. In the example given the line of symmetry is d produced, and therefore centre of gravity lies in it, at a distance as already shown of $\frac{2}{9}d$ from centre.

If we cannot apply the principle of symmetry we must repeat the process of the plane, by assuming it in another position and thus getting a new line, in which also the centre of gravity is situated.

Since the centre of gravity of none of the parts must be in contact with the assumed plane, it is in some cases necessary to take that plane at a distance, which, for the sake of simplicity, we consider to be 1. Thus, to find centre of gravity of four-fifths of the *perimeter* of a regular pentagon—Let a = radius of inscribed circle, and W, weight of each side; and assume a vertical plane parallel to deficient side (exactly as directed in case of square) and at a distance of 1 from it, and let x be distance of required centre of gravity from plane.

$$\left\{\begin{matrix}\text{Then moment of whole perimeter}\\ \text{about this plane}\end{matrix}\right\} = \left\{\begin{matrix}\text{moment of}\\ \text{deficient side}\end{matrix}\right\} + \left\{\begin{matrix}\text{moment of}\\ \text{remainder}\end{matrix}\right\}$$

$$\text{or} \quad 5W(a+1) = W\times 1 + 4Wx;$$

$$\text{or} \quad 5(a+1) = 1+4x;$$

$$\text{or} \quad x = \frac{5a}{4} + 1$$

subtracting distance of plane, we have the point required $\frac{5a}{4}$ from deficient side.

Central Forces.—After mastering the first problem—to find centrifugal force—the candidate is recommended, at least upon the first reading, to omit the succeeding propositions between it and the definition of central forces. Not being con-

cerned with *central forces* we have often found them cause some confusion. It should be noticed that the essence of a central force is *a constant acting towards a fixed point*,—a body need not move *round* the centre,—thus it may describe an ellipse in connection with a centre of force situated *outside* the curve. F, indicates the force acting along a radius vector—a line joining the body with the centre of force; f, the force along the normal to the curve at any point, where the body may happen to be. A very important formula is $F = \frac{h^2 R}{p^3 r}$, where R is radius vector, r radius of circle of curvature, &c. This gives the law of force by substituting for p and r, their values for the particular case. Of late years there has usually been given a question selected from those printed in chapter on Central Forces in Todhunter's Mechanics.

OPTICS, ACOUSTICS, AND ASTRONOMY.

For the Acoustics and Physical Optics, the candidate may make use either of Golding Bird's "Manual of Natural Philosopy" (Churchill's Series), or Ganot's "Elementary Treatise on Physics,"—translated by Atkinson—the former is perhaps, upon the whole, to be preferred. For the Geometrical Optics, Galbraith and Houghton's "Manual."

The special points required are stated pretty fully in the published Syllabus of the Examination,

and it will not therefore be necessary to do more than append a note or two in reference to them.

Physical Optics treats of the phenomena of light descriptively, or as deduced from certain hypotheses respecting its nature; *Geometrical Optics* follows out in a geometrical manner the results of certain experimental laws,—chiefly the simple principles of reflection and refraction. The *geometrical focus* of a pencil is the focus of those rays which pass near the axis, and it is to this that the ordinary formulæ refer.

The undulatory theory assumes that light consists of the vibrations of an exceedingly elastic and rare medium, which pervades all space, and exists between the molecules of material substances,—being in them of less elasticity in proportion to the refracting power of the substance. The principal *proofs* are derived:—

First. From the phenomena of Interference and Diffraction.

Second. From M. Foucault's experiments. By means of a rotating mirror, he directly estimated the velocity of light, and found it to be *less* in the more highly refracting medium. This is a crucial proof of the truth of this theory, against the doctrine of emission.

Third. From the phenomena of Polarisation.

Experimental Mode of finding principal Focus of Mirrors or Lenses.

If the mirror or lens be converging, the focus point is easily ascertained by exposing to sun's rays, and observing the position of the smallest circle of light on a screen.

If, however, the mirror be convex, or the lens concave, a different mode of proceeding becomes necessary. For a mirror,—cover the surface with some opaque paint, except two small holes on the same principal section, and at equal distances from centre of mirror. A screen, with a round opening in its centre,—this opening being of a diameter somewhat greater than the distance between the two uncovered spots,—is held before the mirror, which is exposed directly to the solar rays. Two brilliant images are formed on the screen, by light reflected from the uncovered portions of the mirror. Now move the screen nearer to, or farther from the mirror, till distance between these spots is *double* the distance between uncovered portions. The screen will then be in focus of mirror.

Similarly, with a concave lens, cover one face with some opaque substance, leaving two small apertures, as in mirror, expose opposite face to solar rays, and receive transmitted pencils on a screen. Then, when distance of spots on screen equals double that between apertures in opaque covering of lens, screen is situated in focus. The proof of this proceeding is easily deduced.

The candidate should make himself acquainted with the mode of deducing the laws of reflection and refraction, from the principles of the undulatory theory. We may notice that what in Galbraith and Houghton's "Manual" is termed the "simple" microscope, is always in England designated "compound."

A "Manual," also in the series by Galbraith and Houghton, will supply the necessary information in Astronomy.* A more general acquaintance with the subject may be obtained by studying, in addition, Herschel's "Treatise," omitting, if the reader choose, the last four chapters. Special attention should be directed to the three systems of great circles which determine the position of the heavenly bodies,—the *ecliptic* (latitude and longitude), the *equinoctial* (declination and right ascension), and the true or celestial *horizon* (altitude and azimuth); the explanation and conditions of lunar and solar *eclipses;* and the variations in the appearance of the visible heavens, according to the position of the spectator, and with the diurnal and annual rotation of the earth.

ANIMAL PHYSIOLOGY.

The London University was perhaps the first amongst the great educational institutions of this

* A most admirable little manual of astronomy has lately been published, Lockyer's "Elementary Lessons in Astronomy" (Macmillan). For completeness and clearness it is unrivalled; and we strongly recommend it to the student in preference to all other books on the subject

country to recognise the importance of a knowledge of the structure and functions of the animal economy as a branch of *general* education; and a paper in this subject constitutes an essential part of the examination for its degrees in arts or science. This is not the place to enter into any detailed justification of this innovation, but we cannot help remarking that, to us, no spectacle seems more incongruous than that of a scholar intimately versed in Greek roots, and at home in the differential calculus, who yet would be sorely puzzled to give any distinct account of the mechanism of the circulation, and to whom the fate of a morsel of food, after it had passed out of sight, would be a sealed mystery.

This subject, as understood at London, consists of three parts or sub-branches—(*a.*) The minute structure and properties of the various tissues and organs; (*b.*) Human Physiology; and (*c.*) Animal or Comparative Physiology. The last is important, and should be by no means overlooked. It has been of late years the custom to occasionally give papers almost wholly comparative, and hence, if the student content himself with the human part of the subject, he may find himself in a difficulty. The usual and the best plan is to study the human arrangements as the type, and afterwards note any deviation in the lower animals. The candidate should in this way carefully get up the nervous, digestive, circulatory, respiratory, and reproductive systems, together with the organs of special sense.

In other respects he may confine himself to pure human physiology.

The books usually employed are Carpenter's Manual and Huxley's "Elementary Physiology."* The student should read both, and, if possible, he should refer on the points above-named to Dr Carpenter's larger work—"The Principles of Comparative Physiology," so as to extract from it the most important modifications which the systems above-mentioned present in the lower animals. This is the course of reading we should recommend, but other books are not unfrequently found in the hands of students; amongst these are:—

Shea's Physiology, which is a tolerably good summary, and contains in a compact form the chief points in Comparative Anatomy; it is, however, very defective in its account of minute structures.

Hilles' Compendium.—A similar work, useful to refresh the student's knowledge previously to examination.

Kirke's Physiology.—This work is about the size of Carpenter's Manual, and is intended to occupy similar ground; but we can, without hesitation, recommend Dr Carpenter's work as the best adapted for the student.

Since this is a subject with which men, for various reasons, not unfrequently experience some difficulty, we shall enter into some detail in connection with it, for the double purposes of placing the

* Macmillan & Co. Price 4s. 6d.

student in a better position for appreciating the various works which he may read on this branch of science, and of suggesting the best modes of arranging the numerous details which it is essential that he should retain in his memory.

The so-called "cell-theory" (that is—the theory which regards cells as the ultimate agents in growth, secretion, &c.) occupies the same place in the study of Physiology, as does the atomic theory in that of Chemistry. It is a fundamental generalisation which enables us to bring a vast number of otherwise unconnected phenomena under one great principle; it is the chain which, running through the endless minutiæ which have been accumulated by the labour of generations of observers, links them into a scientific unity. We do not here enter into the question of how far it may be regarded as true, it is sufficient for the purposes of the student if it enable him clearly to understand his facts, and so to group them as to stamp them ineffaceably upon the memory. Our own opinion is that the evidence which has been adduced is amply sufficient to establish its general truth; and we shall proceed to notice the chief points in connection with this doctrine.

A "*cell*," then, in its typical form, consists of a closed sac or bag of membrane (averaging from $\frac{1}{1000}$ to $\frac{1}{3000}$ inch in diameter), the "*cell-wall*," enveloping certain solid or fluid matters, *the contents*, in which lies another vesicular body, *the nucleus;* in some part of whose interior, a spot or

granule may often be detected—"*the nucleolus.*" The exact shape of the cell may vary,—the *original* form is in nearly all cases spherical, but they are subject to a great variety of modifications in this particular, from external pressure, their own growth or development, and so forth. Nor must it be supposed that the nucleolus, or even the nucleus can *always* be seen in every cell; the nucleolus particularly, and the nucleus very frequently disappear in the course of the changes which the cell undergoes; but the nucleus at least is always present at some time or other in the life-history of the cell.

Cells are *active*, *living* bodies, and all the operations of minute life in the animal and vegetable kingdoms are carried on by their agency; the phenomena of animal life for instance, is, in fact, neither more nor less than the *sum* of the individual lives of countless cells. It is cells which do all the work of secretion, which draw or separate by some unknown power, from the great storehouse, the blood, whatever is required in the animal economy—bile, gastric juice, milk, &c.*

I. *The function of cells as living agents is chiefly to draw materials from the blood, and afterwards to dispose of these in various ways.* Let the reader imagine a number of cells resting in a layer in contact with one side of a structureless membrane,

* This must not be understood to mean that the matters secreted always pre-exist *as such* in the blood; cells often *form* new compounds in the act of separating them.

beneath, or on the other side of which, is a plexus or network of capillary blood-vessels, through which a stream of blood perpetually flows. Though these capillaries may be in close contact with the membrane, none of them pass through it so as to touch the cells. By virtue of what we must at present be content to call their "vital powers," the cells possess the faculty of drawing into themselves from the blood in the capillary plexus, whatever it is their function so to separate. Liver cells for instance, will separate, "secrete," attract into themselves, the elements of their peculiar product, bile, and they will become at length more or less filled with biliary constituents, which may be *seen* in their interior. This simple explanation gives all that is really known of the secreting or separating power of cells; in other words, cells have the power of drawing from the blood-vessels in their immediate vicinity whatever materials it is their office thus to separate. It will be observed that in this particular example given, the cells draw their secretion through the membrane of the capillary wall, the membrane upon which they lie, and also through their own; and this is the case with all secreting glands, of the mode of action of which the above is a general account.

The next step in the general inquiry, is to determine *what the cells do with the material thus separated from the blood.* It is disposed of in one or more of the three following ways:—

1. The cells may give off again what they have separated from the blood— { By transudation. / By dehiscence.
2. They may store it up within themselves till it is required for some purpose in the animal economy.
3. They may themselves appropriate it in their growth,—*i.e.* may use it up in their changes of size, form, or structure.

The first includes what we commonly call "*secretion*," and the process is everywhere essentially the same, as in the suppositional case explained above. *True secreting glands* present this essential structure under two modifications,—forming the two classes of *racemose* and *tubular* glands. In the latter, the membrane, on the inner side of which the cells lie, assumes the form of a tube closed at the lower extremity; if the reader imagine a common test-tube lined with cells, and having blood-vessels in a network applied to its outside, he will have a very correct idea of a *simple* tubular gland. In *compound* tubular glands, the only difference is that the primary tube is subdivided and branched, as in the kidney. If, on the other hand, we suppose a comparatively large bulb blown at the extremity of the test-tube,—which bulb is, of course, lined with secreting cells,—we shall mentally construct a *simple* racemose gland. Almost invariably, however, the primary tube is subdivided, and these

branches are again subdivided, and so on till a very large number of ultimate tube-twigs is formed, each ending in a bulb-like dilatation, so that the entire gland bears some resemblance to a bunch of currants or grapes,—this is a *compound* racemose gland. Such are the salivary glands, the milk or mammary glands, the pancreas. The distinction, then, between the two great types of secreting glands is this,—that in one the membrane upon which the cells rest is disposed in the form of elongated tubes; in the other of minute sphericles. It is further evident that the gland cells, when gorged with the materials which they have drawn from the circumfused blood, can give up their contents in one of two ways only—(*a*) by *transudation—i.e.* the filtering of the liquid part through the wall of the cell, without injury, rupture, or detachment of the cell; or (*b*) by *dehiscence*—that is, the breaking of the cell wall, destruction of the cell itself, and escape of its contents. The latter process, however, probably occurs *sooner or later* in every instance, since the life-history of every cell is comprised within comparatively narrow limits.

We would remark, *en passant*, that the reader should be careful not to confound the true secreting glands above-described, with a very different class of organs also denominated "*glands*,"—we refer to the so-called "ductless" or "blood-vascular" glands, of which the spleen, suprarenal capsules, lymphatic glands, and the closed follicles embedded

in the digestive tract of mucous membrane, are the chief examples. These consist essentially of masses of cells and cell-nuclei, variously arranged and supported, through which a stream of blood (either in a net-work of capillaries, or in direct contact with the cells) continually filters. Their function is probably that of *blood manufactories*—taking the raw material furnished from the intestinal canal, they elaborate it to render it fit for the sustentation of the vital processes; and they are, moreover, believed to be the source whence are derived the multitude of cells or corpuscles which float in the circulating fluid.

The *second* mode in which cells may dispose of the matters which they draw from the blood, is by storing it up in their interior, till it is required for some purpose in the animal economy. Of this kind are "fat cells;" "adipose tissue," of which the "fat" of meat is an example, consists of a mass of cells ($\frac{1}{1000}$-$\frac{1}{200}$ in diameter) each cell being filled with oily or fatty matter. Now this fat is gradually laid up in stock till wanted—if a man be starved, the fat cells, instead of being full and plump, become shrunken, half-empty, and flaccid, the oily matter being drawn into the circulation again by the same path as that by which it left it.

The *third* mode includes all the processes of growth and change in cells. Simple growth need not be specially referred to, but since all, or nearly all, structures in both the animal and vegetable

kingdoms are formed *by modifications and combinations of cells*, we may enter into a few details on this point. In building up a tissue, cells may change without becoming actually and structurally united to each other, so that at any time we can detect the separate origin of each element of the tissue; or, on the other hand, they may be so completely fused together and organically continuous, that in the fully developed structure, all trace of the origin of the parts from separate cells may be obliterated. Amongst the more important of these developmental changes are:—

(*a.*) The conversion of a *cell* into a *fibre*. This consists simply in the gradual elongation of the cell, which becomes, at the same time, solid, or remains more or less hollow, as the case may be. Such are the "fibre cells" which constitute non-striated muscle; in these the nucleus remains and undergoes elongation with the cell. In "elastic fibres" (yellow elastic tissue"), however, all traces of cell structure may disappear, and a solid, cylindrical, or flattened thread remains. These last, we may remark, are characterised by their yellow colour, their elasticity (which causes their extremities to curl up, when the fibre is divided), and their resistance to decomposition, boiling, and chemical reagents.

