THE ANALYTICAL CHEMISTRY OF URANIUM

2/- NET

H. BREARLEY

THE ANALYTICAL CHEMISTRY OF URANIUM

THE ANALYTICAL CHEMISTRY OF URANIUM

BY

HARRY BREARLEY

JOINT AUTHOR OF "THE ANALYSIS OF STEEL-WORKS MATERIALS"

LONGMANS, GREEN, AND CO.
39 PATERNOSTER ROW, LONDON
NEW YORK AND BOMBAY
1903

PREFACE

Any one desirous of mastering the practical determination of any metal in its ores and in the commercial products whose value it influences, perhaps could do no better, if immediate results were of no consequence, than to choose a gravimetric and a volumetric process which worked well with pure solutions of the metal's salts, and then to set about observing the influence exerted by variations in the mode of operating and by the presence of other metallic salts. Such a procedure, at any rate, usually gives ultimate satisfaction and confidence, and makes valuable additions to one's permanent knowledge of chemical facts, as well as, now and again, eliminates some fictions.

Some years ago the author was invited to familiarize himself with the assay of some metals of which he had no special knowledge with the view of taking charge of an analytical practice in which these metals were to be largely dealt

with. As far as time permitted, his mode of doing so was that just indicated. In a few instances the outlines then accumulated have been filled in, and an orderly arrangement of the material made, so that it might be as useful as possible in the laboratory.

If each element were dealt with in such a manner, the accumulated result would save much vexation and laborious search. This, in time, some industrious person, free from the necessity of earning a living, may do. Meanwhile this booklet, by the manner in which it is received, may assist one to decide whether more of a like kind are desirable, or whether the author is mistaken in the general usefulness of the plan.

CONTENTS

THE ANALYTICAL CHEMISTRY OF URANIUM

INTRODUCTORY NOTE.

Uranium was discovered by Klaproth in 1789, but the actual metal was isolated by Peligot in 1842; what had previously been regarded as the metal was really its lower oxide (UO_2).

The ore occurs in Saxony, Cornwall, and America, but the deposits are generally of a very sparing character. The Cornish mine at St. Stephen's, where ore (mostly uranic phosphate) is said to occur in a continuous lode from 3 to 5 feet thick, is exceptional.

Uranium is closely related (chemically) with chromium, molybdenum, and tungsten. These latter metals have each an acid-forming trioxide; the trioxide of uranium, however, acts both as an acid (sodium uranate) and a base (uranyl nitrate). Early papers on the chemistry of uranium are unintelligible unless one bears in mind, not only that the protoxide was mistaken for the metal,

but also that the atomic weight of the metal has been doubled in recent times.

Uranous oxide is formed by heating U_3O_8 in hydrogen. It is the base from which the unstable uranous salts are derived, *e.g.* $U(SO_4)_2$.

Uranic oxide unites with strong bases to form uranates which have a composition analogous to dichromates, *e.g.* $Na_2U_2O_7$ (sodium uranate). But it also acts as a base in the formation of uranyl salts ; *e.g.* UO_2SO_4 and $UO_2(NO_3)_2$.

Uranoso-uranic oxide occurs in nature as pitchblende, and may be prepared artificially by heating any oxide in air or oxygen. When digested with nitric acid it dissolves to $UO_2(NO_3)_2$, and this salt by limited ignition is converted to the trioxide, of which it is a derivative. When U_3O_8 is very strongly ignited it loses oxygen, and passes to U_2O_5 ; this, it is surmised, is the change which takes place — with the formation of an intense black colour — when porcelain painted with the uranic glaze is fired.

Higher oxides, which give rise to peruranates, are formed by adding hydrogen peroxide to uranyl solutions. These have been investigated by Fairley and others, and made use of to a limited extent in the analysis of uranium compounds.

I.

MODES OF DETERMINING URANIUM.

Gravimetrically, the determination of uranium depends on its precipitation as alkaline uranate, which is weighed as such or ignited to oxide ; as protoxide by means of ammonium sulphide ; or as phosphate.

The yellow precipitate formed when caustic soda is added to a solution of uranyl nitrate is a hydrated diuranate, which loses water merely on ignition, and may be weighed as $Na_2U_2O_7$. When ammonia is used instead of soda, the analogous precipitate is decomposed on ignition, and yields a compound approximating more or less to U_3O_8, according to circumstances. If only moderately heated the ammonium uranate does not ignite uniformly to the dark green colour of U_3O_8 ; it contains visible streaks and patches of a yellow or brown colour.[1] At higher temperatures, however, the oxide becomes practically black (though

[1] These are said to be formed when traces only of alkaline earths are present.

it gives a green streak), and loses slightly in weight. According to Zimmermann, pure U_3O_8 is formed only when heated and cooled in a current of oxygen; if heated in air and cooled quickly a small amount of oxygen is lost, and in an indifferent gas the loss is still greater: nevertheless, the elaboration of a current of oxygen may be omitted in technical assays, as the error is comparatively trifling.

The precipitation of uranium by means of ammonium sulphide is accurate, and lends itself to a number of important separations; but great care must be taken to exclude carbonates from the solution and the reagent, as they prevent a complete precipitation. The precipitate thus formed may be ignited in hydrogen and weighed as UO_2, or ignited in air to U_3O_8. Kern found that $(NH_4)_2U_2O_7$ could be readily converted to UO_2 by ignition in hydrogen, but that a previously ignited precipitate could not be so reduced and reweighed for purposes of control, particularly if the operation was carried on in a porcelain crucible.

The precipitate of UO_2HPO_4, which is formed when sodium phosphate is added to an acetic acid solution containing uranium, is gelatinous, and washes badly—worse than ammonium uranate even,—and is to be desired only on account of

the lower factor needed to convert the weight of the ignited precipitate to metallic uranium. This difficulty can be partly met, as Kern points out, by the careful use of dihydrogen ammonium phosphate instead of the sodium salt; the most satisfactory procedure, however, is that noticed in the next section.

Attempts to weigh the dried precipitate as ammonium uranyl phosphate ($UO_2NH_4PO_4$) have not met with much success; it is customary, therefore, to ignite it apart from the paper, and weigh as pyrophosphate $(UO_2)_2P_2O_7$. If ignited at low redness the precipitate has a pure yellow colour, but at higher temperatures it is partly reduced and becomes green. It is feasible, of course, to ignite precipitate and paper together, and then treat the green residue with nitric acid, evaporate, and ignite to low redness, so as to restore the characteristic yellow colour.

Uranium may be electro-deposited from acetate solutions, and ignited to U_3O_8. Separations from barium, calcium, magnesium, and zinc have been based on this reaction, but it is interfered with by many of the common metals, particularly those of the iron group.

Volumetric processes for the determination

of uranium have attracted little attention, and failed to inspire much confidence. The titration with a standard solution of microcosmic salt, using ferrocyanide as a spot indicator, is known rather as the inverse of a common way of titrating phosphoric acid than as a widely usable means of estimating uranium. Guyard's process depends on the precipitation of a triple ammonium-uranium-manganese phosphate when a solution of manganic metaphosphate is added to an acetate solution of uranium. The process is only suitable for the estimation of large amounts of uranium.

The volumetric method most in vogue depends on the reduction of UO_3 to UO_2 in acid solutions by means of zinc, aluminium, or magnesium, followed by titration with permanganate in the usual manner, contact with air being prevented as much as possible. There are no decisive colour changes to indicate complete reduction, so that an abundance of the metallic reducing agent must be used, and a time limit, depending on the amount of uranium dealt with, must be adhered to. Under the most favourable circumstances this limit exceeds the time needed to perform a gravimetric estimation, so that the usefulness of volumetric processes generally are confined to special cases.

II.

THE DETERMINATION OF URANIUM AS PHOSPHATE.