Nerve fibres, often improperly called

nerve tubes, are, in like manner, formed from cells. Here the cells elongate, and unite end to end, so as to give rise to a long fibre. The contents simultaneously become solid and indistinguishable from the cell wall—this is the "*gray nerve fibre.*" In the "*white nerve fibre,*" however, a higher degree of development is manifested in *the contents;* the uniform, granular material of the gray fibre becomes differentiated into *two* portions,—the inner, an elastic transparent thread occupying the very axis or centre of the nerve fibre; the *outer* part becoming an oily-looking matter, called the medulla, or "white substance of Schwann." A white fibre, therefore, consists of the membraneous sheath, the representative of the original cell membrane, within that the semi-fluid medulla, and in the centre the solid axis cylinder.

(*b.*) In a somewhat similar manner—that is, by elongating, while, at the same time, they retain their cavities, and join on to each other—cells may form tubes, such as the capillaries of the different parts.

(*c.*) In *striated muscular fibre,* the cell elongates, and, at the same time, its contents split up into fibrillæ, which consist of alternate light and dark portions; and

these being placed exactly side by side, produce the transverse striation characteristic of this tissue.

II. Having thus passed briefly in review the various modes in which cells manifest their vitality by furnishing, as secretions, or appropriating to themselves the materials which they withdraw or elaborate from the blood, we may pass on to notice with equal brevity the second important office which they fill in the animal economy—we refer to their functions as "*transmuters of force*," by which is meant that an impression transmitted to certain cells, may induce a modification in them, which is manifested by the evolution of some altogether distinct kind of effect. Examples of this kind are chiefly to be found in the nervous system, and the student will probably gain a clearer idea of the actions of this highly-important part of the animal system, if he will take the trouble to peruse the following explanations. We may first premise that the nervous system contains two distinct structural elements,—*cells* which receive or originate impressions, and *fibres* which conduct them,—some to, some from, the cells. The former, when they constitute the greater portion of the structure, form "*gray nerve matter*" (which, however, almost always contains fibres also); the latter aggregated together, constitute "*white* nerve matter or tissue."*

* The word "gray" has been used in several senses, as applied to nerve tissue,—there is "gray nerve matter," formed by an

Let the reader picture to himself a nerve fibre, proceeding from a sensory surface or organ, as the skin or eye, and connected by its other extremity with a nerve-cell in the brain. An impression made upon the outer extremity of this fibre is transmitted along it, till it reaches the cell. In this it produces some unknown change, which is manifested as a conscious sensation. Let it be noticed that we approach the problem entirely from a physiological point of view —we make no attempt to explain the connection of mind and body—an explanation is but the resolution of a phenomenon into a case of some more general law, it must end somewhere, and we would so far explain sensation *physiologically*, by defining it as a change in the nerve-cells of some particular parts of the nervous system. For the present we may say that such a change *is* sensation. If, further, such a cell be connected also with an *outgoing* fibre, proceeding to a muscle, it is easily conceivable that the same impression which caused a sensation, might simultaneously so stimulate the cell, as to cause it to send an impulse along this fibre, and cause the muscle to contract,—such may be the mechanism of "*consensual actions.*" Again, suppose a nerve-cell in the spinal cord, for instance, connected as before with two fibres,—one afferent,

aggregation of nerve-cells; "*gray nerve fibres,*"—the less developed form of fibre noticed previously; and finally, in a recent Manual (Shea's), the axis cylinder of white fibres is called the "internal gray substance." This source of confusion should be avoided.

the other efferent,—an impression transmitted along the former, might give rise to a muscular contraction, by means of the latter, even if the cell were one of those whose excitement did *not* cause a sensation. In such a chain of phenomena, we should have an example of a *reflex action.* On the other hand, we can conceive it possible that a cell connected only with an efferent fibre to a muscle might, when that change is induced in it which is manifested to our consciousness as an act of volition, transmit a stimulus along the nerve which would cause the muscle to contract. Such, in brief, is the mechanism of a nervous system, reduced to its simplest elements, and viewed from a purely physical point of view. The student is recommended to follow out the explanation with the aid of simple diagrams.

We may add a few words on the *origin and multiplication of cells.* It has been said that they may originate in two ways:

1. Independently of pre-existing cells,—"Free cell development."
2. From pre-existent cells. { By division. / By endogenous formation.

"*Free Cell Development*" was usually described as taking place in the following manner. In a fluid, or semi-fluid mass (matrix, blastema), a granule is precipitated; this forms the "*nucleolus*"

of the future cell; this nucleolus aggregated around itself material, and became a "*nucleus;*" and this again attracted to itself a mass which formed the "*contents*," around which, as a final step, *a membrane* was developed. The most eminent physiologists, however, now incline to the opinion that no such process as this actually occurs; but that in every case a cell has its origin from a pre-existent cell, in one or other of the following modes:—

(*a.*) *By "Division."*—Nucleus divides, and cell contents and *membrane* simultaneously dividing in a corresponding manner, two or more new cells are produced.

(*b.*) *Endogenous Formation.*—Nucleus divides and contents also; but *not* the membrane or wall of the parent cell. Round the separate masses of contents, aggregated round the new nuclei, membranes are developed without any connection with cell wall of parent cell, so that the whole of the new brood is enclosed within the old cell wall; hence this mode of formation is termed "endogenous." The old membrane finally ruptures or is absorbed, and the new cells are thus set free.

By processes of this kind, the original embryo cell, a single nucleated cell—alike, as the saying goes, for a frog and a philosopher—is developed first into *a cellular mass*, and from this is formed, by various processes of growth and development,

some of the chief of which have been already noticed, the entire individual.

III. We shall conclude with the following details, which may be useful, not only in themselves, but as suggestive of the mode of arranging such facts, so as to be easily remembered :—

Blood.—

Water . .	782		
Solids . .	218	= (200 + 18.)	
Red Corpuscles	130	200	
Albumen .	70		
Fibrine .	2	18	
Fats . .	2		
Extractives .	7		
Mineral Salts	7		

Urine.—The average daily amount of the chief constituents :—

Water . . .	50 ounces.		
Solids . . .	1000 grs.	(=700+300.)	viz. :—
Urea	450 grs.	700 of Organic Matters.	
Uric Acid . . .	10 ,,		
Other Organic Matters	240 ,,		
Inorganic or Mineral Salts	300	300	

Specific gravity 1025. Daily amount of acid equal to 38 grains of crystallised oxalic acid in neutralising power.

The above are high averages, and would repre-

sent the amount in a vigorous man working moderately hard.

Bone everywhere is composed of a substance which may be termed *osseous tissue*, and which, under the microscope, is seen to be composed of a matrix in which are imbedded numerous peculiar cells, with many branched, radiating processes. These cells are termed "lacunæ," and their branches "canaliculi." This material is so worked up as to form two distinct varieties of bone—the *compact*, and the *cancellous* or spongy. If the student procure one of the long bones of a large animal, and split it down the middle longitudinally, he will find these two varieties very distinctly displayed, the former constituting the shaft, and the surface of the joint-ends, the latter the interior bulk of those enlargements themselves. It is well to remember that, though the structure of bone varies according to the mode of arrangement of the osseous tissue, this latter always has the same structure—that above described; but in compact bone it is arranged in rings around long channels, called the Haversian canals; whereas in the cancellous, it forms a sponge-like structure—as is evident to the naked eye. If the student bear this point in mind, he will have no difficulty in understanding the structure of bone, as given in the manuals.

In its exact *chemical composition* bone varies a good deal; in a general way, we may say that it

consists of $\frac{1}{3}$ animal and $\frac{2}{3}$ mineral matter. Of the 67 parts of inorganic material, we have—

Phosphate of lime, . . .	58
Carbonate of lime, . . .	6
Phosphate of magnesia, . . .	1
Salts (alkaline), ...	2

With traces of fluoride of calcium and silex. A rough analysis may be made, either by calcining a bone, which removes the organic and leaves the mineral matter, or by digesting it in dilute hydrochloric acid, which dissolves out the mineral, and leaves the organic constituents.

If the student can readily procure the various organs which he studies, he will find it of immense advantage to conduct a rough dissection or examination of them. The organs of the various mammalia used for food differ but little from those of the human subject,—and by a little judicious negotiation with the butcher, the candidate may much facilitate his physiological studies. The joints, the heart, and the brain, and the very curious stomach of ruminants, are specially instructive objects of study in this kind of way. The University authorities in a note "strongly recommend candidates either to attend a course of lectures in which the structure of the principal organs of the animal body is demonstrated, or to obtain the like practical information through the private aid of some person conversant with the

subject." Of course, if the student reside in the neighbourhood of a medical school, or can obtain the assistance recommended in any other way, it would be unwise to neglect such an opportunity; but if, as is more commonly the case, he is unable to do so, he will find a few private dissections the best substitute.

LOGIC AND MORAL PHILOSOPHY.

The branch of the examination thus designated, is scarcely fully indicated by the title—it includes, in fact, three distinct subjects. 1. Logic proper; 2. Mental Science—Metaphysics, or Psychology; and 3. Moral Philosophy, strictly so called; and we shall consider this part of the examinational programme under these three heads respectively.

The Logic of the Pass occupies the single paper given on the morning of Thursday at the second B.A. and B.Sc. examinations. The course of reading for this particular subject is sufficiently definite—it being well understood that Whately's "Elements," and certain portions (see further on) of the two volumes of Mill's "System of Logic" are essential, and, at the same time, sufficient for a knowledge of the subject, which will ensure success at the pass examination. Previously to the establishment, in 1859, of the system of two examinations for the Bachelor's degree, the logical syllabus was exclusively limited to certain portions

of Whately; but, subsequently to that change, the paper has almost invariably contained a greater or less number of questions, which could only be satisfactorily, if at all, dealt with by those who had studied the admirable work of Mr Mill, and indeed have sometimes had almost exclusive reference to that work. To trust, therefore, to the knowledge of logic which it is possible to glean from Whately alone, would involve considerable risk, and indeed might not improbably lead to the rejection of the candidate. There can, however, be no question that a mastery of Whately's treatise is almost essential as a groundwork for a competent knowledge of logic, and as a preliminary to the study of more elaborate and profound authorities. As regards his accuracy, however, we may notice that the archbishop—probably from the desire of simplifying his subject as much as possible—has advanced doctrines and assigned meanings to logical technical terms, which, inasmuch as they are altogether at variance with those recognised by other logicians, may be regarded as incorrect. Amongst such we may mention—(1.) *Enthymeme*, which he defines as "a syllogism with one premiss suppressed,"—retained, as it were, in the mind (*ἐν θυμῳ.*) Now this is wrong, both as to the original meaning and derivation. Enthymeme does not mean something (retained) in the mind, but "the result of an act of reflection," nor is it a syllogism with one premiss suppressed; but,

as Aristotle says, a syllogism, one or both of whose premisses is a "*likelihood*," or a "*sign;*"—by a "likelihood" understanding what is usually designated a "plurative" proposition—*i.e.* of the form, Most *A* is *B*—; and by a "sign," a proposition which has an individual or singular subject, as, "Cæsar is dead;" "This man is unhappy."

(2.) Again, Whately defines *First intention* as the use of a name in its original and fundamental signification; *Second intention*, as its use in some secondary or derivative sense, as when we speak of the "leg" of a table. Here again he is at variance with those who first invented and assigned a meaning to the terms, with whom the "first intention" had reference to a thing looked at in itself, and "second intention," a thing regarded through the medium of a general notion.

(3.) The doctrine of the "Definition of a *Thing*," as contrasted with that of a *Name*, is not—at least as expounded by Whately—recognised by the highest authorities in logic. What that author, in reality, indistinctly intended to express by the phrase, "Definition of a *Thing*," is, says Mr Mill, nothing more than the definition of a *Name*, with a postulate or implied assertion of the *real* existence of things corresponding to that name. The student of Mill will also discover that it is an error to regard the syllogism as the *type* of the reasoning process, or the "*Dictum de omni et nullo*" as its fundamental axiom.

(4.) The doctrine of *Modality*, too, has been confused by the different accounts of logical writers, and Whately amongst the rest. Its original and fundamental sense has reference to *the degree of certainty with which the mind affirms the connection of the two terms of a proposition;* it is not difficult to understand how the term "modal proposition" came to be applied to any proposition, which happened to contain any word or phrase which expressed or modified that certainty, as "This man is *perhaps* honest," or "probably honest," and so forth; and how at length the final step in the transition of the meaning occurred, when it came to be applied to propositions with any kind of qualification or limitation whatever, as "He decided *honourably*," "He left *instantly*." This last is the doctrine adopted by Whately.

The chapters on Propositions, and their Opposition and Conversion, are excellent; as also on the Moods and Figures of the Syllogism. His treatment of the Fallacies is commonly regarded as the best part of his work, and unquestionably he has been successful in the discussion of the particular fallacies in detail, although his division and arrangement is incomplete, and has been superseded by the exhaustive classification of Mr Mill. (See table in Appendix.) The Introduction and Books I., II., and III. form the important portions of Whately.

In order to prevent confusion, the student

should be warned that in one particular respect Whately is inconsistent with himself. He sometimes speaks of logic as being essentially concerned with *Language*, in other places as being essentially concerned with *Thought;* either of these opinions may be held separately, but they cannot consistently be maintained together. It may be worth while to add, that the "Easy Lessons on Reasoning," by the same author, is nothing more than a condensation of "The Elements of Logic," and the student should not be misled by the title; it will be found to present greater difficulties than the larger treatise. It is not necessary to introduce *here* any special remarks on the study of Mill, except to indicate the most important portions. His treatise is divided into six books, the last of which, on "The Logic of the Moral Sciences," may be passed over, both as being itself less important and seldom or never referred to in examinations. Candidates for honours should read the whole of the first five books, but for the pass it is sufficient to be well acquainted with the following portions:—

Introduction—the whole (see Appendix).

Book I. The whole.

Book II. Chapters 1, 2, 3; also that portion of chapter 5 which treats of the grounds of our belief of axioms.

Book III. Chapters 1, 2, 3, 5, 7, 8, 20; also (but less important) 11, 16, 21, 25.

Book IV. Chapter 2.

Book V. The whole (see Appendix).