About ten times as much microcosmic salt as there is judged to be uranium present is added to the boiling solution; then dilute ammonia, until a small precipitate is formed; then just as much nitric acid as clears the solution, but no more; and, finally, sodium thiosulphate equivalent to about 10 grams of the crystallized salt. The solution becomes intensely yellow, and almost immediately deposits a voluminous precipitate. After boiling for ten or fifteen minutes, this precipitate contains all the uranium, and is so dense that it settles immediately, and may be easily washed by decantation and collected on the filter. The precipitate is transferred to a porcelain crucible, ignited, the green residue weighed, just moistened with nitric acid and gently heated. It dissolves to a yellow solution with slight effervescence, and is then dried, ignited at low redness, and the yellow

residue weighed. ($(UO_2)_2P_2O_7 \times 0{\cdot}6681 = U.$) Pure pyrophosphate dissolves entirely when heated with nitric acid; in practice an insoluble residue, weighing a milligram or so, may be found.

If a series of weighings of the green and yellow residues be scrutinized, a fairly uniform relation is seen to exist between them, and, for many technical purposes, it is unnecessary to take the extra trouble of converting the former to the latter. This is illustrated by the following table, which also justifies the above mode of operating. In each case the solution was diluted to about 300 c.c. before precipitating.

U. taken.	Green Residue.		Yellow Residue.	
	Weighed.	× 0·6855.	Weighed.	× 0.6681.
0·2220	0·3233	0·2216	0·3322	0·2219
0·1226	—	—	0·1840	0·1229
0·1110	0·1617	0·1108	0·1663	0·1111
0·0666	0·0972	0·0666	—	—
0·0444	0·0660	0·0452	0·0675	0·0448
0·0220	0·0320	0·0219	0·0340	0·0227
0·0111	0·0170	0·0116	0·0170	0·0114

The green precipitate is decidedly less hygroscopic than the yellow pyrophosphate, and may be easily brushed from the crucible even after strong ignition: it, however, is too hygroscopic to make

the practice of brushing from the crucible a commendable one. Fresenius' statement, that the yellow salt is not hygroscopic, is contrary to all my experience; in fact, a good dessicator and quick weighing are imperative if its weight is to be depended on. The residue disintegrates and leaves the sides of the crucible after absorbing moisture from the air.

In each of the following experiments 30 c.c. of a standard solution of uranyl nitrate, containing 0·2045 gram uranium, was used, and the volume of the solution precipitated was about 300 c.c. The figures in brackets represent the amount of uranium obtained when calculated from the green residue by the factor already used (0·6855.) The agreement of the two sets of figures confirms the statement already made, that its composition is sufficiently constant to warrant its weight being used in calculating the percentage of uranium for technical purposes.

Acetic Acid.—The operation is in no way affected by moderate amounts of this acid.

Acetic acid (c.c.)	0	10	30	50
U obtained (gr.)	0·2045	0·2042	0·2047	0·2049
Green precipitate		(0·2046)	(0·2053)	(0·2048)

Time of Boiling.—When large amounts of

uranium are being handled, it is sometimes a difficult and dangerous operation to boil the solution from ten to fifteen minutes on account of the vigorous bumping. Nearly all the uranium is down after boiling for a minute or two, but this can hardly be depended on. The danger may be avoided after adding the thiosulphate, by heating only as long as is necessary to liberate a considerable amount of sulphur and form a precipitate, which settles readily. Then, if 5 c.c. strong ammonium acetate are added to destroy any free mineral acid and complete the precipitation, little or no further boiling is necessary. A small amount of acetate may be added after long boiling, if further assurance of a complete precipitation is desired. The added acetate is harmless, as the following tests show :—

Acetate (c.c.)	5	30	50
U obtained (gr.)	0·2046	0·2045	0·2044
		(0·2051)	(0·2049)

Ammonium Nitrate (20 grams).

0·2048 (0·2050) instead of 0·2045 gram uranium.

Ammonium Chloride (20 grams).

0·2042 (0·2046) instead of 0·2045 gram uranium.

Ammonium Sulphate (20 grams).

0·2038 (0·2046) instead of 0·2045 gram uranium.

The precipitated uranyl phosphate, formed on neutralizing, clears up less readily on adding nitric acid than when ammonium sulphate is absent. The same observation applies to the added sodium sulphate.

Sodium Nitrate (20 grams).

0·2047 (0·2043) instead of 0·2045.

Sodium Chloride (20 grams).

0·2049 (0·2043) instead of 0·2045.

Sodium Sulphate (20 grams).

0·2035 (0·2036) instead of 0·2045.

Potassium Nitrate (20 grams).

Potassium salts are carried down. The weight of the ignited pyrophosphate was equivalent to 0·2200 gram uranium, but, on dissolving and reprecipitating a residue corresponding to the correct weight of uranium is obtained, *i.e.* 0·2040 gram.

Microcosmic Salt.—Varying excesses of this reagent may be used without detriment, but more than the theoretical amount is necessary. For example, the author, when using 5 grams instead of the usual 2 grams, of microcosmic salt, obtained a precipitate having a weight equivalent to 0·2042 gram uranium. On dissolving this and reprecipitating, without adding any more

microcosmic salt, the resulting precipitate was equivalent to 0·1988 gram; on again dissolving, adding microcosmic salt, and again precipitating, the weight of the residue was equivalent to 0·2030 gram. This shows that the second precipitate, which contained nearly all the uranium, was a basic compound.

Properties of the Precipitate. — The ignited pyrophosphate is more readily soluble in nitric than in sulphuric or hydrochloric acid; contamination with ferric oxide greatly decreases the solubility. It is easily attacked by fused sodium carbonate or caustic soda, but on extracting with water the yellow residue contains only about 90 per cent. of the uranium operated with. The portion in the filtrate is at once detected by the yellow colour which carbonated alkali solutions give with hydrogen peroxide.

III.

THE SEPARATION OF URANIUM.

SEPARATIONS FROM IRON.

By Acetates.—The separation of uranium from iron, by precipitating the latter as basic acetate, was referred to in a general way by Gibbs,[1] but no particulars were given. Some phases of the process were studied by Rheineck,[2] who suggested that the operation was a delicate one, and observed that a crystalline precipitate is formed at once in concentrated, and, after some time, in more dilute solutions, when sodium acetate is added to any salt of the oxide of uranium.

The following experiments were made with the object of determining in which direction the weakness of the separation lay, rather than with the idea of improving it for regular service. Five grams of bar iron were dissolved in hydrochloric, and oxidized with nitric acid, 25 grams ammonium chloride and 150 c.c. standard uranium solution

[1] *Chemical News*, xi. 102. [2] *Chemical News*, xxiii. 233.

added, and the mixture then neutralized and divided into five equal portions.

(*a*) Was diluted to 300 c.c., and boiled. The iron was almost entirely precipitated, and no acetate whatever was added: 0·2055 gram uranium was found in the filtrate, instead of 0·2045 gram.

(*b*) Five cubic centimetres strong ammonium acetate were added, which precipitated the iron immediately in the cold. The solution was then boiled three or four minutes. The filtrate contained only 0·0853 gram uranium.

(*c*) Treated like (*b*), but 10 c.c. acetic acid were added before the acetate. A precipitate formed after very little heating. The filtrate contained 0·1994 gram uranium.

(*d*) Treated as (*a*), but added 0·5 c.c. acetate to the boiling solution, to completely precipitate the iron—0·2000 gram uranium in the filtrate.

(*e*) Treated as (*a*), but added 5 c.c. acetic acid to the cold solution, and 1 c.c. ammonium acetate to the boiling solution. The precipitation of the iron was complete; in fact, less acetate might have been used. The filtrate contained 0·2048 gram uranium.