The first obstacle which impedes the progress of the student in this department of knowledge is the difficulty of *thoroughly comprehending the system of each individual author*. The majority of logical treatises have by no means been written with an eye to the requirements of the mere beginner, but commonly discuss the subject from a more general and often controversial point of view—a statement pre-eminently true of Mr Mill's elaborate system. It would be, to the majority of persons, an almost hopeless task to set about the getting up of the subject directly from the book itself. Condensation, clear arrangement, and definiteness are absolutely essential to the student, who has not only to comprehend, but to remember. The best, and, in fact, the only plan, is either to make or procure a good analysis, in which these requisites are secured. By an "analysis," we do not mean a mere abridgment,—which in general is more difficult to comprehend than the original work—this is a common mistake with those who attempt the task; a really good analysis is somewhat of a rarity. We are not aware that any such attempt has been made to lessen the difficulty in the study of the logical works ordinarily read, with the exception of a little book by Stebbing, published as an analysis of Mr Mill's "Logic." It is not, however, in any proper sense an analysis at all; it is an able abridgment, which might possibly be understood

by one who had thoroughly mastered the original; but the abridgment of such a work as Mr Mill's, only tends to render a difficult book still more incomprehensible, by excising the varied modes of statement, and the frequent and happy illustrations, which materially assist the student of the original. It is unfortunate that this attempt has not been more successful, for a lucid and thorough analysis is almost indispensable.* We cannot too strongly impress upon the student the futility of the attempt to acquire, in any reasonable time, by *mere reading* of such works as Mr Mill's "Logic," that clear and precise knowledge, which is not only essential to a fair general acquaintance with the subject, but is especially so for success under any examinational test. It is necessary to reduce its most important parts to a more compact and definite form; and the amount of time and labour ultimately saved by the use of such aids is remarkable.

If the student has time and inclination, he may make his own analyses, and this is by far the better plan; if not, he is strongly recommended to procure them if possible.

Though the "Logic" of Mr Mill has been specially alluded to here, these remarks are intended to have more general application to all similar works, amongst which we may mention Mr Bain's two volumes on the "Human Mind." To give the

* *The Student's Manual of Mill's System of Logic* (Longmans) includes a complete analysis, with every necessary explanation.

reader an idea of the proper mode of analysing, we have inserted some specimens in the Appendix.

A *second*, and by no means trifling difficulty, which awaits the beginner in logical studies, is connected with the partial and one-sided point of view from which the majority of logical writers treat their subject. The reader of Whately, when he takes up Mill, seems to have entered, not merely on a new author, but upon a new subject; and were it not for the occasional occurrence of technical terms and expressions, he would scarcely recognise any point of contact or identity between the two authors. The consequence of this is, that great difficulty is often experienced in connecting and harmonising, or, at least, discovering the relation between the varying statements of different authorities on the same point. The attempt to fuse the discordant or apparently unconnected statements of the writers of different schools into one complete and harmonious system, would require a distinct treatise: none such has yet been given to the world, and all that can be attempted here is to furnish the student with the key to the explanation of the most important and fundamental of these apparent or real discrepancies. This explanation will be found, to a very considerable extent, to be involved in the distinction between what may be called "Objective Inference," and "Subjective Inference,"—a distinction, therefore, of great importance, and essential to be thoroughly understood.

In *Objective Inference* the fact stated in the conclusion is a *bonâ fide* new truth, a distinct fact, and not merely part of the same fact or facts stated in the premisses. Thus, if I find that three magnets, *A*, *B*, *C*, attract iron, and hence infer that the next magnet I encounter, *D*, will also attract iron, it is perfectly clear that this last fact is by no means included in the previous fact that *A*, *B*, *C*, have that property. Moreover, it is evident that in objective inference, the conclusion follows by a law of *external nature*, hence the designation "*objective*," and not by a mere law of the mind; for there would be no contradiction in thinking that *A*, *B*, *C*, attracted iron, while *D* did not. Hence, further, such an inference cannot be expressed in symbols so as to be evident from the *mere form*,—*i.e.* whatever meaning we choose to apply to the symbols. Objective inference is, with Mr Mill, synonymous with "Induction;" with other writers it is equivalent to "Material, as contrasted with true Logical Induction."

Subjective Inference, on the other hand, affords a contrast in all these respects. It is, in short, an *explicit statement* of a fact drawn from premisses in which it was in reality *implied*, so that, the mind being in possession of the premisses can, by a mere comparison of their expression in words, evolve the conclusion,—the fact stated in conclusion being really included in, or part of the fact or facts stated in the premisses.

Thus, if from the proposition "All men are mortal," I draw the conclusion "John Thomas is mortal," it is clear that this last fact is really contained in the former statement, and we could not believe the former, and disbelieve the other without violating a law of the mind itself; in other words, without being guilty of a contradiction. Hence this form of inference may be expressed in *symbols*, in such a way that the inference may be seen to follow from the *mere form* of the expression, whatever meaning we choose to assign to them. Thus, putting A, for "men," B, for "mortal" (beings), C, for Cæsar, we get—

All A is B.
C is A.
therefore C is B.

Now, whatever A, B, and C, stand for, if we can assume the premisses to be true, we cannot refuse our assent to the conclusion without a contradiction.

The "*Syllogism*," and the so-called "*Immediate Inferences*," are the principal forms which subjective inference assumes. If this important distinction be clearly understood, its application is easy. Logic is defined to be the Science of Inference. The majority of logicians, and particularly Whately, Mansel, and Sir William Hamilton, limit its province exclusively to the consideration of *subjective* inference,—in other words, to the syllogism and certain subordinate processes; *objective* inference they refuse to recognise as coming within the pro-

vince of the science at all, and relegate it to the limbo of the "extra-logical." Whately over and over again asserts that all reasoning is syllogism, that to this the province of logic is exclusively confined; that objective inference, the process by which we arrive at the knowledge of *new truths*, is altogether foreign to the subject, and that it is impossible to lay down rules for it.

Mr Mill, on the other hand, takes a view as directly opposed to this as possible, for he refuses to recognise what we have above distinguished as "subjective inference," as being true inference at all; he terms it "interpretation,"—*i.e.* the conclusion in a syllogism is a mere *interpretation* of, not *an inference from*, the premisses.

Further, he regards objective inference, or true induction, as the peculiar province of logic, and the greater portion of his work is occupied with the consideration of *this* process, its laws, its methods, and the general conditions of its validity, almost to the exclusion of the other kind of inferences.

Now, it is scarcely to be wondered at that authors who differ on such fundamental points in their subject, should totally differ in their mode of treatment. The truth seems to be this:—Logic is undoubtedly the science of inference, and *not merely of one but of both forms*,—induction is within its province as well as syllogism; the latter *may* be, as Mill has expressed it, a mere mode of interpreting and applying inductions, but even on that view its consid-

eration would form an important division of the general science of logic. It will thus be seen that the great apparent discrepancies between such authors as Whately or Sir William Hamilton on the one hand, and Mr Mill on the other, are in reality to a great extent not differences at all; they are treating of *different branches* of the total science of inference; and apart from inconsistencies necessarily connected with the different metaphysical tenets of the various schools, the general body of their logical doctrines may be combined into one system, each having its distinct function in the generation of scientific belief. A *complete* treatise on logic would necessarily incorporate the principal doctrines of them all; their systems are not, *as a whole*, inconsistent, but complementary. Similar considerations will throw some light on the foggy and much-disputed question as to whether the syllogism does or does not involve a *petitio principii*, a question more clearly expressed in this form:—Are we, or are we not, justified in designating by the term Inference, that process by which from the premisses of a syllogism we arrive at the conclusion? Putting the discussion in this light, it is evident enough that the answer depends simply upon the meaning we choose to assign to the term Inference; if, with Mr Mill, we limit true inference to objective inference—where the fact stated in the conclusion is *bonâ fide* different from the fact or facts given in the premisses—then subjective infer-

ence, the inference in the syllogism, is *not* true inference, and the syllogism must unquestionably be held guilty of a *petitio principii*. On the other hand, if the syllogistic process is to be regarded as a real inference, the answer is as plainly in its favour. With these observations we leave the general subject of logic in the hands of the student, and proceed to notice some of the more commonly read manuals of the science.

The caution may perhaps be superfluous, but we may just mention, *en passant*, a treatise professedly on logic by Dr Watts. It consists, however, merely of an *olla podrida* of exploded philosophy, interspersed with vague and inane platitudes on the acquisition of knowledge, mental improvement, and so forth, of no value whatever to the logical student.

Aldrich's "Logic," a Latin treatise, for many years the Oxford text-book, is only valuable as the vehicle for the notes and expositions of its editor, Professor Mansel. These furnish much valuable material, and we may specially notice the Appendices on the Predicables, on the Categories, and on the Enthymeme. The first of these, on the Predicables, contains an admirable exposition, in which, after an examination of the different modes of dealing with this subject adopted by other logicians, an arrangement is proposed which is unquestionably the clearest, and the most in accordance with modern philosophical doctrines. The work may often be obtained second-hand, and if the student

have an opportunity of consulting it, we would recommend the essays above-named to his special consideration.

The fullest exposition perhaps of the syllogistic logic is to be found in the Lectures of Sir William Hamilton. This elaborate work, in two large volumes, contains the course delivered by him during the time that he held the professorship of the science in the University of Edinburgh. It has, however, the serious disadvantage of not representing in several respects the latest views of the author. Of his doctrine of the quantification of the predicate and of his system of syllogistic notation, the notices in these volumes are fragmentary and obscure. The work as it stands is chiefly valuable for the copiousness and accuracy of its historical disquisitions, and for the fulness and clearness with which it treats the general subject.

An excellent and concise epitome of the most characteristic and important of Sir William Hamilton's doctrines is contained in Mr Spencer Baynes' "Essay on the New Analytic," which would unquestionably prove the best and readiest resource for the student anxious to become acquainted with the special novelties introduced into logical science by Sir William Hamilton. We may remark, however, that no *special* reference is commonly made to these doctrines in the questions of the pass examination.

The principal design of the Archbishop of York

(Dr Thomson) in his "Outlines of the Laws of Thought," is to incorporate into the general scheme of logic, such parts of the doctrines of Sir William Hamilton as he conceived to be really useful. It is an excellent treatise on the syllogistic logic, representing in the main the school of which Hamilton, Baynes, and Mansel, are the most eminent exponents. Of them all, we may say that their works are rather adapted to the student who has made some progress in the science than to the mere learner. Dr Thomson's "Outlines" contains, amongst other things, a very intelligible account of Nominalism and Realism; a useful table of the chief forms of Immediate Inference, a discussion of the questions connected with the relation of Language and Logic, and an exposition of the Moods and Figures of Syllogism, on a system nearly the same as that of Sir William Hamilton.

A very lucid and useful little hand-book (published by Longmans) has been compiled as an introduction to logic, by Mr Morell, one of her Majesty's inspectors of schools. In a preliminary chapter, he gives in a small compass an explanation of certain fundamental psychological points; and in the body of the work deals in a satisfactory manner with the ordinary branches of the syllogistic logic. The least successful part of the book is the chapter on Fallacies, which is so brief and incomplete as to be almost worthless.

In the general observations in the earlier part of

this article, it has been stated that no author has yet attempted the task of harmonising and fusing into a connected whole the systems of the different schools of logicians, as far as this is possible. An essay in this direction has, however, been made by Mr Devey, in a "Treatise on Logic," published in Bohn's series. This is a somewhat remarkable book; it proceeds upon a correct fundamental principle, and contains much valuable information and instructive discussions; but its utility is much impaired by a vicious style, and by numerous errors and misapprehensions. The author examines the doctrine of predicate-quantification proposed by Hamilton, and rejects it as tending to complicate rather than simplify the science. A large portion of the work is occupied with extracts from Mill, and hostile criticisms upon certain of his doctrines—criticisms unfortunately often founded upon a total misapprehension of their import. It is a book, in fine, rather for the advanced student, who can discriminate and form his own opinions, than for the beginner.

In conclusion, we would suggest to the candidate that if, in examination, he is requested to construct concrete syllogisms in any given mood and figure, the best plan is *to write them down first with abstract symbols* (as *A*, *B*, for major and minor, and *M*, for middle term), this is easily done, and then he will find no difficulty in substituting for these symbols appropriate concrete terms.

MENTAL SCIENCE.

In this branch of the examination, the subjects of the programme are the *Senses*, the *Intellect*, and the *Will*, with the Theory of Moral Obligation for the ordinary pass. The most complete and elaborate exposition of mental science is undoubtedly to be found in Professor Bain's two volumes,—the first discussing the Senses and the Intellect, the second comprehending the consideration of the Emotions, the Will, and, in connection with the Ethical Emotions, the Theory of Moral Obligation. It is fortunate that for a number of years past, the examination has had such a form, that a candidate who has carefully got up the first of Mr Bain's volumes, may consider himself fairly prepared for it; for, were it otherwise, the general mode of treating the entire subject, and the special points discussed, are so widely different in the hands of different authorities, that an undue amount of labour would be imposed upon the student reading for this part of the examination. The *author* here is, in fact, of equal importance with the *subject;* a knowledge, for instance, of a work so elaborate as Sir William Hamilton's "Lectures on Metaphysics," would often fail in affording any assistance to the candidate. Under present arrangements, the student who has made himself thoroughly acquainted with Mr Bain's volume on the "Senses and the Intellect" (especially if he read in addition his

chapter on the "Ethical Emotions," in the second volume), may present himself with confidence for this branch of the examination. We should recommend to the student, not as an absolute necessity, but certainly as a proceeding in the long run the most satisfactory, in addition to a general study of his analysis of the book, to commit to memory certain important points in Bain—amongst which we may mention, as suggestions, the classifications of the sensations derived through the different senses; the proofs that the brain is the organ of mind, the characteristics of intellect, the laws of association, the circumstances which influence the operation of those laws, the modes in which volition can control the intellectual trains, Mr Bain's theory of the origin and growth of the power of voluntary command over our moving organs (see Appendix); what is implied in the voluntary command of our moving organs; with the proofs that imitation (and therefore other forms of voluntary action), are not instinctive. The connection of the law of similarity, with the operations of the reasoning faculty, is an important subject. An essential point in the successful study of this volume is to understand clearly what the author means by the emotional, intellectual, and volitional character of a sensation. Another characteristic which runs through Mr Bain's system is the prominence which he assigns to the *sensations derived from the muscles* in the genesis and growth of our knowledge; ac-

cording to his views all our knowledge of external realities without us, and of their properties, their form, magnitude, distance, and direction, is a product of what may be called our *muscular experience.* It is from *movements* of various kinds, and from the *sensations* which accompany them, that any recognition of the *non-ego*, the object, as something real and external, is exclusively derived. In order to obtain a clear notion of the different elements of the muscular sense, let the reader raise a weight from the ground with his eyes closed. He will then find that he is conscious (*a*) of the exact position in which his hand and arm are placed; (*b*) of the distance or range through which he has moved them; and (*c*) of the amount of the weight or pressure which he is supporting—in other words, he is conscious of the degree of shortening in his muscles; of the length of the space through which they have shortened; and finally of the amount of effort required to maintain the shortening. The student may form his own opinion as to how far these three are really distinct. If, further, he fully comprehend Mr Bain's theory of volition, he will probably find little else to cause him difficulty in this admirable work. We may, moreover, hint to the student not to overlook the foot-notes and appendices contained in these volumes, as questions are not unfrequently proposed having reference to them. If the candidate have sufficient time at his command, he would find it advantageous to read

the entire section on the Will in the second volume. It contains a fuller exposition than is to be found in the somewhat brief allusions in the first; it is not, however, absolutely necessary.

On account of the fulness of exposition, and the abundance of detail and illustration, which are essential in a work on a subject so inherently difficult as mental science, the treatises in question are somewhat voluminous, and the reader will find it by far the best mode of proceeding to make at once a good and complete analysis. Having once done this, he has not only obtained a good general knowledge of the subject, but is in a position at any time to refresh his memory with those details which are sure to escape him, and yet which are essential for satisfactorily passing an examination.

It would scarcely perhaps be credited, were not positive instances of the fact occasionally met with, that men will present themselves for examination in this subject, without special preparation, trusting to answer the questions by the mere force of "common sense," and believing that questions on Sensation, Imagination, and so forth, can be satisfactorily dealt with by a knowledge of the common meaning of the words, or an interrogation of consciousness on the spot. We need hardly remark that such a course will necessarily end in a mortifying failure, and that even to seriously contemplate such an expedient, is to prove one's-self sadly

deficient in the very faculty upon which reliance is placed.

Mr Bain has published in a small pamphlet (in Chambers's "Papers for the People"), a series of essays on the principal departments of mind, and which represent the chief conclusions of his larger treatises. It may be obtained for a few pence, and might be useful in refreshing the memory previously to examination.

We cannot, in dismissing this subject, omit to refer those who desire to extend their knowledge of this interesting branch of science to the masterly treatise of Dr Carpenter, to be found in his larger work on Human Physiology, in connection with his discussion of the Nervous System. For clearness of exposition, and for scientific value, this admirable essay is, in our opinion, unrivalled.

MORAL PHILOSOPHY.

Moral Philosophy, or Ethics, consists of two subdivisions—*Pure and Applied;* the former discusses all questions connected with right and wrong in a *general* manner, without special reference to any one class of moral actions. In the latter, these general principles are applied to our duties in detail, with the view of eliciting specific rules for our guidance in doubtful cases. It is only with *Pure Ethics* that we are here concerned; for the one or two questions which are generally

included in the London paper usually refer exclusively to that part of the subject.

We are inclined to think that, in the majority of treatises on Moral Philosophy, the subject is rendered unnecessarily difficult and perplexing, by the neglect, on the part of the authors, to keep clearly distinct and separate the different questions which are involved in its consideration. A careful examination will show us that, at least, four or five such elementary problems may be recognised; two of which may be regarded as *principal*, and the remainder as secondary and *subordinate*.

These, then, which involve *the chief points in dispute in the Theory of Morals*, we shall briefly notice, to furnish the student with a general clue in reading up this subject; and we would suggest that each statement or argument of the authors he consults should be arranged under the head to which it seems most properly to belong.

The *two principal* of these fundamental questions are:—

I. The nature of Virtue and Vice in themselves. In other words, what is that exact quality in an action which should lead us to denominate it virtuous or vicious? Many systems have been framed in reply to this question, amongst which are those which assert:—

(*a.*) That the quality in an action which leads

us to denominate it virtuous or vicious is *absolute*:—*i.e.* is not explicable by, or resolvable into, any other elements. The distinction is eternal, immutable, and inherent in "the nature of things." *

(*b.*) Aristotle's doctrine was, that a virtuous action is one which possesses the attribute of being a certain *mean* between two extremes.

(*c.*) Utilitarians pronounce an action virtuous in proportion to the tendency which it has in its total consequence to produce the greatest happiness of the greatest number.

(*d.*) If in (*c.*) for the "*greatest number*" we substitute "*the doer of the action*," we have the doctrine of those who base virtue upon *Prudence*, *Self-Love*, or a far-sighted regard to our personal welfare.

(*e.*) According to others, that attribute or quality of an action which should lead us to pronounce it virtuous, is consistency with "*Right Reason*," "*Propriety*," or the "*Fitness of things*," a definition which requires itself to be defined.

* As a necessary counterpart to this view of the nature of virtue, it is held that the Creator has implanted in us a *special faculty*, an innate "conscience" or "moral sense," by which the moral qualities of actions are recognised and discriminated, just as the eye has been furnished to us (amongst other purposes) to distinguish black from white. (See Quest. iii.)

(*f.*) Finally, some have laid it down that the quality, virtuousness, is the being in accordance with the *Will of the Deity*, either revealed expressly to us, or capable of being in some way inferred. In this latter category may be placed the system which makes the Will of God the *ultimate* Source of moral distinctions, but regards Utility as the *index* through which we may discover that Will—the Creator being supposed to have so constituted the world as to make the actions pleasing to Him, tend in their total consequences to the highest happiness of His intelligent creatures.

We have entered into some detail under this head, with the view of suggesting to the reader a methodical plan of studying the subject and arranging his results. The arguments *pro* and *con*, under the head of each doctrine, may be collected together, as they are met with in special treatises on this science. We shall refer to the remaining questions more briefly.

Before proceeding to notice these, however, we may caution the reader that—

This question, as to the ultimate principles by which we should test any doubtful moral action, or to which we should refer, and which ought to guide us in any attempt to revise or improve the moral code at present generally accepted, must not

be confounded with certain somewhat similar, but really altogether distinct, inquiries, amongst which are :—

(*a.*) *What is the actual basis of men's moral judgments?* Why, *as a matter of fact* do men pronounce certain actions virtuous and others vicious? Ask any ordinary individual why he considers bigamy to be morally wrong, and if he answer truly, he will generally reply that it is because he has been *taught* to regard it in that light. He has been educated to the belief that such is the case; and he has really very little ground for his conviction, beyond a general reliance on the principle that "what everybody says must be true."

Education, however, though *the cause of his believing*, does not furnish the premisses of what he believes. In fact, he has no premisses at all—he has never attempted to deduce his conclusion from *anything*. Moral rules, *as held in everyday life*, are not inferred from first principles, but are almost necessarily received upon trust from others. Just so the great majority of individuals hold their scientific and religious doctrines; being educated in them, they have a firm belief in their truth, without examining into, or being able to assign, the ultimate grounds or evidences which would warrant their convictions. It is only in this secondary sense, we believe, that it is true to assert that moral rules are the result of education and custom.

(*b.*) *The historical inquiry as to what has given birth to the code now actually recognised in the community. Taking the common collection of moral rules as we find it, upon what is it based, and how did it spring up?*

This question is fully discussed by Mr Bain ("Ethical Emotions"), and his general conclusion is, that the moral rules which are found actually to prevail in a society, are almost invariably founded, partly on *Utility* (especially upon that

universal and most urgent utility—security to person and property), and partly upon *Sentiment, i.e.* upon mere preferences and dislikes, for which no rational basis can be assigned. And that, moreover, if we inquire more definitely into the history of their origin, or enactment, we shall usually find that they have been first *explicitly* enunciated and enforced by some assignable individual, who has been recognised as invested with a moral legislative authority. We may instance Confucius, Solon, Lycurgus, the Grecian philosophers to some extent, and, above all, Moses and the Divine Founder of the Christian religion.

II. The second principal question refers to *Moral Obligation*, and may be expressed thus:—*What are the motives to obey the laws of morality?* or, in other words, What are their *sanctions?*

"Punishment," says Professor Bain, "is the test of Moral Obligation,"—that is to say, the motive to obey a moral rule is the prospect of suffering, in some form or other, as a direct consequence of our disobedience; and, unless this is the case, we do not consider the observance of the rule as *obligatory*, however *commendable* it may be.

Amongst the subordinate questions in connection with the science of morals, are—

III. *The perception of Right and Wrong; that is, admitting the distinction, how or by what faculties do we recognise it?*

The answer to this question is evidently

closely connected with the particular view which we choose to take of the nature of virtue. If we adopt the high theory of an "Innate Moral Sense," of a "Supreme Conscience," implanted in us for this very purpose of distinguishing right from wrong, it must be admitted that we recognise moral distinctions *intuitively*, as a mere matter of ultimate feeling, just as we distinguish black from white, or harmony from discord. If, on the other hand, we take Utility or Prudence as the basis of our moral system, and, examining the consequences of actions, deduce from thence our conclusions as to their morality, it is evident that our recognition of right and wrong is intellectual, a simple process, in fact, of argumentation or inference.

IV. The source of our *approbation* of Virtue and *disapprobation* of Vice, with sense of *merit* or *demerit* in the agent.

This question, too, is evidently to a great extent merely subordinate to the first. If we are furnished with an Innate Moral Sense, it must be that our feeling of approbation, or the reverse, accompanies the perception of right and wrong in actions, just as a sense of the agreeable or disagreeable accompanies our taste of a rich viand or of a nauseous drug. Consideration for

self, or the benevolent feelings towards others, would lead a man to disapprove of and discountenance immorality, if he regards the essence of vice to consist in its tendency to imperil or diminish his own or the general happiness.*

We may conclude our consideration of this branch of the examination with a remark on one or two of the most popular works on this subject. The Essays of Professor Bain ("Emotions and Will," Part I. chap. 15, and Part II. chaps. 9, 10), have been already referred to. The same author has edited "*Paley's Moral Philosophy*" (Chambers), and has enriched the original work with numerous valuable notes and discussions. A large portion, however, of Paley's text is occupied with Applied Ethics, or the consideration of the Special Duties, which is of minor importance to the candidate reading for the London degree. Dugald Stewart's "Moral Philosophy," edited by Dr M'Cosh, contains in a condensed form the arguments which bear upon the chief points in dispute. Its extreme brevity, however, renders it less perspicuous and useful than it otherwise might be.

* Question iii. relates to the *Intellectual* (or discriminative) element of "*Conscience:*" Question iv. to the *Emotional* part or element of Feeling therein. The analysis of "Conscience," and the investigation into its real nature, origin, and growth, would therefore be included in any complete discussion of these questions. (See Bain's "Paley," pp. 37–42, 83, 92.)

In the concluding part of Adam Smith's "Treatise on the Moral Sentiments," the student will find a very clear *resumé* of the principal theories of morals; and those who desire to become acquainted with the doctrines of the school of moralists represented by Bishop Butler may read his three sermons on "Human Nature," and his essay on the "Nature of Virtue," of which Whewell's edition is best. It is almost needless to mention Mr Mill's "Utilitarianism."

CLASSICS AND GRECIAN HISTORY. (2d B.A.)

Upon the general subject of classical study, it is not necessary to add anything here to what has been previously said under Matriculation. The Grecian History may be studied in Dr Smith's work ("History of Greece;" Walton and Maberly, price 7s.) Since our object is to be useful to the candidate, we shall not, for the sake of an appearance of completeness, waste space upon subjects, where directions *can* only be of very little value to him. With reference to the Grecian History, we may however add, that to supplement and arrange his knowledge on the most important events, the candidate will find it worth his while to procure a little work by Mr Dawson Turner—"Heads of an Analysis of the History of Greece." (Parker & Son, price 2s.) It consists of a general sketch of the important points, with quotations from numer-

ous authorities, relative to the chief events, persons, and eras.

CHEMISTRY OF B.SC.

The printed Syllabus in the Regulations gives, in complete detail, the subdivisions of this subject, of the Inorganic department for the first, and of the Organic for the second examination. Nothing remains for us, but to remark, that as an *Introduction* to the science, Fownes' "Manual" (Churchill's Series), is perhaps as good a book as the student can make use of. The style is clear, and the facts are presented in such a form as to be easily remembered. It will pass the candidate fairly in the Inorganic branch of the subject; but, for the second examination, he should read also Miller's "Organic Chemistry," those chapters, at least, which treat of the special points indicated in the programme. For the general philosophy of the subject, no work is equal to Naquet's Chemistry, of which a translation is published in London. The student may also read the following articles in Watt's Dictionary of Chemistry:—Acids, Classification, Metals, Isomerism (see Appendix on "Works on Chemistry"). Amongst questions which are frequently proposed, we may mention two:—(*a.*) The means at our command for ascertaining the molecular weights, or the true rational formula of the different classes of organic compounds; and (*b.*) The reactions, or other indica-

tions, by which we determine the mono-, bi-, or tri-basic character of the various inorganic and especially organic acids.

GEOLOGY AND PALÆONTOLOGY. (2d B.Sc.)

For the theory of this subject, the candidate may use Page's "Advanced Text-Book of Geology" (Blackwood, Edinburgh, price 6s.)* For the practical part, he must resort to a museum. In London, the Jermyn Street Collection is open free, and most of the larger country towns have local museums, often very well supplied with geological specimens.

With the Geology of the British Isles, he should be sufficiently acquainted to be able to sketch and describe the areas of the different formations, especially of the chief coal-fields, and other important industrial deposits.

If the time, which can be devoted to this subject, be limited, we think the candidate will find it the best plan to compile a table of the characteristic fossils of each formation, commit it thoroughly to memory, and in the museum confine his attention to identifying and learning these, the most important.

* The "Manual of Geology," by S. Haughton (Longman, price 7s. 6d.), and the Guide to Geology," by S. Philips (Longman, price 4s.), are both good books. Haughton's book, however, is not a book for mere beginners,—it is only adapted for those who have made some progress in the science.

BOTANY. (1st B.Sc.)

In this subject also our task is limited to the recommendation of books; and, amongst the large number of excellent manuals, it is almost impossible to decide which is absolutely the best. Bentley's "Manual" (Churchill's Series) is certainly at least as good as any similar work, and is cheaper than some of them. For *the practical part*, the candidate should, if possible, avail himself of a Botanical Garden. Residents near London may obtain a student's ticket for Kew or Chelsea, and a very short time, diligently employed there, will enable him to master the particular orders of plants named in the Syllabus.

Of course, such a proceeding may be supplemented by botanical rambles in the fields and lanes, with the assistance of some British "Flora," as Hooker's (Longman & Co., with twelve plates, 14s., coloured, 21s.),—the only resource for those who cannot obtain access to a regular Botanical Garden.

If the subject is altogether new to the student, he will find it more advantageous, in the first instance, to get a general notion of the science from some elementary treatise, such as "Lessons in Elementary Botany" (by D. Oliver, 4s. 6d., Macmillan & Co.), or Moore's "Elements of Botany" (Longman & Co., 2s. 6d.); or he will be perplexed by the vast amount of detail, and the complexity of

botanical terminology. The "Rudiments of Botany," by Henfrey, is a simple introductory book; the "Lessons in Botany," by Oliver, though introductory, is more elaborate and complete, and contains an account of the Natural Orders of Plants.

ZOOLOGY. (1st B.Sc.)

This part of the examination may be subdivided into three branches:—

(*a.*) The difference between Plants and Animals.

(*b.*) General Physiology.

(*c.*) The classification, and characteristics of each class, of the Animal Kingdom.

For the second, we can only refer to the remarks on the study of Animal Physiology, in connection with the second examination; but the candidate will commonly find sufficient on this head incorporated with the works on Zoology which he may make use of.

With respect to the differences between Plants and Animals, we may remind the student, that *the characteristic distinction* lies in *the kind of materials which they appropriate;* in other words, which they require for their nutrition and growth. Plants derive these from the *inorganic* world; from Carbonic Acid, they separate Carbon, and from Ammonia Nitrogen, and from these, with the aid of air and water, they build up their most complex products.

On the other hand, the animal, however high or however low in the scale, is incapable of this synthetic process; it requires for its nourishment materials from the *organic* world—materials which, in fact, have been formed by vegetables, especially the proteine compounds. The function of the vegetable is that of building up,—that of the animal, rather of appropriating, and ultimately breaking down into simpler compounds. Thus, if we find that a minute cell organism, as to whose animal or vegetable character we are in doubt, decomposes Carbonic Acid and gives off Oxygen under the influence of sunshine, we may certainly conclude it to be a plant.