There is no doubt that when phosphoric acid

is absent, and the proportion of uranium is large enough to yield a sufficient amount in the filtrate, without having to deal with unwieldy precipitates of basic ferric acetate, this separation is a reliable one. The neutralized solution, however, should contain 1 or 2 per cent. of free acetic acid, and no more acetate should be used than will comfortably precipitate all the iron. With these precautions the separation appears to be quite as easy as that of iron and nickel by the same process. It is probable, also, that others of the alkaline salts which have the power of precipitating neutralized ferric solutions might advantageously be substituted for ammonium acetate.

By Alkalis.—When ammonium carbonate is added to a solution containing iron and uranium, the former is precipitated, but may or may not be free from the latter. A separation, which is practically perfect, can be made by pouring a solution containing as much as 2 grams of iron into a solution, which is kept agitated, of ammonium or sodium carbonate or sodium bicarbonate. A little iron, however, is apt to remain in solution, and it is customary, if its presence is objectionable, to allow it to settle out after prolonged standing or to precipitate it with ammonium sulphide.

Separations made in this way gave the following results :—[1]

	Fe present.	U present.	U found.
Am. carb.	2·0 grams	0·0621	0·0623
Sod. carb.	2·0 „	0·0621	0·0622
Sod. bicarb.	2·0 „	0·0621	0·0619

Caustic alkalis, of course, precipitate the uranium along with the iron, but, according to Walker, it remains in solution if hydrogen peroxide is also present.[2] This separation appears to be quite successful only when the proportion of iron is not large and the total weight of the metals dealt with is small.

By Ether, etc.—Kern's valuable contribution to the quantitative separation and determination of uranium[3] deals particularly with the separation of iron. His experimental work is confined to the ether-extraction process, which in other directions is already well known, and he finds that the most complete separations are obtained by using hydrochloric acid of 1·10 specific gravity. More than one extraction is

[1] I am indebted to my friend, Fred Ibbotson, B.Sc., for these results.

[2] *Jour. Amer. Chem. Soc.*, xx. 513.

[3] *Jour. Amer. Chem. Soc.*, xxiii., and *Chemical News*, vol. lxxxiv.

necessary, and it is doubtful whether the process is a desirable one unless ether extractions in other directions are being regularly carried out.

A separation described by Rose depends on the precipitation of the two oxides by ammonia, ignition in a stream of hydrogen, and extraction of the metallic iron with hydrochloric acid. Or the iron may be volatilized from the mixture by heating it in an atmosphere of the gaseous acid.

The electro-deposition of iron from oxalate solutions is said to lead to a perfect separation.

The separation by means of alkaline acetates is trustworthy and convenient within the limitations already referred to. Its value and accuracy is further attested by the following results; nevertheless, some other alkaline salt instead of acetates could probably be used with advantage:—

Fe present.	% U present.	% U found.
5 grams	0·817	0·836
3 ,,	3·18	3·15
2 ,,	4·73	4·77
1 ,,	20·45	20·40
2 ,,	10·22	10·15

When a minor constituent of any mixture is required to be estimated, it is generally best to

separate it by direct precipitation. This can be accomplished with a mixture of uranium and iron by applying, under suitable circumstances, the method already described for determining uranium in pure solutions. The operations are similar to those used for separating small amounts of aluminium and chromium from steel as phosphate. The separation can, of course, be used equally well when the proportion of uranium is great.

The iron being in the ferrous state, and preferably as chloride, heat the solution nearly to boiling, add microcosmic salt in the proportion already indicated, and then dilute ammonia until the precipitated flocks of ferrous hydrate are no longer quite redissolved. Clear with the smallest possible excess of hydrochloric acid, add 10 grams of sodium thiosulphate and 20 c.c. acetic acid, and boil for ten to fifteen minutes. Allow the precipitate to settle, filter as quickly as possible, and wash with hot water containing a few cubic centimetres per litre of acetic acid and ammonium acetate.

The residue, after redissolving from the filter and the accompanying sulphur, may be reprecipitated to separate the remaining portion of iron, which, when the operation is properly performed,

is rarely greater and often much less than the amount of uranium. Or, instead, the residue may be ignited, fused with sodium carbonate, dissolved in hydrochloric acid, filtered after evaporation to remove any such insoluble body as silica, and reprecipitated as before. The ignited precipitate has the characteristic green colour, and may, if desired, be converted to the yellow pyrophosphate. Not more than a negligible trace of ferric oxide, carried down by the sulphur in the final precipitation, should be present. The following results were obtained in this way :—

Iron Used.	% U present.	% U found.
5 grams	0·136	0·136
5 „	0·273	0·280
5 „	0 546	0·555
10 „	0·068	0·070
5 „	0·819	0·836

The addition of ammonium acetate to complete the precipitation and shorten the boiling is not commendable when much iron has to be separated. In order to avoid violent bumping, I have found the following plan to work well : Slide a small widely perforated filter-plate into the solution, and limit its movement along the bottom of the beaker by putting the drawn-out end of a glass

stirring-rod through one of the holes. A similar plate, allowed to move freely, breaks the steam envelopes in a haphazard way, and may cause the liquid to boil over.

SEPARATIONS FROM NICKEL, COBALT, AND ZINC.

These metals are usually separated from uranium by passing a stream of sulphuretted hydrogen through a boiling solution of the acetates (Gibbs). Zinc only may be separated by means of ammonium carbonate (Rammelsberg). Nickel and cobalt, on the other hand, remain in solution when an emulsion of barium carbonate is added to a mixture of the metals containing a small amount of free acid and some ammonium chloride. Uranium is precipitated, but must, subsequently, be separated from the excess of barium carbonate. The electro-deposition of the uranium as hydrated oxide from an acetate solution is not interfered with by the presence of zinc.

The presence of either nickel, cobalt, or zinc in no way interferes with the estimation of uranium by the method already given for pure solutions. The following are results of test analyses :—

Metal present. (0·10 grams.)	Acetic Acid (c.c.).	U present.	U found.
Zinc . . .	0	0·2045	0·2056
Zinc . . .	50	0·2045	0·2056
Nickel . .	0	0·2045	0·2053
Nickel . .	50	0·2045	0·2049
Cobalt . .	0	0·2045	0·2046
Cobalt . .	50	0·2045	0·2049

The respective filtrates can be used conveniently for determining the separated metal; those containing zinc or cobalt (after boiling with nitric acid to destroy the thiosulphate) by precipitating as the double ammonium phosphate, and those containing nickel by making alkaline and titrating with potassium cyanide and silver iodide.

SEPARATIONS FROM MANGANESE.

The separation of manganese from uranium does not appear to have been much studied. It can be separated, according to Rammelsberg, with ammonium carbonate alone, but the separation generally described is that applicable to other members of its group, viz. precipitation with sulphuretted hydrogen from a solution containing alkaline carbonates.

When uranium is precipitated as phosphate in

the manner described above, it carries down a small portion of any manganese present in the solution. A series of separations of 0·10 gram Mn from 0·2045 gram uranium were made in solutions containing amounts of acetic acid, varying from 0 to 50 c.c. The manganese associated with the uranyl pyrophosphate varied from 0·0013 to 0·0006 gram.[1] When the $Mn_2P_2O_7$ equivalents of these figures were deducted from the total weights, the remainders calculated to amounts of uranium varying between 0·2030 and 0·2050 gram.

SEPARATIONS FROM ALKALIS AND ALKALINE EARTHS.

The separation of alkalis from uranium is of technical importance, as potash is a very considerable constituent of an industrial ore—carnotite. Alkalis, alkaline earths, and magnesia can be separated by precipitating the uranium several times with ammonia in the presence of ammonium chloride; but, considering how badly ammonium uranate filters, this separation is an

[1] The amount is easily determined by dissolving in nitric acid oxidising with sodium bismuthate, and titrating the permanganate formed with ferrous sulphate.

undesirable one. It is much better to precipitate the uranium from acetic solutions with ammonium phosphate, which, according to Fresenius, effects a complete separation from alkalis and alkaline earths. Potash is the most difficult element to separate, and if present in large amounts a second precipitation may be necessary.

The separation of calcium as oxalate from ammonium carbonate solutions has been strongly disparaged by Alibigoff. He effects the separation—also from alkalis and strontium, but not barium — by boiling the solution, containing ammonium chloride or nitrate, with an emulsion of mercuric oxide.

The separation of barium with sulphuric acid is accurate and convenient. The separation of calcium and strontium, in the same way, from alcoholic solutions is practised, but for small amounts is much less satisfactory.

The precipitation of uranium as phosphate by boiling acetic acid solutions with thiosulphate effects a complete separation from calcium. If no acetic acid is present a portion of the calcium is precipitated as phosphate. The following tests were made on solutions (300 c.c.) containing 0·10 gram of calcium and 0·2045 gram uranium :—

Acetic Acid (c.c.).	U found.
0	0·2536
5	0·2063
10	0 2056
20	0·2047
50	0·2043

The lime in the filtrate can be determined simply by adding an excess of ammonium oxalate, allowing the solution to cool, filtering, igniting the residual oxide, transforming it to sulphate, and weighing. The weight of the oxide cannot be relied upon, as it may contain sulphuric acid.

Magnesium does not interfere with the precipitation of uranium.

Acetic acid (c.c.) .	0	50
U obtained (gr.) .	0·2046	0·2051

SEPARATION FROM COPPER AND OTHER METALS PRECIPITATED BY SULPHURETTED HYDROGEN.

The presence of metals whose sulphides are insoluble in very dilute acid solutions would interfere with the chosen method of precipitating uranium. When any single member of this group—which includes lead, cadmium, mercury, bismuth, copper, silver, tin, antimony, and arsenic

—has to be separated, its precipitation with sulphuretted hydrogen, from a suitably acidified solution, can be arranged. But if it is desired to detect and separate any (unknown) one of them, the acidity must be slight enough to permit the complete precipitation of the one whose sulphide is most easily dissociated, viz. lead. A complete precipitation of lead as sulphide can be made from solutions containing 2 per cent. of concentrated hydrochloric acid. When $2\frac{1}{2}$ per cent. of concentrated acid is present the precipitation is incomplete. This is the conclusion arrived at by Kern, after making a series of quantitative separations under varying conditions of acidity and temperature.

SEPARATION FROM SILICA.

The ignited pyrophosphate always contains silica when the precipitation has been made from a solution containing a soluble silicate. Thus, from a solution containing sodium silicate equal to 0·184 gram silica, 0·2045 gram uranium carried down in the two cases 0·010 and 0·006 gram silica respectively.

If the silica is not removed by evaporation with acids prior to the precipitation, it remains insoluble on digesting the pyrophosphate with

nitric acid, and can be filtered off, weighed, and approximately allowed for, or the uranium may be reprecipitated from the filtrate.

Uranyl pyrophosphate loses weight when treated with hydrofluoric acid alone. With a mixture of hydrofluoric and nitric acid no loss occurs; but it is necessary to evaporate a second time with nitric acid only, in order to secure the yellow pyrophosphate free from fluorides. A mixture of hydrofluoric and sulphuric acids may also be used if the weight of the green residue is being depended upon; but in that case a very strong ignition is needed in order to drive off all the sulphuric acid.

SEPARATION FROM MOLYBDENUM.

Molybdenum is partly precipitated as sulphide when an acid solution containing it is boiled with thiosulphate. The means of precipitating uranium previously adhered to cannot therefore be used in the presence of this element; but a very satisfactory determination can be made by raising the clear acid solution of the two metals to boiling point, and adding at once the required amount of phosphate mixed with as much hot ammonium acetate as will destroy all the free mineral acid.

The precipitate is then washed well by decantation, and collected on the filter. The washing is somewhat facilitated by adding a small quantity of floured sulphur during the decantation.

Mo present .	0·0000	0·1000	0·2000 gram
U obtained .	0·2045	0·2046	0·2046 ,,

The estimation of the molybdenum in the filtrate, at least so far as its precipitation as lead molybdate is concerned, is complicated by the presence of phosphoric acid; it may therefore be remarked, that molybdenum can be estimated on a separate portion in the following manner, without previously removing the uranium :—

To the hot solution containing a few cubic centimetres hydrochloric acid in excess, add enough lead acetate to combine with all the molybdenum present, and then sufficient ammonium acetate to destroy the free hydrochloric acid. The precipitated lead molybdate, which is very granular and easily washed, is ignited and weighed. The traces of uranium which the precipitate may contain can be recovered, if desired, by pouring the hydrochloric acid solution of it into caustic soda; the error which they introduce is, however, quite insignificant. The uranium in the original filtrate may be estimated as phosphate only after

separating the lead either by passing sulphuretted hydrogen or evaporating with sulphuric acid.

SEPARATION FROM TUNGSTEN.

Tungsten may be completely precipitated from neutral solutions by uranyl nitrate or chloride (but not acetate, according to Hitchcock) in the form of uranyl tungstate. This fact, and the marked tendency of tungstic acid to precipitate spontaneously from acidified solutions, prevent uranium from being determined as phosphate in a mixture of the two metals. Evaporation to dryness on the water-bath with a good excess of hydrochloric acid is a very satisfactory means of making the separation, because, after boiling with dilute hydrochloric acid (1 in 5), all the tungsten is left in the residue, and requires to be merely ignited and weighed as tungstic oxide; and all the uranium is in the filtrate ready to be estimated in the usual manner. From a synthetic mixture of 0·1992 gram tungsten and 0·2045 gram uranium there were obtained 0·1989 and 0·2040 gram respectively.

SEPARATION FROM CHROMIUM.

The separation from this element can be made most easily when it exists as chromic acid; as chromic oxide it is completely precipitated along with the uranyl phosphate. The chromium can be conveniently oxidized with sodium peroxide, but it is almost impossible in the presence of uranium to entirely decompose the excess of peroxide by boiling. It is therefore necessary to proceed as follows :—

Neutralize most of the free acid with sodium carbonate, and then add sodium peroxide until the solution becomes strongly alkaline. Both metals are precipitated and again dissolved, the chromium being entirely in the higher state of oxidation. Boil the solution well, then acidify, and add a small volume of decinormal permanganate (10 c.c. should be ample), and boil for about ten minutes. If the permanganate decomposes at all (thus showing that a portion of the chromic acid was reduced by the residual hydrogen peroxide in the acid solution) then filter off the manganic oxide through asbestos fibre, and destroy any unused permanganate with a few drops of hydrochloric acid. The acid liquor is now made slightly alkaline with ammonia, decidedly acid with acetic,

and when it boils briskly an excess of microcosmic salt is added, and the filtration proceeded with as in the separation from molybdenum. The chromium in the filtrate is estimated volumetrically.

Uranium could probably be precipitated from an acetic solution of chromic acid as uranyl vanadate; the converse of this is Klecki's method for separating vanadium from chromium. The uranium may also be precipitated with caustic soda, or the chromium may be thrown down with mercurous nitrate. Other means of making the separation are those of electro-deposition, and that depending on ignition of the oxides in a current of hydrogen and extraction of the uranium with nitric acid.

SEPARATION FROM VANADIUM.

Vanadium is an essential constituent of Carnotite, and occurs also in small amounts in other uranium ores. Artificial compounds of uranium and vanadium do not occur in commerce, and therefore the separations to be found in the literature of the subject refer almost exclusively to the analysis of particular ores, and may not be generally applied. For instance, such amounts of

vanadium as occur in pitchblende are separated (Lallemand) by pouring the filtered nitric acid solution of the mineral into sodium carbonate, which causes the vanadium to go down with the iron and the uranium to pass into solution. Fritchle, on the other hand, precipitates the dissolved carnotite with a mixture of sodic hydrate and carbonate, which throws out iron and uranium, and leaves vanadium in solution. The separation with mercurous nitrate and mercuric oxide (Langmuir), and the extraction of uranium with ammonium nitrate after evaporating the mixture to dryness with nitric acid are both more widely useful.