Of the other, but less fundamental differences, the existence of the functions of sensation and voluntary movement in animals is the most important. With these hints, the student will probably succeed in thinking out the question completely for himself.

As regards the books from which the candidate is to collect his knowledge of this subject, just as with botany we should recommend his first obtaining a general idea from some elementary work, as Alleyne Nicholson's "Text-book of Zoology for use of Schools" (price 6s., Blackwood & Son), and he may then proceed to read Yeo's "Student's Manual of Zoology." * There is a very good treatise

* Or Alleyne Nicholson's "Manual of Zoology." Price 12s. Blackwood.

on this subject in Orr's "Circle of the Sciences." The course of reading, however, which we should recommend is as follows:—For the *Protozoa* and *Cœlenterata*, Galbraith & Houghton's excellent Manuals * (price 2s. each, Longman & Co.); for the *Mollusca*, Woodward's books in Weale's Series; and for the *Articulata* and *Vertebrata*, the English translation of the "Zoology" of Mr Milne Edwards may be made use of (the edition published by Renshaw). Though it may appear at first sight inconvenient to collect a knowledge of the subject from such various sources, yet, since all except the last are very small and cheap books, the inconvenience is more apparent than real. In Woodward's Manuals, the student may confine his reading to the first few pages which introduce each division, the detailed description of the different species being omitted as far as he may think proper. In a course of lectures by Professor Huxley, published in the *Medical Times*, about the year 1856, the reader will find a thorough exposition of the homology of the Annulosa and their congeners, which will be of interest to those who desire to proceed further in the study of the subject.

Amongst larger works on the entire subject, which the student may consult upon special points, we may mention Dallas' "Animal King-

* "Manual of Animalculæ and Sponges," and "Manual of Corals and Sea-jellies."

dom;" Van der Hooven's "Zoology," translated by Clarke (Longman & Co., 60s.); Rymer Jones's "Animal Kingdom," and the systematic treatises of Professor Owen, published by Longmans.

MECHANICAL PHILOSOPHY. (1st B.Sc.)

The extent of the knowledge required is something below the standard of the second examination in the same subject. Projectiles, motion round centres of force, and the laws of elastic fluids, are omitted from the list; otherwise, we refer the reader to the consideration of this subject at matriculation and the 2d B.A. examinations. Moreover, neither Physical Optics, Acoustics, nor Astronomy is required.

NATURAL PHILOSOPHY. (1st B.Sc.)

Includes *Heat*, *Electricity*, and *Magnetism*. A competent knowledge of these subjects may be obtained from Golding Bird's "Natural Philosophy" (Churchill's Series), or from Ganot's "Elementary Physics," translated by Atkinson (Longmans & Co., price 15s.) In Ferguson's "Electricity" (Chambers), the student will find not only an excellent and easily intelligible account of the phenomena of Electricity and Magnetism in general, but also an abstract of the more modern investigations into these subjects.

APPENDIX.

I.

ANALYSIS OF INTRODUCTION TO MILL'S LOGIC.

MILL gives two Definitions of Logic, which he criticises, before enunciating his own.

1*st Definition.*—"Logic is the Science and Art of Reasoning."

[Whately added the term Science to this definition, and properly so. By it we mean the analysis of the mental process which takes place whenever we reason; and by *Art*, the rules for properly conducting the process, founded upon that analysis.]

[*Meaning of term "Reasoning."*—In its *restricted* sense, it is equivalent to Syllogising or Ratiocination; in a *more extended* and proper sense, it is simply to infer any assertion from assertions already admitted.]

Criticism of this Definition.—This definition of Logic is *too narrow*,—the mere theory of argumentation does not include all that is properly within

the scope of Logic. Precision of language (Naming and Definition), and accuracy of classification, are almost always considered amongst the objects of Logic; for we find the—

(*a.*) *View of strict logicians is more extensive.* Most authors, dividing Logic into three parts, treat in the first two of Names, or Notions, and Propositions, under one or other of which heads they include Definition, Division, &c.; and only in the *third* part do they discuss Reasoning.

(*b.*) Also the *popular view* of Logic is more extensive. In common discourse we as often hear of "a logical arrangement," or of expressions "logically defined," as of conclusions logically deduced from premisses; and a man is called "a great logician," not for the accuracy of his deductions, but for the extent of his command over premisses; that is, the general propositions necessary to refute a sophism or establish a conclusion, promptly occur to him.

2d Definition.—"Logic is the Science which treats of the operations of the understanding in the pursuit of truth."

Criticism.—This definition is *too wide*, because—

(*a.*) Logic has nothing to do with one large class of truths, —those of *Intuition.*

[Truths are known to us in two ways:—

1. By our immediate consciousness, *i.e.*, by Intuition.
2. By Inference.

The truths known to us by Intuition are our Sensations, bodily

or mental,—that I see a white object, or that I feel vexed or hungry, &c., are truths of this kind;—which truths are the original premisses from which all others are inferred.

With these original data of our knowledge, Logic has no direct concern. Whatever we know in this way,—as, for instance, the *fact* that I have a sensation of heat, or of a white colour,—is known beyond the possibility of doubt. No science is required for the purpose of testing the validity of such truths as these; no art can possibly render our knowledge of them more certain.

We must not, however, confound *rapid and unconscious inferences* with intuitions. We may really *infer* what we fancy we *see* or *feel;* thus a certain combination of sensations of form and colour have always been marks of the presence of an external object, as my *father*, and hence, whenever I experience such a combination of sensations, I *infer* his presence, though I *may* do so wrongly, as in delirium or spectral illusion.]

(*b.*) Because it would introduce into Logic many questions with which it has no direct concern—many metaphysical inquiries for example.

[Such inquiries as:—

What truths are the objects of Intuition, what of Inference? What is the nature of Perception, Memory, Belief, &c.? Are God and Duty realities, the existence of which is manifest *à priori?* and so forth,—are all connected with the pursuit of truth, but are foreign to Logic.]

Province of Logic and its relation to Knowledge in general.—The province of Logic, then, must be restricted to that *portion* of our knowledge which consists of *Inferences* from data, given either by intuition, particular observations, or general propositions.

[*To draw inferences has been said to be the great business of*

human life; by far the greater portion of our knowledge is avowedly matter of inference, so that not only the entire field of science, but almost the whole of human belief generally, is amenable to logical tests. The business of the physician, magistrate, &c., is chiefly to draw inferences from data, and act accordingly.]

[*The function of Logic in relation to that part of our knowledge of which it does take cognisance*, is to judge of the validity of the inference by which this knowledge was arrived at. The science or particular subject-matter furnishes *the evidence* itself; while Logic supplies the principles or rules for the *estimation of the* (*worth of it as*) *evidence.*]

[*The Utility of Logic.*—"If there exist a Science of Logic, that Science must be useful; if there be rules to which every mind conforms when it judges rightly, it seems self-evident that a person is more likely to observe those rules, if he know them, than if he be ignorant of them."]

Mill's Definition.—"Logic is the Science of the operations of the understanding, which are concerned in, or are subservient to, the Estimation of Evidence."

Its *main* subject, therefore, is Inference; amongst the *subsidiary* we may notice:—

(*a.*) *The theory and use of Names and Propositions*,—for language is an instrument of thought.

(*b.*) *Definition and Classification*, which serve, (1.) To keep our evidences and conclusions in a convenient and permanent form; and (2.) To marshal our facts in a clear order.

[Analysis of Instruments necessary.—The Analysis of the Instruments (Names and Propositions) we employ in the investigation of Truth is part of the analysis of the investigation

itself; since no art is complete unless another art, that of constructing the necessary tools, is embodied in it.]

[How far this Analysis must be carried.—The Analysis of the processes of Inference, and of the processes thereto subordinate, need only, for the purposes of Logic, be carried far enough to enable us to ascertain the difference between a correct and incorrect performance of those processes.]

The above is intended as an example of a *complete* analysis, which shall include everything really contained in the author. If the time can be spared, it is better to pursue this plan, *marking by square brackets, or some similar means*, the parts which are less important, or which interrupt the course of the main argument, and then in a hasty review they can be omitted. Every device to aid the memory, such as differences in the size of the writing, width of margin, and so forth, should be employed. These suggestions may perhaps seem almost trivial, but much depends upon the mode in which an analysis is made. It is usually the best plan to read an entire chapter carefully through, so as to obtain a general notion of the whole, before attempting analysing in detail.

II.

THE FALLACIES

are divided by Mr Mill into *five great classes*, thus :—

I. "Fallacies of Simple Inspection," or "à Priori Fallacies."

(Where a proposition is improperly accepted as being "Self-Evident;" received as an *à priori* truth which requires *no evidence*, upon a "Simple Inspection" of it as it were, *i.e.*, upon the mere comprehension of its meaning.)

II. Fallacies of Inference.

- Evidence clearly conceived, and understood.
  - **Inductive.**
    - Evidence false. → **Fallacies of Observation.**
    - Evidence true, but inconclusive. → **Fallacies of Generalisation.**
  - **Deductive.**
    - Evidence false. → Since the false evidence must either be particular facts or general propositions, this class must come under one of three preceding heads.
    - Evidence true, but inconclusive. → **Fallacies of Ratiocination.**
- Evidence not clearly conceived..... → **Fallacies of Confusion.**

I.—Fallacies of Simple Inspection.

The following are examples of some principal forms :—

(*a.*) That the Inconceivable is False.

(*b.*) That everything which can be conceived in the mind must have a corresponding real existence in fact. (*Realism* an exaggerated form of this Fallacy.)

(*c.*) The doctrine of the "Sufficient Reason," that a thing must be so and so, because we know of no reason why it should be otherwise.

d.) That the distinctions in nature must correspond to distinctions in language. (Common error with Greek philosophers.)

(*e.*) That a phenomenon can have but one cause. (An error which vitiated Bacon's Principles of Inductive Inquiry.)

(*f.*) That there must be a resemblance between a phenomenon and its conditions.

II.—Fallacies of Observation.

Here the error lies in *overlooking* or in *mistaking* something (*i.e.*, in collecting our data), and therefore we have either :—

Fallacies of Observation.
- (*a.*) *Fallacies of Non-Observation* (overlooking)
  - Of Instances.
  - Of Essential Circumstances.
- (*b.*) *Fallacies of Mal-Observation*—(seeing wrong) mistaking inference for perception—believing that we have an immediate knowledge of something which we really infer.

Non-Observation or neglect of instances may occur either (*a.*) *From the circumstance that some of the instances are naturally more impressive than others*,—as, for instance, positive against negative instances. We are very apt to notice instances in which a phenomenon occurs, without regarding the equally important instances in which it does *not* occur. (*b.*) *From preconceived opinion*—the most fertile source of error of this kind.

III.—Fallacies of Generalisation.

Here we have rightly obtained the obtainable evidence bearing on the conclusion; but we have wrongly concluded from it. The error lies in making the Inference, not in collecting the data.

This class of Fallacies—the error of drawing conclusions from insufficient evidence—is the most extensive of all, as might indeed be anticipated. It is only possible, therefore, to indicate some of the principal sub-classes:—

Fallacies of Generalisation.

- (*a.*) Generalisations which *cannot* in the nature of the case be established, where we have no real data or evidence to go on,—as, for example, inferences as to what may go on in remote parts of the universe.
- (*b.*) All propositions which assert impossibility (universal negative propositions), except those which assert mathematical truths or the impossibility of exceptions to the universal law of causation.
- (*c.*) All generalisations which profess to resolve radically different phenomena into the same.
- (*d.*) The fallacy involved in placing mere empirical laws (and those often of the lowest kind) on the same footing of generality as true causal laws. As—
  - (1.) Empirical laws generalised from mere negations. ("What *has* not happened, never *will*.")
  - (2.) Empirical laws arrived at merely by the "induction by simple enumeration."
- (*e.*) Generalisations which improperly infer causation. (*Fallacia non causa pro causâ.*)
- (*f.*) Arguments from false analogy. (*Fallacia non talis pro tali.*)

Avoid confusion between "Ind. by *Simple* enumeration;" and "Ind. by *Complete* enumeration;" in the former we conclude that a law is true simply because we have never met with an instance to the contrary; the latter is the same as the "Mere Verbal Transformations" of Mill.

IV.—Fallacies of Ratiocination.

Fallacies of Ratiocination.

1. Fallacies of *Immediate Inference* (as in the Conversion, Opposition, Æquipollency of Propositions).
2. Syllogistic Fallacies (= the "*Logical Fallacies*" of Whately). Undistributed middle, illicit process of major and minor, and so on.
3. "Changing the Premisses" { *Secundum quid.* / *Per accidens.*

The meaning of the phrase, "Changing the Premisses," applied by Mill to a certain class of the Fallacies of Ratiocination, is this :—A premiss in a syllogism is regarded as being the conclusion of some previous act of inference. Now, if the proposition, *as laid down for a premiss*, is really distinct from that which was proved, an error may easily arise in making a deduction from it,—*a change* is made in passing from the proposition *as a conclusion* to the proposition *as a premiss*. The *Fallacia a dicto secundum quid ad dictum simpliciter* (briefly designated "*secundum quid*)," and the *Fallacia accidentis* are important forms of this sub-class of Fallacies ; in both cases, the error lies in laying down a major premiss too absolutely or generally,—more generally, in fact, than the evidence which supports it will warrant. Thus, if we say, "*All men have a right to their personal liberty*," it is clear that generally speaking we should really mean to limit it in some such way as this,—"All men, who are of sound mind, and who are not guilty of criminal conduct, have a right to their personal liberty." The evidence for the proposition only proves this more limited form ; and if we use it as a premiss without these tacit limitations, we may be guilty of a fallacy.

V.—Fallacies of Confusion.

Here the mistake lies, not so much in over-estimating the probative force of known evidence, as in the absence of a distinct and definite conception of what that evidence really is.

Fallacies of Confusion are :—

- 1. Ambiguous language (the "semi-logical" of Whately).
  - F. *equivocationis.*
  - F. *amphiboliæ.*
  - F. *figuræ dictionis.*
  - F. *compositionis.*
  - F. *divisionis.*
  - F. *plurium interrogationum.*
- 2. *Petitio Principii.* — The employment of a proposition to prove that upon which it is itself really dependent for proof.
- 3. Arguing in a circle. — Proving two propositions reciprocally from one another.
- 4. *Ignoratio Elenchi.*
  - Proving part of a conclusion.
  - Proving a conclusion vague from the use of complex and general terms.
  - Fallacy of shifting ground.
  - Fallacy of objections.
  - Fallacy of special appeals, as "*ad hominem*," &c.

The Fallacy, "*Ignoratio elenchi*"—ignoring the elenchus*—is the proving of a proposition resembling more or less the conclusion required, but not really identical with it,—a *very common* form of Fallacy.

In addition to the classification here given, in which that of Whately is fused into the exhaustive arrangement of Mill, we may notice the older division into F. *in dictione* and *extra dictionem*:—

Fallacies "*in dictione*" are those which arise from defects in the arbitrary signs of thought, and hence are generally confined to a single language, and disappear in a translation. They are thus essentially connected with *language*,—such are those of *equivocationis*, *amphiboliæ*, and so forth.