The analysis of a complex ore may often be completed without any separation of uranium and vanadium being made. This is accomplished by determining vanadium volumetrically with ferrous sulphate and permanganate, or colorimetrically with hydrogen peroxide, according to its amount, and making the necessary correction in the weight of the precipitated compound used for the estimation of the uranium. The varied uses of devices of this kind cannot be explicitly stated, but it may generally be assumed that, when precipitated with ammonia, the uranium will carry down all the vanadium, and the weighed U_3O_8 will be too

heavy by the V_2O_5 equivalent of the amount of vanadium already determined. Also, when uranium is precipitated as phosphate in the ordinary manner, any vanadic acid carried down merely replaces its equivalent of phosphoric acid, and the error introduced may be too trifling for consideration, although the exact amount of it can be arrived at by determining the vanadium in the ignited uranyl pyrophosphate.

An accurate separation can be made by pouring a faintly acid and heated solution of the two metals into a heated mixture of microcosmic salt and 5 or 10 c.c. ammonium acetate. The latter solution is kept violently agitated, while the former is added through a funnel with a stem so constricted that only a thin column passes out of it. The precipitate is washed by decantation and weighed as usual; the combined washings are evaporated to a convenient bulk, and titrated with ferrous sulphate and permanganate. The following results were obtained :—

V present.	U present.	V found.	U found.
0·0503	0·1552	0·0503	0·1554
0·0615	0·1704	0·0615	0·1700
0·1205	0·2045	0·1208	0·2043

SEPARATION FROM TITANIUM.

Titanium is precipitated entirely with the uranyl phosphate in a form very closely approximating to $TiO_2 . P_2O_5$. It occurs so sparingly in ores that a colorimetric estimation satisfies most requirements. In larger amounts it can be separated by adding 30 to 50 c.c. acetic acid to the hot solution, and then sufficient ammonium acetate to destroy the free mineral acid. A large excess of ammonium acetate is to be avoided. (See "Separation of Iron.")

Titanium is completely precipitated by boiling its acid solution with an excess of thiosulphate in the presence of much free acetic acid; uranium is not at all precipitated under these conditions, providing phosphoric acid is absent, but quantitative separations on this principle from synthetic mixtures have not been attempted. When phosphates are present uranium and titanium must be precipitated together, ignited, fused with sodium carbonate, extracted with water, and the residue (consisting of all the titanium and most of the uranium) dissolved in acid, and separated as above.

SEPARATION FROM ALUMINIUM.

Since the introduction of alumino-thermic reductions, experimental metallurgy often requires rapid assays to be made by such means as are not interfered with by aluminium, and it is therefore to be regretted that one's choice of means of separating this element from uranium are so limited. Of the methods proposed for the separation of iron and uranium only two are applicable to the separation of uranium and aluminium, and these with no great measure of success.

The separation of aluminium as basic acetate is never very satisfactory unless preponderating amounts of iron are also present. Its separation as hydroxide with ammonium carbonate is less successful than usual when applied to a mixture containing uranium. Uranium passes entirely into solution when a hot and slightly acid mixture of the two metals is poured in a thin stream into an agitated solution of ammonium carbonate, but much of the aluminium also goes into solution, and it cannot with certainty be assumed that all this will again separate even if allowed to stand twelve or fourteen hours in a warm place, and a small amount of aluminium left unprecipitated has an important influence on the estimation of the

uranium on account of its comparatively low combining weight. Boiling, of course, cannot be resorted to, for fear of precipitating uranium.

All the aluminium passes into solution when a mixture of the two metals is poured into aqueous caustic soda, but much uranium also goes into solution, and no amount of boiling causes it to separate again. Uranium is precipitated from acetic acid solutions with nitroso-β-naphthol, and aluminium is not; but persistently reliable results were not obtained with this reagent, which is to be regretted, because the uranyl naphtholate filters and washes much better than most other precipitated compounds of uranium.

Generally in the course of analysis aluminium and uranium are obtained together as phosphates. In this form the separation with ammonium carbonate is much more successful; in fact, it is entirely successful if the phosphates are dissolved in nitric acid, most of the acid neutralized,[1] and the clear heated solution poured into the agitated alkaline liquid. If filtered at once a few milligrams of

[1] A pale yellow crystalline precipitate forms on adding ammonia, and not an amorphous cloud such as when solutions of either aluminium or uranium phosphate are neutralized. The former precipitate does not redissolve so quickly in hydrochloric acid as the latter, and more care must therefore be taken over the neutralization. I do not know the composition of the lemon-coloured crystalline precipitate.

aluminium phosphate remain in solution, and possibly also traces of uranyl phosphate remain in the precipitate. Standing for an hour or two in a warm place minimizes both these errors.

A modification of this separation, which is sometimes to be preferred, is to pour the dissolved metallic phosphates into an excess of sodium carbonate. The clear or merely opalescent liquid is then heated to boiling, but not boiled, removed from the flame, and ammonium chloride (in amount more than equivalent to the excess of sodium carbonate) added. This solution also, if filtered at once, contains a few milligrams of aluminium phosphate; but it is an easy matter to dissolve the uranyl pyrophosphate subsequently obtained (and weighed) in nitric acid, pour the solution into ammonium carbonate, collect the precipitate, and weigh it. The following results were obtained after separating from a gram of aluminium :—

	U present.	U found.
Ammon. Carb.	0·2132	0·2122
Sod. Carb. and Am. Chlor.	0·2132	0·2132

The behaviour of the ignited pyrophosphate when fused with sodium carbonate is referred to

on page 12. It might be imagined that a separation of practical utility could be based on this reaction if supplemented by a colorimetric estimation of the small fraction of uranium extracted by digesting with water. Experiment, however, shows that the amount of uranium passing into solution is very much greater when the fused pyrophosphate contains aluminium. But this opportunity may be taken to say that small amounts of uranium, either alone or associated with other metals, may often be conveniently estimated by adding an excess of potassium carbonate and half a gram or so of sodium peroxide, and then matching the colour formed by running a standard uranyl solution into an equal volume of distilled water in which are dissolved similar amounts of potassium carbonate and sodium peroxide. A milligram of uranium can be detected in 60 to 100 c.c. of solution by these means, and the indication is more characteristic than that given with potassium ferrocyanide.

IV.

THE ANALYSIS OF URANIUM ORES AND ALLOYS.

Pitchblende.—Pitchblende is the best-known ore of uranium; it is an impure U_3O_8, containing from 40 to 95 per cent. of that oxide, but not always exactly in the proportion of $UO_2 : 2UO_3$. The following elements have been found associated with it:—sulphur, selenium, phosphorus, calcium, magnesium, aluminium, silicon, vanadium, manganese, arsenic, bismuth, antimony, tin, zinc, lead, iron, cobalt, nickel, copper, and silver. Many of these occur in such small amounts, that their presence is negligible so far as commercial analyses are concerned. Nitrogen and a number of rare earths are also to be found in uraninite from some localities (*vide* "On the Occurrence of Nitrogen in Uraninite, and on the Composition of Uraninite in General," Hillebrand, *U.S. Geological Survey Bulletin*, No. 78, and *Chemical News*, vol. lxiv., p. 221, etc.). The following outline method of analysis meets most

industrial demands. The particular form in which the results are expressed is a matter of expediency.

Digest 4 grams of the finely powdered ore with 20 c.c. (1·42) nitric acid, boil down to low bulk, and filter off the siliceous residue. This residue very rarely contains uranium; besides silica, alumina, and ferric oxide, it may contain small amounts of vanadium, tin, and antimony. A further analysis is made, or not, according to circumstances.

The soluble portion is evaporated with hydrochloric acid, diluted, any silica or silver chloride filtered off, and a current of sulphuretted hydrogen passed. The precipitated sulphides of antimony, arsenic, tin, lead, copper, and bismuth, are separated in the usual manner into two groups with sodium sulphide, and the separate determinations made as usual.[1] A separate determination of the arsenic may be desirable, as a portion is probably volatilized from the main portion during the evaporation with hydrochloric acid.

The main filtrate is boiled to expel sulphuretted hydrogen, and nitric acid added to oxidize the

[1] It is hardly feasible to give details of these separate determinations, but the general procedure followed by the author is dealt with, in relation to the analysis of white-metal alloys, in "The Analysis of Steelworks Materials" (Longmans, Green & Co.).

iron. It is then made up to 250 c.c.; 100 c.c., or some other volume well suited to the supposed amount of the impurities to be determined, is measured into a flask containing a few crystals of ammonium phosphate, then nearly neutralized, and poured into an excess of aqueous sodium carbonate. The mixture is raised to boiling, and at least as much ammonium chloride added as will destroy the free soda. After standing a few hours the precipitated phosphates are filtered off. Uranium is determined in a portion of the filtrate after acidifying and boiling free from CO_2. The residue is dissolved in sulphuric acid. A portion of this acid solution is reduced with sulphur dioxide, and the iron titrated with permanganate, care being taken to make allowance for any vanadium which may be present. The vanadium may also be estimated, colorimetrically, on this portion if its amount is small compared with the alumina and ferric oxide. The remaining portion of the sulphuric acid solution is boiled with sodium phosphate and thiosulphate to obtain a precipitate from which alumina and titantic oxide may be determined; any uranium not having passed into the ammonic carbonate solution would be found here.

To another fraction (100 c.c.) of the main

solution, an excess of microcosmic salt is added, then an excess of ammonium acetate to ensure the complete precipitation of uranium, iron, aluminium, etc., from a strongly acetic acid solution. A fraction of this solution is filtered, most of its free acetic acid neutralized, and the lime precipitated as oxalate, and the magnesia subsequently as phosphate. There is generally not sufficient manganese in these ores to interfere with this procedure.

The remaining portion (50 c.c.) of the main filtrate is used for the determination of phosphoric acid *viâ* the molybdate precipitation; or a separate portion may be prepared by digesting the ore with nitric acid in case no appreciable amount of tin is present.

Separate determinations may be made of manganese by digesting 1 gram of the ore with nitric acid, oxidizing the solution with sodium bismuthate, and titrating the permanganate formed; of vanadium, by fusing 1 gram with sodium carbonate, extracting with water, and determining colorimetrically with hydrogen peroxide, or otherwise; of nickel, cobalt, and zinc, by precipitating uranium, aluminium, iron, etc, as phosphates from strongly acetic acid solutions, and applying the usual processes to the filtrate.

The sulphur and moisture are determined as in samples of pyrites.

Carnotite.—This ore, which has attained commercial importance, is found chiefly in Western Colorado. It is a canary yellow compound associated with a fragile sandstone bearing some resemblance to Roscoelite. The analysis is comparatively easy.

Digest 3 grams of the ore with nitric acid, and filter. The ignited siliceous residue may be reported as such, or fused with sodium carbonate, evaporated with hydrochloric acid, etc. Uranium is usually entirely absent from the residue, but vanadium (V_2O_3) and barium sulphate are frequently present along with the usual constituents of silicates.

The filtrate is evaporated with hydrochloric acid, the trifling amount of silica collected, and a few drops of sulphuric acid added to precipitate any barium. If no barium is indicated, sulphuretted hydrogen is passed to separate copper, and, in rare cases, other metals of this group. The filtrate is boiled, oxidized with nitric acid, and made up to 300 c.c. From this point the analysis proceeds on similar lines to that of pitchblende. Vanadium is estimated on a separate portion by titration with ferrous sulphate or otherwise,

Carbon dioxide must also be separately determined. The following analyses are of commercial ores :—

Pitchblende.			Carnotite.		
	Cornwall.	Joachimsthal.		Insoluble.	Soluble.
U_3O_8	43·47	49·95	UO_3	—	19·22
SiO_2	25·31	18·54	SiO_2	62·85	0·20
Fe_2O_3	0·44	1·14	Fe_2O_3	0·48	0·50
Al_2O_3	2·25	3·25	Al_2O_3	1·09	0·68
MnO	0·20	0·11	CaO	0·17	1·17
CaO	1·34	2·52	MgO	0·18	0·90
MgO	0·25	0·38	BaO	—	—
V_2O_5	0·25	0·02	V_2O_5	0·10	2·90
TiO_2	traces	—	TiO_2	0·09	—
ZnO	—	1·09	P_2O_5	—	traces
P_2O_5	3·28	0·33	SO_3	—	1·03
S	8·25	5·08	CO_2	—	2·70
Ag	0·075	0·03	H_2O	—	3·95
Sn	—	—	K_2O and traces of other metals	—	1·79
Sb	0·62	—			
As	1·00	0·44			
Pb	2·02	1·73			
Bi	0·015	0·24			
Cu	1·32	0·89			
Fe	7·14	8·04			
H_2O	1·50	0·67			
CO_2	—	5·02			
Oxygen combined with Fe not existing as FeS_2, etc.	1·27	0·53			
	100·00	100·00		64·96	35·04

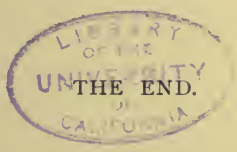
Metal and Alloys.—Metallic uranium was

prepared originally by reducing the chloride with potassium, and this process, or some modification of it, was the only one available until a few years ago. Moissan prepared "cast uranium" by submitting an intimate mixture of the oxide and sugar charcoal, contained in a coke crucible, to the electric current. He isolated a crystallized carbide (C_3U_2) whose melting point is much higher than that of platinum, and he prepared samples of the metal containing less than 1 per cent. of impurities. On this latter metal and other samples prepared by the electrolysis of the double uranium-sodium chloride ($UCl_4 . 2NaCl$) he determined some of its properties. Ferro-uranium alloys are formed by the last-mentioned process when iron electrodes are used. The metal and some of its alloys have been prepared by various modified forms of the alumino-thermic process: the author, however, found this method to yield poor and very uncertain results.

Pure uranium is a white non-magnetic metal, and can be easily filed; it does not scratch glass, is easily carbonized, and may be tempered. Its specific gravity is said to be about 18·7, but the carbonized metal usually met with has a specific gravity of about 12 only. When in fine powder

the metal burns at a comparatively low tempera ture (170° in pure oxygen), and also very readily combines with nitrogen. It tarnishes on exposure to air, and also decomposes water to some extent, particularly if heated.

Metallic uranium is decomposed by dilute hydrochloric acid, but black flocks of carbide persist until a few drops of nitric acid have been added. With ferro-uranium alloys or uranium steels it is advisable to filter off this black residue, ignite, fuse it with sodium carbonate, dissolve the melt in hydrochloric acid, and add it to the main solution. The simultaneous precipitation of uranium and separation of iron is made in the manner already described. Carbon in metallic uranium is determined by simple ignition in a stream of oxygen, the resulting carbon dioxide being collected and weighed. The determination of the remaining impurities which affect the value of the metal or alloy for steel-making purposes is made by the usual processes, with which uranium does not interfere.



THE END.

PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, LONDON AND BECCLES.

A SELECT LIST OF BOOKS

IN

NATURAL AND PHYSICAL SCIENCE MATHEMATICS AND TECHNOLOGY

PUBLISHED BY

MESSRS. LONGMANS, GREEN, & CO.

LONDON: 39 PATERNOSTER ROW, E.C.