Fallacies "*extra dictionem*" lie in the thought itself,—either *materially*, as in the false application of thoughts to things; or *formally*, in the violation of the laws of thought itself.

* The "*elenchus*" is the contradictory of the assertion of the supposed opponent.

III.

THIRD DECLENSION.

Dative anciently ended in *e.*

Accusative.

These make *im.*

- *Amussis, buris, cucumis, ravis, sitis tussis, vis.*
- Names of places in *is.*
- Many names of persons in *is;* and in *old* Latin many other nouns.

These make *em* and *im.*

- *Aqualis, clavis, cutis, febris.*
- *Lens, navis, pelvis, puppis.*
- *Restis, securis, sementis, strigilis.*

Ablative.

These have *i.*

- Accusatives in *im* (see preceding list).
- *Canalis, securis.*
- The names of months, as *Aprilis, September,* &c.
- Words of an adjective form, as *gentilis,* a relation.

These have *e* or *i*.

- Accusatives in *em* or *im* (see preceding list), but *reste*, *securi*, always.
- *Finis*, *occiput*, *rus*, *supellex*, *tridens* and *vectis*.
- Also *vesper* and *mare* (*mari* usually; *mare*, Ovid and Lucretius).

These usually have *e*, sometimes *i*.

- *Amnis*, *anguis*, *avis*, *civis*.
- *Classis*, *fustis*, *ignis*, *imber*.
- *Postis*, *sors*, and *unguis*.

Neuters in *e*, *al*, and *ar* (gen. *āris*) have *i* in ablative singular, and *ia* in nom. and acc. plural.

Far, *hepar*, *jubar*, *nectar*, *baccar* have *e* in ablative singular. *Far* in plural makes *farra*.

Genitive plural.—The regular plural is in *um*, but these have *ium*—

1. All nouns which end or may end in *i* in ablative singular (see preceding lists).
2. Nouns in *es* and *is* not increasing in genitive.
3. Monosyllabic stems ending in two consonants, or in two consonants followed by *i* (usually expressed thus :—"Nouns in *s* or *x* after a consonant)."
4. Monosyllables in *as* and *is*, as *mas*, *lis*, *as* (gen. *assis*, a unit of weight or money).
5. Also—

   Caro, *cor* (?), *cos* (?), *dos*.
   Faux, *lar*, *linter* (a wherry), *mus*.
   Nix, *nox*, *strix* (*strigis*, an owl), *pax*.
   Os (*ossis*, a bone), *par* (a pair or opponent).
   Imber, *uter* (a leathern bag), *venter*, *Insuber* (a Gallic tribe).
   Compounds of *as*, and *uncia*, as *sextans*, *septunx*.

These, however, have *um*—

Trabs, canis, forceps, juvenis.
Mugilis, opes, panis, parens.
Strigilis, vates, volucris, hyems.
Ambages and *strues*, with words of Greek origin, as *Arabs, Gryps.*

These have *um* and *ium*—

Apis, mensis, sedes.

These have *um*, more rarely *ium*—

1. Words of more than one syllable in *ns*, as *cliens, adolescens* (except *parens, parentum*).
2. National names in *as—ātis*, and *is—ītis*, as
   Arpinas—Arpinātis = a native of Arpinatum.
   Quiris—Quirītis = a Roman.
   Also *Optimates* = Nobles.

According to Madvig, the *Genitive plural* of *Cor, cos, rus, sal, sol, vas* (*vadis*, a surety), do not occur in classical Latin.

Accusative plural.—The *es* of acc., and sometimes nom. plural, may become *is*, particularly when genitive plural is in *ium*.

IV.

SIR WILLIAM HAMILTON'S DOCTRINE OF THE QUALIFICATION OF THE PREDICATE.

In the ordinary system the rule given for the quantity of the predicate is this:—"that it is undistributed in affirmative, distributed (*i.e.*, taken in its whole extent), in negative propositions." On this view we obtain the four kinds of propositions respectively designated by the symbols A, E, I, O, thus—

A. All men are (some) mortal beings.

E. No men are (all) mortal beings.

I. Some men are (some) mortal beings.

O. Some men are not (all) mortal beings.

In the Hamiltonian system we have four *additional* propositions; that is, one corresponding to each of the above, but with a differently quantified predicate; these are commonly indicated by the letters U, e, Y, o, thus—

U. All men are (all) mortal beings
(that is, there are no mortal beings but men).

e. No men are (some) mortal beings
(that is, there is a certain class of mortal beings which does not include men).

Y. *Some men are (all) mortal beings (that is, some men are mortal and no other beings).*

o. *Some men are not (some) mortal beings (that is, amongst some mortal beings some men are not to be found).*

With regard to the position which this innovation should take in logic, it will be sufficient to remark in this place that the truth seems to be this—that *commonly* the mind does not, but that *sometimes* it does, specifically quantify the predicate of a judgment, and that when such is the case the quantity ought to be expressed in the proposition. The reader will find this to be true of propositions of this kind, for example: "The virtuous only are happy." "Few persons (only) take deadly poison." "None but the brave deserve the fair," and in many other cases.

By quantifying the predicate every proposition may be written with the sign of equality between its two terms (like an equation), instead of the ordinary copula; and thus all the forms of conversion are reduced to one—the simple—effected by a mere transposition of the terms.

V.

Mr Bain's Theory of the Origin of the Power of Voluntary Command over the Muscles.

The origin of this voluntary power is based upon, and is developed out of, the existence of *three fundamental facts* in the human constitution :—

1. "Law of Self-Conservation" ("The instinctive germ of Volition"), the intuitive tendency to increase or diminish a present movement in obedience to a present feeling.*
2. The occurrence of sufficiently isolated involuntary movements, chiefly spontaneous.

   [By "spontaneous movement" is meant such as arises from the mere discharge of central nerve force, without any impression or stimulation *from without.*]
3. The powers of retention and contiguity, linking such movements permanently to the corresponding sensations.

These, then, are the three primitive, innate, essential elements, upon the existence of which in our original constitution the possibility of the acquisition of voluntary

* This primitive Law of our Constitution is necessary to explain *why certain movements are retained in preference to others* (out of a great number happening), so as to enter into cohering union with definite states of feeling.

control over our muscles depends. The *mode* in which it springs up out of these is as follows :—

We suppose involuntary movements to occur, and accidentally to cause or increase some pleasurable sensation; with this pleasure there will be an increase (in the general vital energy, and therefore) in the fortunate movements by the "Law of Self-Conservation." A few repetitions of this fortuitous concurrence of a feeling, and a certain movement, will lead to the forging of an acquired link of connection between them under the Law of Contiguity; so that at a subsequent time, the feeling, or its idea, shall evoke the proper movement at once. Definite feelings are thus connected with definite actions.

Mr Bain gives his theory of Volition in a few words, thus :—

"Volition springs from *spontaneity*, working under trial and error; the successful strokes being clinched and sustained by the law of conservation, and permanently bound up with the feeling by the operation of the law of contiguity."

VI.

In studying the sensations it is of great consequence to notice the order in which Mr Bain discusses the principal points in regard to each severally. These are :—

1. The external object—causing the sensation.
2. The Sensory organ itself. { Description of Changes in during, and necessary conditions for, its action.
3. The character of the sensations considered in themselves. { Pleasurableness or Painfulness. / Massiveness (Voluminousness) or Keenness. / Obtuseness or Acuteness.
4. Classification of the sensations of each sense.
5. Relation to external expression.
6. Relation to Volition. { Tendency to initiate action of some sort, as opposed to a pure or serene feeling.
7. Relation to Intellect. { Retention. { Immediate. / Permanent, *i.e.*, recoverability in idea. / Discrimination. { Degree, Locality, &c. / Retention of a standard. { Relative. / Absolute. / Improvability.

This Table will be found exceedingly useful, and should be kept in view whenever the candidate may be required to discuss any particular sense. He should consider the different kinds of sensations derived from it in reference to each of the points above suggested.

VII.

PERSONAL ENDINGS OF PRESENT TENSE OF ACTIVE VERB IN SANSKRIT.

Singular.	Dual.	Plural.
1. mi . .	vas . .	mas
2. shi *or* si .	thas . .	tha
3. ti . .	tas . .	nti *or* ati

Thus the *m* sound is the characteristic of the termination of the first person singular, the *sh* or *s* sound of the second; the *ms* of the first plural, and so on. The student should compare these with the corresponding endings of the present tense in Latin, Greek, Anglo-Saxon, and English. The *m* in am is perhaps the only example in modern English of the preservation of the *m* ending *as a sign of person.*

GOTHIC ENDINGS OF PRESENT TENSE.

Singular.	Plural.
1. . .	m *or* mes
2. s . .	ath
3. th . .	nt *or* nd

The first and third plural afterwards passed into *en.*

In Anglo-Saxon there were two signs for the two distinct sounds now represented in the language by *th.* The

sharp, as in *thin*, indicated by a letter resembling a *p*, and the flat, as in *thine*, by a letter like a Greek delta with a line through the stroke. It is the flat *th* which we have in the above table.

PERSONAL VERB ENDINGS IN MODERN ENGLISH.

Singular.	Plural.
1st	No peculiar personal endings, but in old and middle English *en* for all three persons.
2d st	
3d th or a sibilant	

MODES OF CONSTRUCTING A "MEMORIA TECHNICA."

We have already several times incidentally remarked, in the course of this work, that there are certain classes of facts which can hardly be permanently fixed in the memory without some form of *artificial aid;* such a device is commonly called a "*memoria technica*"—a mechanical reminder. Most students will sooner or later have found the necessity of expedients of this kind ; and where there is such unlimited scope for ingenuity, will probably have invented contrivances of their own for assisting the memory in this way. This is not altogether so trivial a matter as might at first sight be supposed, and we shall devote a short space to a suggestion or two on the subject.

A very good method where *numbers* are concerned, as in dates or chemical formulæ, is the following, which depends upon the principle of *substituting fixed consonants for the digits, and thus reducing a numerical series to a word,* which is commonly much more easily remembered.

If we remove from the alphabet the vowels and the letter *y*, we have remaining twenty consonants, two out of which are assigned to each of the nine digits and the cypher. The arrangement is quickly learnt by keeping in mind the annexed key-words, thus :—

1.	q	t	(quit)	4.	z	r	(zoar)	7.	c	k	(cook)
2.	n	h	(Noah)	5.	j	l	(jail)	8.	b	w	(bow)
3.	m	g	(Magi)	6.	d	v	(dive)	9.	p	f	(puff)
								0.	s	x	(sex)

So that *q* or *t* indicates 1 ; *n* or *h* 2 ; and so on.

To remember any collocation of numbers it is only necessary to write down the corresponding letters, and then to introduce vowels between them to make words as significant as the case admits of. Thus the date of the battle of Marathon (490) would give the word "*raps ;*" of Salamis (480) "*rows ;*" the Peace of Nicias (421), "*reunite ;*" and so on. It is obvious that the system may be adopted to any extent that the student may think fit.

In constructing Mem. Tech. for chemical formulæ on this principle, it is only necessary in addition to adopt *an invariable order for the initials of the elements.* Since it is only in the organic department of the science that any difficulty can arise in permanently fixing formulæ in the memory, it is best to adopt the order usually followed in chemical books—C, H, O, N. If the student can succeed by any means in recollecting the sequence of the numbers in a formula, he will seldom have any trouble in assigning its proper value to each element, and this the system in question enables him to do.

Another method of fixing facts upon the mind is to embody them in rhymes. Many minds are so constituted as to retain easily and permanently anything expressed in such a form, however rough or *outrè* the verses may be. It will suffice to give one or two examples :—

RULES OF A LOGICAL DEFINITION.

1. It must be co-extensive with
   The name which we define,
2. And parts of less intension must
   For clearer sense combine.
3. A negative will seldom do.
4. Use words in literal sense, and few.

The meaning of the second rule is that the definition must be composed of parts less in comprehension (*i.e.*, containing fewer ideas), than the name defined ; and each part, on account of thus embracing fewer or less complex ideas, *clearer* than the name defined.

RULES OF A LOGICAL DIVISION.

1. That the members must equal the whole we can see,
2. Distinct and opposed those members must be ;
3. Parts of same degree of generality choose,
4. Unnatural order of members refuse.
5. Let the parts be marked out by signs well understood.
6. Intermediate classes in their order include.
7. Take the principle always which best suits your aim,
8. And throughout the division adhere to the same.

These will suffice as examples of this kind. Sometimes any casual coincidence which may be detected will serve to

aid the memory; thus of the three kinds of logical conversion—*Simple*, *Per Accidens*, and *Contra-position*—the first two vowels in each indicate the kind of propositions to which it is applicable, as simple to I and E; per accidens to E and A, &c.

NOTE TO PAGE 13.

Given the equality of two *complex* ratios (where antecedents are similarly involved with antecedents, and consequents with consequents), to prove the equality of two simpler ratios.

Multiply the extremes together, and also the means in the given complex ratios, the resulting expressions are equal by hypothesis. It will then be found practicable *to write these in terms of the products of the extremes and of the means of the simpler ratios*, so that the equality of these last is either evident from inspection, or may be easily proved. Thus :—

Example 1.

If $$\frac{a+b}{c+d}=\frac{a-b}{c-d}$$

prove $$\frac{a}{b}=\frac{c}{d}$$

Multiplying extremes together, and also means, we have

$$(a+b)\,(c-d) = (c+d)\,(a-b),$$

or $$ac-ad+bc-bd = ac-bc+ad-bd,$$

or $$-ad+bc= -bc+ad,$$

or $$ad=bc,$$

or $$\frac{a}{b}=\frac{c}{d}.$$ Q.E.D.

EXAMPLE 2. (Lond. 1865.)

If $$\frac{a^2+ab+b^2}{c^2+cd+d^2}=\frac{a^3d-b^3d}{c^3b-d^3b},$$

prove $$\frac{a}{b}=\frac{c}{d}.$$

Multiplying extremes and means as before, and taking the two minus terms of each side over to the other, we get

$$a^2c^2(bc)+ac(bc)^2+(bc^3)+bd(bc)^2+b^2d^2(bc)=$$
$$a^2c^2(ad)+ac(ad)^2+(ad)^3+bd(ad)^2+b^2d^2(ad)$$
$$\therefore ad=bc,$$

or $$\frac{a}{b}=\frac{c}{d}.$$ Q.E.D.

The following is also added here as an additional example of the use of the formula :—

If $$\frac{a+b+f}{a-b-c}=\frac{a-b-c+d}{a+b+f-d}=\frac{c-d-f}{c-f+d}$$

prove each of these fractions = 1. (Matric. 1863.)

Since the three fractions are equal by hypothesis, each of them will be equal (by the formula) to the sum ($2a$) of all the numerators divided by the sum ($2a$) of all the denominators,—that is, to unity.

Another example for exercise in proportion :—

If $$\frac{a}{b}=\frac{c}{d}$$

prove $$\frac{a+b}{a-b}=\frac{\sqrt{ac}+\sqrt{bd}}{\sqrt{ac}-\sqrt{bd}}$$ (Matric. 1861.)