NEW YORK: 91 & 93 FIFTH AVENUE.

BOMBAY: 32 HORNBY ROAD.

CHEMISTRY.

ARRHENIUS.—A TEXT-BOOK OF ELECTROCHEMISTRY. By SVANTE ARRHENIUS, Professor at the University of Stockholm. Translated from the German Edition by JOHN MCCRAE, Ph.D. With 58 Illustrations. 8vo., *9s. 6d.* net.

CROOKES.—SELECT METHODS IN CHEMICAL ANALYSIS, chiefly Inorganic. By Sir WILLIAM CROOKES, F.R.S., etc. Third Edition, Rewritten and Enlarged. With 67 Woodcuts. 8vo., *21s.* net.

FURNEAUX.—ELEMENTARY CHEMISTRY, Inorganic and Organic. By W. FURNEAUX, F.R.G.S., Lecturer on Chemistry, London School Board. With 65 Illustrations and 155 Experiments. Crown 8vo., *2s. 6d.*

GARRETT AND HARDEN.—AN ELEMENTARY COURSE OF PRACTICAL ORGANIC CHEMISTRY. By F. C. GARRETT, M.Sc. (Vict. et Dunelm.), Assistant Lecturer and Demonstrator in Chemistry, the Durham College of Science, Newcastle-on-Tyne; and ARTHUR HARDEN, M.Sc. (Vict.), Ph.D., Assistant Lecturer and Demonstrator in Chemistry, the Owens College, Manchester. With 14 Illustrations. Crown 8vo., *2s.*

JAGO.—Works by W. JAGO, F.C.S., F.I.C.

INORGANIC CHEMISTRY, THEORETICAL AND PRACTICAL. With an Introduction to the Principles of Chemical Analysis, Inorganic and Organic. With 63 Woodcuts and numerous Questions and Exercises. Fcp. 8vo., *2s. 6d.*

AN INTRODUCTION TO PRACTICAL INORGANIC CHEMISTRY. Crown 8vo., *1s. 6d.*

INORGANIC CHEMISTRY, THEORETICAL AND PRACTICAL. A Manual for Students in Advanced Classes of the Science and Art Department. With Plate of Spectra and 78 Woodcuts. Crown 8vo., *4s. 6d.*

KLÖCKER. — FERMENTATION ORGANISMS: a Laboratory Handbook. By ALB. KLÖCKER. Translated by G. E. ALLAN, B.Sc., and J. H. MILLAR, F.I.C. With 146 Illustrations in the text. 8vo., *12s.* net.

MELLOR.—HIGHER MATHEMATICS FOR STUDENTS OF CHEMISTRY AND PHYSICS. With Special Reference to Practical Work. By J. W. MELLOR, D.Sc., late Senior Scholar, and 1851 Exhibition Scholar, New Zealand University; Research Fellow, the Owens College, Manchester. With 142 Diagrams. 8vo., *12s. 6d.* net.

MENDELÉEFF.—THE PRINCIPLES OF CHEMISTRY. By D. MENDELÉEFF. Translated from the Russian (Sixth Edition) by GEORGE KAMENSKY, A.R.S.M., of the Imperial Mint, St. Petersburg; and Edited by T. A. LAWSON, B.Sc., Ph.D., Fellow of the Institute of Chemistry. With 96 Diagrams and Illustrations. 2 vols. 8vo., *36s.*

MEYER.—OUTLINES OF THEORETICAL CHEMISTRY. By LOTHAR MEYER, Professor of Chemistry in the University of Tübingen. Translated by Professors P. PHILLIPS BEDSON, D.Sc., and W. CARLETON WILLIAMS, B.Sc. 8vo., *9s.*

MILLER.—INTRODUCTION TO THE STUDY OF INORGANIC CHEMISTRY. By W. ALLEN MILLER, M.D., LL.D. With 71 Illustrations. Fcp. 8vo., *3s. 6d.*

CHEMISTRY—*Continued.*

MUIR.—A COURSE OF PRACTICAL CHEMISTRY. By M. M. P. MUIR, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, Cambridge. (3 Parts.)

Part I. Elementary. Crown 8vo., 4*s.* 6*d.*

Part II. Intermediate. Crown 8vo., 4*s.* 6*d.*

Part III. [*In preparation.*

NEWTH.—Works by G. S. NEWTH, F.I.C., F.C.S., Demonstrator in the Royal College of Science, London.

CHEMICAL LECTURE EXPERIMENTS. With 230 Illustrations. Crown 8vo., 6*s.*

CHEMICAL ANALYSIS, QUANTITATIVE AND QUALITATIVE. With 100 Illustrations. Crown 8vo., 6*s.* 6*d.*

A TEXT-BOOK OF INORGANIC CHEMISTRY. With 155 Illustrations. Crown 8vo., 6*s.* 6*d.*

ELEMENTARY PRACTICAL CHEMISTRY. With 108 Illustrations and 254 Experiments. Crown 8vo., 2*s.* 6*d.*

OSTWALD.—SOLUTIONS. By W. OSTWALD, Professor of Chemistry in the University of Leipzig. Being the Fourth Book, with some additions, of the Second Edition of Oswald's 'Lehrbuch der allgemeinen Chemie'. Translated by M. M. PATTISON MUIR, Fellow and Prælector in Chemistry of Gonville and Caius College, Cambridge. 8vo., 10*s.* 6*d.*

PERKIN.—QUALITATIVE CHEMICAL ANALYSIS (ORGANIC AND INORGANIC). By F. MOLLWO PERKIN, Ph.D., Head of the Chemistry Department, Borough Polytechnic Institute, London. With 9 Illustrations and Spectrum Plate. 8vo., 3*s.* 6*d.*

PLIMMER.—THE CHEMICAL CHANGES AND PRODUCTS RESULTING FROM FERMENTATIONS. By R. H. ADERS PLIMMER. 8vo., 6*s.* net.

REYNOLDS.—EXPERIMENTAL CHEMISTRY FOR JUNIOR STUDENTS. By J. EMERSON REYNOLDS, M.D., F.R.S., Professor of Chemistry, University of Dublin. Fcp. 8vo., with numerous Woodcuts.

Part I. Introductory. Fcp. 8vo., 1*s.* 6*d.*

Part II. Non-Metals, with an Appendix on Systematic Testing for Acids. Fcp. 8vo., 2*s.* 6*d.*

Part III. Metals, and Allied Bodies. Fcp. 8vo., 3*s.* 6*d.*

Part IV. Carbon Compounds. Fcp. 8vo., 4*s.*

SHENSTONE.—Works by W. A. SHENSTONE, F.R.S., Lecturer on Chemistry in Clifton College.

THE METHODS OF GLASS-BLOWING AND OF WORKING SILICA IN THE OXY-GAS FLAME. For the Use of Physical and Chemical Students. With 43 Illustrations. Crown 8vo., 2*s.* 6*d.*

A PRACTICAL INTRODUCTION TO CHEMISTRY. Intended to give a Practical acquaintance with the Elementary Facts and Principles of Chemistry. With 25 Illustrations. Crown 8vo., 2*s.*

CHEMISTRY—*Continued.*

SMITH AND HALL.—THE TEACHING OF CHEMISTRY AND PHYSICS IN THE SECONDARY SCHOOL. By ALEXANDER SMITH, B.Sc., Ph.D., Associate Professor of Chemistry in the University of Chicago, and EDWIN H. HALL, Ph.D., Professor of Physics in Harvard University. With 21 Woodcuts, Bibliographies, and Index. Crown 8vo., 6*s.* net.

THORNTON AND PEARSON.—NOTES ON VOLUMETRIC ANALYSIS. By ARTHUR THORNTON, M.A., and MARCHANT PEARSON, B.A., Assistant Science Master, Bradford Grammar School. Medium 8vo., 2*s.*

THORPE.—Works by T. E. THORPE, C.B., D.Sc. (Vict.), Ph.D., F.R.S., Principal of the Government Laboratory, London. Assisted by Eminent Contributors.