Writing in another form and alternating, we get—

$$\frac{\sqrt{a}\sqrt{a}+\sqrt{b}\sqrt{b}}{\sqrt{a}\sqrt{c}+\sqrt{b}\sqrt{d}}=\frac{\sqrt{a}\sqrt{a}-\sqrt{b}\sqrt{b}}{\sqrt{a}\sqrt{c}-\sqrt{b}\sqrt{d}}$$

It is now evident that in both fractions the numerator and denominator are similar expressions, therefore we may prove by method first, A and B being $\sqrt{a}$ and $\sqrt{c}$ respectively, or by formula, as by it both fractions are $=\frac{\sqrt{a}}{\sqrt{c}}=\frac{\sqrt{b}}{\sqrt{d}}$

NOTE TO ACOUSTICS OF SECOND B.A.

For determining in a general way the velocity of sound in gases, the following formula may be used :—

$$v=\frac{\sqrt{e}}{\sqrt{d}}$$

where v = the velocity required, e the elasticity of the gas, and d its density.

The velocity in atmospheric air at 32° Fahr. is 1093 feet per second.

If the gas be at the temperature and pressure of the atmosphere, its *density* is of course represented by its *specific gravity*, which for any given gas may be found by the rule, p. 30. The *elasticity* of a gas is measured by the pressure it exerts upon the interior of the vessel which either actually contains it, or may be supposed to do so. The following illustrations of the application of this formula will enable the reader to comprehend it fully :—

(*a.*) Suppose we have a cylindrical vessel, closed at the lower end, in which an air-tight piston moves, and which contains a gas at the temperature and pressure of the atmosphere. The velocity of sound in that gas will be inversely as the square root of its specific gravity (the atmosphere being the unit of comparison in both respects), for its *elasticity* is the same as that of the external air. If now the piston be pressed down, till the gas occupies one-half of its original volume, the velocity of sound in it will not be altered, for both the elasticity and density are increased in the same proportion.

(*b.*) If the temperature of the gas in such a vessel be raised, the piston being fixed so that it cannot expand, the elasticity is increased while the density is unaltered; hence the rapidity of the transmission of sound waves through it will be augmented.

(*c.*) If, however, the piston be allowed to rise freely, the elasticity is unaltered (remaining the same as that of the atmosphere), while the density is diminished; here, too, then, but for a different reason, the velocity is increased.

(*d.*) If the gas is not contained in any vessel, but exists free, as in the atmosphere, the rise in temperature, as in (*c*,) is accompanied with no change in the elasticity, but with a diminished density. Hence the warmer the air the faster does sound travel; while barometric variations, as in (*a*,) do not affect the rate.

In comparing the velocities of sounds in gases by means of this formula, the sounds are supposed to be of nearly equal intensity. Sounds are propagated *faster*, the *greater* their intensity or violence.

APPENDIX ON BOOKS ON CHEMISTRY.

Books on Chemistry have of late years become so numerous, that we thought it better to throw together a few notes on some of the principal as an Appendix, rather than encumber the text of the Article on Chemistry therewith. We may divide the whole of such works into two classes :—(1) *The elementary;* and (2) *The higher.*

As far as books on Elementary Chemistry are concerned, the last few years have been remarkably prolific. As regards the London Matriculation, we have, however, as yet seen none which has induced us to change our opinion expressed in the text, though Roscoe's Chemistry is perhaps as good as Wilson's. Next to these, or even on an equality, we would place Guthrie's *Elements of Heat and Non-Metallic Chemistry* (Van Voorst), which, moreover, has the further advantage of including the subject of Heat, this work, indeed, having been drawn up exactly in accordance with the Syllabus of Matriculation. For the rest, as regards books of this class, we shall content ourselves with a few guiding observations on each :—

Wilson's Chemistry (Chambers) is in its last edition separated into two volumes, respectively Inorganic and Organic, and is now an excellent exposition of Elementary Chemistry.

Roscoe's Chemistry.—Same observations apply ; but it includes both Inorganic and Organic, in one volume.

Williamson's Chemistry (Macmillan) is, besides other causes of unsuitability, too advanced for mere beginners.

Barff's Work (Groombridge), though a great success as regards a large sale, has no special merit, and is far inferior to Roscoe, or Wilson.

Kay Shuttleworth's is solely an exposition of the modern doctrine of definite Atom Fixing Power, the so-called "Atomicity" of Atoms. Of this it gives a very clear account.

To *Hofman's Chemistry* a somewhat similar observation applies. It is exclusively an exposition of the doctrine of Volume Combination of Gases.

Bernay's Notes (Churchill) contains, in an exceedingly condensed form, the most important points in Elementary Inorganic Chemistry. It is the best book for rapid review just previous to an examination.

Galloway's First Step.—An excellent exposition of Elementary Chemical Philosophy.

For more advanced students Fownes may be taken as the general text-book, with the translation of Naquet's Chemistry, and Frankland's *Lecture Notes for Chemical Students*, for certain points of Chemical theory. Naquet's book especially is really essential; it is by far the best exposition of the Modern Chemical Philosophy extant. W. A. Miller's volumes are the best repertoire of *facts*, but they do not enter into questions of Chemical theory, with that fulness which is now-a-days so essential. Certain articles in Watt's Dictionary —though the older volumes are a little out of date—may be added to list, especially those on *Acids*, *Classification*, *Metals*, and *Isomerism*; also with *Atomic Weights*, *Chemical Affinity*, *Formulæ*, and *Types*. Under the article *Acids*, will be found a very useful table of the relations of the most important classes of Acids; and also materials for the answer to a frequently-recurring question, How do we determine alomicity and basicity of any given acid? We say *materials* for an answer, since the article having been written before distinction between alomicity and basicity was recognised, overlooks that important and fundamental point.

ON MUTUAL CONVERSION OF THERMOMETRIC SCALES.

A hint as to mode of doing this may be of value. Always begin by reckoning the number of degrees, the given temperature is *from the freezing point.* We can then easily find how many degrees of the required scale are equal to the number we have got from freezing point of given scale, and frame answer accordingly. Thus, suppose we require to reduce 9° F. to centigrade, now 9° F. is 41° from freezing point, 41° F. = 22·7° C. ∴ given temperature is 22·7° C. below freezing point.

ON TEMPERATURE REDUCTION OF GASES.

(*Here always use Centigrade Scale.*)

A very convenient mode is to make use of absolute temperatures, *i.e.*, temperatures reckoned from – 273° C. Reckoning this as the 0°, count temperatures from it, and then we may lay it down that *the volume of a gas is directly as temperature.* Thus we have a gas at 15° C., let it be heated (while allowed to expand freely) to 40° C. ; this is the same as having a gas at 288° and 313° absolute temperatures. Volumes at the two temperatures are, therefore, represented by 288, 313. If T stand for absolute temperature of a gas, P for pressure, and V for volume, we get the following very useful formula :—

$$\frac{V_1}{V_2}=\frac{P_2}{P_1}\times\frac{T_1}{T_2}$$

MILL'S LOGIC. Book iii., chap. 8, &c.

This Table is introduced as an example of an extremely condensed analysis in a tabular form.

INDUCTIVE METHODS.

	CANONS.	REMARKS.
METHOD OF AGREEMENT.	POSITIVE METHOD.—*If two or more instances of the presence of the phenomenon in question have only in common the presence of one other circumstance: that circumstance, in the presence of which alone all the instances agree, is the cause or effect of the given phenomenon.* NEGATIVE METHOD.—*Same as above, but substituting "absence for "presence."*	I. The possibility of a "*Plurality of Causes*" introduces the possibility that the two phenomena may only be conjoined *by chance;* this may be remedied by the process for the "*Elimination of Chance*," which enables us to prove that the phenomena are in *some way connected.* II. The possibility of the "*presence of unknown antecedents*" prevents us from going beyond this, and assuming that the one phenomena is the cause of the other. III. This method, therefore, can by itself yield "*Empirical Laws*" only. IV. The instances from which this method infers are usually obtained by *Observation*, and it is the one usually employed in investigating the unknown causes of a given effect.
JOINT METHOD.	*If two or more instances of the presence of the phenomenon in question have only in common the presence of one other circumstance, while two or more instances of the absence of the phenomenon have only in common the absence of that circumstance; that circumstance, in which alone the two sets of instances differ, is the effect or the cause, or a necessary part of the cause of the phenomenon.*	I. It is an employment of the *positive* and *negative* methods of agreement together. II. It is called the "*Indirect method of Difference*," because the negative instance is obtained, *not* by direct experiment, but *indirectly*, by showing what *would* be the result if the direct experiment could be made. III. It is a great extension of the method of agreement, not being affected by the possibility of a plurality of causes; and, after the method of difference, is the most useful and rigorous. IV. The negative method of agreement being affected by the possibility of absence of unknown antecedents, just as positive method is by the possibility of their presence, in applying the joint method, one of these possibilities *ought* to be got rid of to make the joint method rigorous.

M. OF DIFFERENCE.	*If an instance in which the phenomenon in question occurs, and an instance in which it does not occur, have every other circumstance in common except one, that one occurring only in the former; that circumstance, in which alone the two instances differ, is the effect, or the cause, or a necessary part of the cause, of the phenomenon.*	I. This method is *rigorous*, and is the only one by which we can arrive at "Laws of Causation" (except the methods of residues and concomitant variations, which are essentially the same). II. It is more particularly a method of *artificial experiment*; because, (1) We proceed from the cause to the effect, in most cases; (2) Instances required are rigid and definite. III. Many of the inferences which we constantly are drawing in daily life are simple cases of conclusion by the method of difference.
METHOD OF RESIDUES.	*Substract from any phenomenon such part as is already known to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents.*	I. A modification of the method of difference; but the instance in which a given phenomenon is absent is obtained by deduction, not by observation or experiment. II. It is equally rigorous with the method of difference if, (1) We were certain of the total of the effects of the known antecedents; and, (2) That the remaining antecedent is the only one; but as these are scarcely ever accomplished,— III. The evidence from this method must, therefore, be supplemented, either by the method of difference itself, or by the deductive method. IV. This method is most fertile in unexpected results.
M. OF CONCOMITANT VARIATIONS.	*Whatever phenomenon varies in any manner, whenever another phenomenon varies in some particular manner, is either a cause or effect of that other phenomenon, or is connected with it through some law of causation.*	I. It assumes, as an axiom, that "anything upon whose modifications, modifications of an effect are invariably consequent, must be the cause, or connected with the cause, of that effect." II. This method may often *usefully* follow the method of difference to determine according to what law the changes of the effect follow those of the cause. III. The most *striking* application is in determining the effect of those of the *permanent causes* which we cannot eliminate. IV. The most *satisfactory* is when variations of cause are variations of *quantity*. (*a.*) Two *cases* of this relation:—1st, Cause and effect vanish together; Where they do *not* do so. (*b.*) Two *precautions*:—1st, To know absolute quantities; 2d, Law may not hold beyond the limits of observation.

EXAMPLES OF QUESTIONS.

In the subjoined extracts from the London papers, with the appended observations, our design has been the same as that at which we have aimed throughout. They are selected, not to furnish the reader with fragments of miscellaneous information, but with the view of suggesting the kind of points which are worthy of special attention, and the most advantageous methods of collecting and arranging the information which he may obtain from his reading. The remarks which follow some of the questions are not, therefore, to be regarded as necessarily forming a complete answer.

Since it is only in certain of the subjects that hints of this kind can be of any utility, it is to these that we have limited our selections.

ENGLISH HISTORY.

I. Of what different races is the English nation composed? Give the date and the circumstances of the introduction of each element.

The English people are mainly of Saxon descent, with a large infusion of Norman; the fusion of the two races was practically complete in the time of Henry III. (See Introduction to Macaulay's "History.") The middle of the thirteenth century saw the people (previously Saxon and Norman), become "English;" the language (hitherto "semi-Saxon)," become "Old English;" and the constitu-

tion assume the form which ever since has been characteristically "English," for the House of Commons was called into existence at that period. *Keltic* and *Scandinavian* elements also entered, in some small degree, into the mixture of races from which the English nation has descended.

II. What rights were specially secured by "Magna Charta" and the "Confirmatio Chartarum?"

The following analysis of "Magna Charta" may be useful:—

1. Certain feudal burdens were mitigated and arranged.
2. "Liberty of subject" was secured by clauses 39 and 40.
   (39.) "No freeman shall be taken or imprisoned, or be disseized of his freehold, or liberties, or free customs; or be outlawed, or exiled, or otherwise injured; nor will we pass upon him, nor send upon him, but by lawful judgment of his peers, and by the law of the land." (40.) "We will sell to no man, we will deny to no man, justice and right."
3. "No taxation without representation," by this clause:—
   "No scutage or aid shall be imposed in our kingdom but by the general council of our kingdom."
   This clause is the nearest approach to the principle at the head of it, for the feudal burdens, against the arbitrary imposition of which by the king it was designed to guard, fell chiefly upon the class which was represented by the "commune consilium." This provision was omitted in the charter as confirmed by Henry III., but was restored to the law by a special statute (25 of Ed. I.), the statute "De Tallagio non concedendo;" it was this omission by Henry III. which rendered this statute a necessary appendage to the "Confirmatio Chartarum."
4. The constitution of this general council ("commune consilium)," was settled.
   It was to consist of prelates and barons, summoned by separate writs; while all other tenants-in-chief of the crown were to be summoned *en masse* by the sheriff.
5. The fixation of the courts of justice at Westminster (instead of accompanying the person of the king—an important improvement), and the interests of commerce (by regulations for fairs, weights and measures, &c.) were provided for.

6. Villeins were not to be deprived, by fine, of their implements of husbandry.

This clause is remarkable as the only one out of the entire number which does not exclusively relate to freemen.

III. Name, with dates, the Kings of England, from William I. to James I., inclusive; state in each case the title, and, if defective, point out in what way.

It should be remembered that "the title to the throne" is *entirely a matter of law and custom*,—there is no such thing as a *natural* right to the succession. In discussing questions of title, therefore, the candidate may first examine the claim in relation to the law which generally prevails, that of primogeniture; but the final answer is involved in determining this,—"What was the law or established custom of the community at the time?" Compare, in this respect, the succession of the Saxon with that of the Norman kings. See "Blackstone's Commentaries," book i., "The King and his Title."

We have already insisted on the importance of a ready knowledge of the genealogical tables as a necessary basis for a clear understanding of English history. They show that James I. not only represented the line of William I., through his ancestor, Margaret, but was moreover the true heir of the Saxon line of kings. Edward, the Outlaw, transmitted his right to his daughter Margaret, who married Malcolm I., King of Scotland. The Saxon claim was thus transferred to the son of Malcolm, David I., of whom James I. was the heir. The Saxon and Norman *claims* were thus united in James, and not, as sometimes said, by Henry I., who merely married a Saxon princess, but not the heiress of the Saxon throne.

IV. Which of the English Kings has been called "the English Justinian," and why?

Edward I. For the legislative and executive reforms of this reign, see "Blackstone," book iv., chap. 33, on "The Rise and Progress of English Law;" a most instructive and interesting chapter.

V. The reign of Charles II. has been said to have been "an era of good laws, but of bad government." Explain this statement.

See same chapter of "Blackstone's Commentaries."

VI. What was the condition of England, as to population, wealth, and colonial settlements (*a*) at the accession of Elizabeth; and (*b*) at the revolution of 1688?

Consult the Introduction to Macaulay's "History."

VII. What constitutional questions are connected with the names of Langton, A'Becket, and Lord Chancellor Shaftesbury? What with the "Constitutions of Clarendon," the "Five Members," the "Seven Bishops," and the "Dispensing Power?"

VIII. State the circumstances and describe the positions of the battles of Shrewsbury, Dunbar, Cape La Hogue, and Bannockburn.

IX. Name the most distinguished men who flourished in the time of Charles I., and write a brief life of any two of them.

The last three questions are selected as examples of classes which occur in almost every examination paper.

ENGLISH LANGUAGE.

I. In what parts of speech and in what classes of words have we the greatest proportion of Saxon roots?

The proportion of Saxon words in the dictionaries is about $\frac{25}{40}$ (23,000 in 38,000); the proportion in the works of standard authors is about $\frac{32}{40}$.

Rules for detecting words of Saxon origin:—

(1.) From their forms:—

(*a.*) The Articles, Pronouns, Conjunctions, Prepositions, and Particles are A.-S.

(*b.*) Words which are "irregular," commonly so termed—that is, generally "defective"—as Adjectives in their comparison; Nouns in their plurals; Verbs in their preterites, &c.

(*c.*) Almost all "strong" words; that is, words whose etymological modifications are accomplished by internal vowel changes.

(*d.*) Most words of one syllable.

(*e.*) Certain terminations are characteristic, as *hood; head: ship; dom; th; t; ness; rich.*
ling; kin; och; ie.

Adjectives in *ful; ly* (A.-S. lic); *ish; en; ern; ward;* and *some.*

Most verbs in *en*—as *whiten, quicken.*

(*f.*) Certain beginnings are characteristic:—*kn; sh; wh.*

Most words beginning with *ea; ye; gl; th.*

All words having *ough* or the *ng* sound (as in *king, think*) therein.

(2.) From their signification:—

(*g.*) The A.-S. gives us nearly all the words of *the common objects of sense or idea*—our relatives, domestic objects, the common phenomena of nature, and so forth.

It is a curious and significant fact that the names of the common domestic animals—*ox, sheep, pig, deer*, &c., are A.-S.; while, when prepared for the table, they assume N.-F. designations—*beef, mutton, pork, venison*, &c.

(*h.*) Terms describing *particular* objects, qualities, or modes of action are A.-S.; thus, "*motion*" is Latin, while *creeping, walking, riding, running*, are A.-S.

II. What examples have we of (*a*) deficiency, (*b*) redundancy, and (*c*) inconsistency in the English alphabet? Illustrate by examples some of the anomalies of English spelling, and state how they arise.

The English language contains forty distinct sounds; to represent these there are twenty-six letters, four of which (c, j, q, x) are redundant, so that we are left with twenty-two symbols to express these forty sounds. A perfect orthography would require a perfect alphabet —*i.e.*, a distinct symbol for every distinct sound.

English orthography is imperfect, from

(*a.*) Alphabetical reasons, { Imperfection.

(*b.*) Etymological reasons, {
(1.) Importation of words from foreign sources.
(2.) Changes in pronunciation of native words.
}

Orthographical expedients of various kinds are employed to supply alphabetical defects, some of the chief of which are :—

Addition of *e* mute to lengthen a vowel—*mat, mate.*

Addition of a second vowel to lengthen another—*bet, beet, beat.*

Doubling a consonant to shorten a vowel—*folly.*

Using *h*, after *p*, *t*, *s*, to express the sounds indicated by *ph*, *th*, *sh.*

Using *ce* for *s* sound at end of a word, as in *pence.*

Orthographical equivalents—where a sound is represented by some irregular symbol or symbols, different in truth, but equivalent in pronunciation. The most striking examples occur in the vowel sounds. The following are examples :—

SIMPLE VOWEL SOUNDS AND THEIR EQUIVALENTS.

a in *father—guard, heart, clerk.*
a in *fat—plaid, guarantee.*
a in *fated—bait.*
i in *sit—busy, pretty.*
&c., &c.

The twelve simple vowel-sounds of the English language (*a* in *fat, father, fated, fall; i* in *fit;* and the vowel sounds in *feet, net, not, note, but, bull, fool*), are represented *in the alphabet* by five symbols, but by more than one hundred different *equivalents* in the *written* language.

III. Give the chief rules for the formation of English plurals.

1. *The General Rule.*—When a noun ends in a sharp mute, add the *s* sound; when in a sibilant, the *ez* sound; in other cases the *z* sound.
2. Nouns of Teutonic origin ending in *f* (except those in *ff*, and in *f* preceded by a double vowel) form their plurals in the *ez* sound, as *scarf—scarves. Dwarf* is an exception.
   In A.-S., a final *f* had the sound of *v.*
3. Irregular methods of forming the plural :—
   (*a.*) "Strong plurals," *i.e.*, by change of vowel—*man, men.*
   (*b.*) By adding *n* sound—*ox, oxen.*
   (*c.*) By adding *r* sound.
   (*d.*) By combination of some of preceding, } *Child-er-n.* / *Brethr-e n.*

IV. Explain fully the constructions with the word "*self.*"

The words—*my* (*mei*); *thy* (*tui*); *her*, *its* (*ejus*); *our*; *your*; *their*, are genitive cases.

The words—*mine* (*meus*); *thine* (*tuus*); *hers*; *ours*; *yours*; *theirs* are adjectival in use.

The word "self" has two distinct constructions—either (1), *as a noun following a genitive*,* when it is = "*the very identity of*" (as *myself* = *the self of me* = *the very identity of me*); *or* (2), *as an adjective in apposition with a pronoun preceding it*, = "*the very identical*" (as *himself* = *him*, *the very identical*).

His-self is therefore logically correct as the nominative to a verb, (= the self of him), since *his* is a genitive, but it has been supplanted in usage by *himself*, *as* "*He*, *himself*, *did it.*"

With this preliminary explanation, the rules given by Dr Latham will be readily understood.

V. How are particles in *ing* distinguished from infinitives in *ing?*

The participle performs the functions of an adjective; the infinitive of a noun.

VI. Classify the elementary sounds of the English language.

These are :—

Twelve simple vowel sounds. (See end of remarks on Question II.)

Four diphthongs, *eu*, *ou*, *ei*, *oi*, represented by the vowel sounds in *new*, *house*, *nice*, *oil.*

Two semi-vowels, *w* and *y.*

Fourteen mutes. These may be remembered by the consonants in the following memorial words—*potkis*, *badguz*, *faithchish*, *vaithghizh* (the first *th* as in *thin*, the second as in *thine*). *Ch* and *gh* represent two guttural sounds not found in English. *Sh* and *zh*, the sibilant sounds, as *e.g.*, in *sure* and *azure*, respectively.

The first two words contain the "Lene," the last two the "Aspirate" mutes. In pronouncing the former, the air-passages

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* Or an adjective (mine own-self). Is mine here only an alliteration with the "own?" Own-self may be regarded as one word, another form of self.

are momentarily entirely *closed;* in the aspirate mutes only partially so. Compare in this respect *p* and *f*.

The first and third words contain the "sharp," the second and fourth the "flat" mutes.

The student should accustom himself to write out a table of the mutes, by placing the four in each word in four successive *perpendicular* columns; the top row (*p*, *b*, *f*, *v*) then includes the Labials, the next the Dentals, the third the Gutturals (thus proceeding in regular order backwards from the lips to the throat), and the fourth the Sibilants. By adopting this arrangement, it is not difficult to remember the members of the different classes.

Two double consonants—tsh (*church*); *dzh* (*judge*).

Four liquids—l, *m*, *n*, *r*.

Two peculiar sounds—sound of *ng* in *king*, or of *n* in *think;* and the aspirate *h*.

CHEMISTY—(MATRICULATION).

I. Explain the condition of solids, liquids, and gases in relation to heat. Explain "specific" and "latent" heat.

II. Give the composition of river water, and point out the difference which exists between the constituents of rivers and wells, with the cause of the greater impurity of one as compared with the other.

III. Describe the products of combustion when (*a*) coal is burnt in a fire; and (*b*) when alcohol, oil, or tallow is burnt in a lamp or candle.

IV. Give the volume of 1000 measures of air at 32° Fahr. raised to 100° centigrade; and what would be the volume of 100 cubic inches at 68° Fahr. if raised to 68° centigrade?

V. Describe hydrochloric and carbonic acids, their preparation, physical properties, and *density*.

VI. Explain fully why the flame of a common gaslight is more luminous than that of a Bunsen burner (in the latter a mixture of coal-gas and atmospheric air is burnt).

The luminosity of a flame depends upon the presence in it of minute *solid* particles in a state of incandescence. A *pure gas*, however hot, is but feebly luminous, as burning hydrogen or the oxy-hydrogen flame. In a jet of common coal-gas the unconsumed excess of carbon supplies the necessary solid particles; but in the Bunsen burner the combustion of these is more rapid and complete, and carbonic acid *gas* is at once produced. The same principle explains the intense light emitted by burning magnesium wire, or by the lime exposed to the oxy-hydrogen blow-pipe.

VII. At what temperature is water at its greatest density? What would be the result in rivers and lakes if the bulk of water varied with the temperature according to the ordinary law?

Water possesses two remarkable properties,—both of great importance in the economy of nature. *First*, it possesses a greater specific heat than any other substance, and hence is both warmed and cooled very slowly; large masses of water thus steady the temperature of adjacent districts; and *secondly*, it has its greatest density, that is, occupies the smallest volume, at a temperature of about 40° Fahr. Below this point a decrease of temperature *expands* it, till it reaches the freezing point, at which, moreover, it undergoes a further *sudden* expansion *in the act of solidifying*.* If a lake is exposed to intense cold, the upper layers cannot descend below a temperature of 40° without sinking, and hence no ice will commence to form till the *entire mass* has reached this temperature. After this the upper layers, becoming *lighter* by further cooling, remain on the surface, and then ice forms, which generally protects the mass below from becoming so cold as to extinguish animal life therein. If ice were heavier than water, so as to sink as soon as formed, lakes, rivers, and seas would gradually became *solid masses of ice* from below upwards.

VIII. Give some explanation of the nature of sound. Does

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* These two distinct facts must not be confounded. Many substances are like water in *expanding at moment of solidifying;* water alone expands below a certain temperature, while remaining still liquid.

it travel faster in carbonic acid or hydrogen; in dense air or in rare air; in hot air or in cold air?

The external phenomenon which gives rise to the sensation of sound consists in *longitudinal* vibrations (not less rapid than 16 per second, nor more than 72,000), of elastic bodies, generally atmospheric air; in this respect differing from *light*, the undulations of the "luminiferous ether" being assumed to be *transverse*. A conception of *longitudinal* vibrations may be obtained from the movements of a long spiral spring, or of a thread of caoutchouc, suspended from the ceiling, with a weight at the lower end. For the other parts of the question see formula, p. 175.

LOGIC AND MORAL PHILOSOPHY.

I. Give the contrary and contradictory of "*All A is B*," "*Some men are wise.*"

Be careful not to confound these terms as applied to *Terms*, and as applied to *Propositions*.

II. What are "Inductions improperly so called?"

It is important not to confuse "*Inductions improperly so called*" with "*Inferences improperly so called.*"

III. Explain the Predicables.

The best arrangement and nomenclature is that referred to in the text (p. 124), by Professor Mansel. Taking the division of propositions into *Verbal* and *Real* as the basis of the arrangement, we have this scheme:—

1. Verbal Propositions.	Predicate convertible with subject.	Definition.
	Predicate not convertible with subject.	Genus.
2. Real propositions.	Predicate convertible with subject.	Property.
	Predicate not convertible with subject.	Accidens.

The student may study in addition the arrangement of Whately, and of Mill, who endeavours to bring ancient nomenclature into accordance with modern philosophical ideas.

IV. Give the Laws of the Syllogism.

The reader will find the following arrangement to be the best:—

1. Every syllogism must contain three terms and no more, and three propositions and no more.
2. The middle term must be distributed in one at least of the premisses, or, if not distributed in either, both premisses together must contain more than the whole.*
3. No term must be distributed in the conclusion which was not distributed in the premisses.
4. From two negative or two particular premisses, nothing can be inferred.
5. Two affirmative premisses give an affirmative conclusion.
6. The conclusion follows the inferior premiss, particular being inferior to universal, and negative to affirmative.

(We may remark that Mr Mill spells "*premiss*" in the singular, and "*premisses*" in the plural; it seems best to follow his practice, and thus distinguish from "premises" = houses, &c.)

V. What faculties are employed in the formation of General Notions?

There are four elements in the process of forming general notions or concepts:—

1. The senses and imagination give us a knowledge or conscious-

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* This last clause includes what is termed "ultra-total distribution" of the Middle Term, as in these syllogisms:—

Three-fourths of the army are Russians.
Three-fourths of the army are infantry.
Therefore, some infantry is Russian.

Most men wear hats.
Most men wear coats.
Therefore some who wear hats wear coats.

ness of a confused plurality of objects. This knowledge forms the rough material.

2. *Comparison* of certain of these objects shows them to be possessed of attributes or properties, some of which are similar, others dissimilar, in the different objects.
3. *Attention* (voluntary or not) is concentrated upon the objects which thus partially agree, and *in* them, on those qualities in or through which they are thus similar. This *concentration of attention on the similar attributes* (which are said to be "prescinded"—cut off, as it were, and considered apart), involves an abstraction of attention from those properties which have been recognised and cast aside as dissimilar.

   It is thus a mistake to speak of the similar attributes as being "abstracted": it is the *attention* which is abstracted from the dissimilar.
4. *The synthesis of the prescinded qualities in consciousness*—that is, the unifying process by which all these attributes, similar in the different members of a class, are bound together to form the mental idea or representation of that class—is in reality accomplished by the same act of attention which renders the similarities exclusive objects of thought, but for the sake of completeness may be named as a fourth step.

Comparison and precision may be performed in an exactly similar manner, upon a number of concepts formed in the above way. Attention being concentrated upon their similarities—their dissimilarities being thrown out of view, and the prescinded attributes reduced to a unity by the synthesis of thought—a notion of greater extension is formed.

VI. The Rules of the Separate Figures of Syllogism are :—

First. The minor premiss must be affirmative,
The major premiss must be universal, } laf-gun.

Second. The conclusion must be negative,
The major premiss must be universal, } cone-gun.

Third. The minor premiss must be affirmative,
The conclusion must be particular, } laf-cope.

The memorial words are constructed thus,—*g* = greater or major premiss; *l* = lesser or minor; *co* = conclusion; *af* = affirmative; *ne* = negative; *un* = universal; *pe* = particular. The rules in each figure are arranged in the order in which they should be proved.

The rules of the fourth figure are :—

It cannot have an O premiss or an A conclusion.
If major is affirmative, then minor must be universal.
If either premiss be negative, the major must be universal.
If minor be affirmative, the conclusion must be particular.

For which the student may form similar memorial words if he choose. As to whether the fourth figure should be retained in Logic, the general conclusion is this—If the Logical system is to include *all valid* forms of inference, then it must be retained; if only *the practically useful*, then it should be rejected.

THE END.

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