A DICTIONARY OF APPLIED CHEMISTRY. 3 vols. 8vo. Vols. I. and II., 42*s.* each. Vol. III., 63*s.*

QUANTITATIVE CHEMICAL ANALYSIS. With 88 Woodcuts. Fcp. 8vo., 4*s.* 6*d.*

THORPE AND MUIR.—QUALITATIVE CHEMICAL ANALYSIS AND LABORATORY PRACTICE. By T. E. THORPE, C.B., Ph.D., D.Sc., F.R.S., and M. M. PATTISON MUIR, M.A. With Plate of Spectra and 57 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

TILDEN.—Works by WILLIAM A. TILDEN, D.Sc. London, F.R.S., Professor of Chemistry in the Royal College of Science, South Kensington.

A SHORT HISTORY OF THE PROGRESS OF SCIENTIFIC CHEMISTRY IN OUR OWN TIMES. Crown 8vo., 5*s.* net.

INTRODUCTION TO THE STUDY OF CHEMICAL PHILOSOPHY. The Principles of Theoretical and Systematic Chemistry. With 5 Illustrations. Fcp. 8vo., 5*s.* With ANSWERS to Problems. Fcp. 8vo., 5*s.* 6*d.*

PRACTICAL CHEMISTRY. The principles of Qualitative Analysis. Fcp. 8vo., 1*s.* 6*d.*

WATTS' DICTIONARY OF CHEMISTRY. Revised and entirely Rewritten by H. FORSTER MORLEY, M.A., D.Sc., Fellow of, and lately Assistant Professor of Chemistry in, University College, London; and M. M. PATTISON MUIR, M.A., F.R.S.E., Fellow, and Prælector in Chemistry, of Gonville and Caius College, Cambridge. Assisted by Eminent Contributors. 4 vols. 8vo., £5 net.

WHITELEY.—Works by R. LLOYD WHITELEY, F.I.C., Principal of the Municipal Science School, West Bromwich.

CHEMICAL CALCULATIONS. With Explanatory Notes, Problems and Answers, specially adapted for use in Colleges and Science Schools. With a Preface by Professor F. CLOWES, D.Sc. (Lond.), F.I.C. Crown 8vo., 2*s.*

ORGANIC CHEMISTRY: the Fatty Compounds. With 45 Illustrations. Crown 8vo., 3*s.* 6*d.*

PHYSICS, ETC.

BIDGOOD.—ELEMENTARY PHYSICS AND CHEMISTRY FOR THE USE OF SCHOOLS. (In Three Books.) By JOHN BIDGOOD, B.Sc., Headmaster of the Gateshead School of Science.

Book I. Elementary Physics. With 120 Illustrations. Crown 8vo., 1*s.* 6*d.*

Book II. Physics and Chemistry. With 122 Illustrations. Crown 8vo., 1*s.* 6*d.*

BOSE.—RESPONSE IN THE LIVING AND NON-LIVING. By JAGADIS CHUNDER BOSE, M.A. (Cantab.), D.Sc. (Lond.), Professor, Presidency College, Calcutta. With 117 Illustrations. 8vo., 10*s.* 6*d.*

*** *This volume describes experimental investigations on animal, vegetable and inorganic substances regarding their response to stimulus. These researches show that the effects of fatigue, stimulants, depressants and poisons are alike in the organic and inorganic, and demonstrate that the response phenomena in the 'living' have been foreshadowed in the 'non-living'.*

GANOT.—Works by PROFESSOR GANOT. Translated and Edited by E. ATKINSON, Ph.D., F.C.S., and A. W. REINOLD, M.A., F.R.S.

ELEMENTARY TREATISE ON PHYSICS, Experimental and Applied. With 9 Coloured Plates and Maps, and 1048 Woodcuts, and Appendix of Problems and Examples with Answers. Crown 8vo., 15*s.*

NATURAL PHILOSOPHY FOR GENERAL READERS AND YOUNG PEOPLE. With 7 Plates, 632 Woodcuts, and an Appendix of Questions. Crown 8vo., 7*s.* 6*d.*

GLAZEBROOK AND SHAW.—PRACTICAL PHYSICS. By R. T. GLAZEBROOK, M.A., F.R.S., and W. N. SHAW, M.A. With 134 Illustrations. Fcp. 8vo., 7*s.* 6*d.*

GUTHRIE.—MOLECULAR PHYSICS AND SOUND. By F. GUTHRIE, Ph.D. With 91 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

HELMHOLTZ.—POPULAR LECTURES ON SCIENTIFIC SUBJECTS. By HERMANN VON HELMHOLTZ. Translated by E. ATKINSON, Ph.D., F.C.S., formerly Professor of Experimental Science, Staff College. With 68 Illustrations. 2 vols., crown 8vo., 3*s.* 6*d.* each.

HENDERSON.—ELEMENTARY PHYSICS. By JOHN HENDERSON, D.Sc. (Edin.), A.I.E.E., Physics Department, Borough Road Polytechnic. Crown 8vo., 2*s.* 6*d.*

MACLEAN.—EXERCISES IN NATURAL PHILOSOPHY. By MAGNUS MACLEAN, D.Sc., Professor of Electrical Engineering at the Glasgow and West of Scotland Technical College. Crown 8vo., 4*s.* 6*d.*

MEYER.—THE KINETIC THEORY OF GASES. Elementary Treatise, with Mathematical Appendices. By Dr. OSKAR EMIL MEYER, Professor of Physics at the University of Breslau. Second Revised Edition. Translated by ROBERT E. BAYNES, M.A., Student of Christ Church, Oxford, and Dr. Lee's Reader in Physics. 8vo., 15*s.* net.

VAN 'T HOFF.—THE ARRANGEMENT OF ATOMS IN SPACE. By J. H. VAN T'HOFF. Second, Revised, and Enlarged Edition. With a Preface by JOHANNES WISLICENUS, Professor of Chemistry at the University of Leipzig; and an Appendix 'Stereo-chemistry among Inorganic Substances,' by ALFRED WERNER, Professor of Chemistry at the University of Zürich. Translated and Edited by ARNOLD EILOART. Crown 8vo., 6*s.* 6*d*

PHYSICS, ETC.—*Continued.*

WATSON.—Works by W. WATSON, A.R.C.S., F.R.S., D.Sc., Assistant Professor of Physics at the Royal College of Science, London.

ELEMENTARY PRACTICAL PHYSICS: a Laboratory Manual for Use in Organised Science Schools. With 120 Illustrations and 193 Exercises. Crown 8vo., 2*s.* 6*d.*

A TEXT-BOOK OF PHYSICS. With 568 Diagrams and Illustrations, and a Collection of Examples and Questions with Answers. Large crown 8vo., 10*s.* 6*d.*

WORTHINGTON.—A FIRST COURSE OF PHYSICAL LABORATORY PRACTICE. Containing 264 Experiments. By A. M. WORTHINGTON, M.A., F.R.S. With Illustrations. Crown 8vo., 4*s.* 6*d.*

WRIGHT.—ELEMENTARY PHYSICS. By MARK R. WRIGHT, M.A., Professor of Normal Education, Durham College of Science. With 242 Illustrations. Crown 8vo., 2*s.* 6*d.*

MECHANICS, DYNAMICS, STATICS, HYDROSTATICS, ETC.

BALL.—A CLASS-BOOK OF MECHANICS. By Sir R. S. BALL, LL.D. 89 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

GOODEVE.—Works by T. M. GOODEVE, M.A., formerly Professor of Mechanics at the Normal School of Science, and the Royal School of Mines.

THE ELEMENTS OF MECHANISM. With 357 Illustrations. Crown 8vo., 6*s.*

PRINCIPLES OF MECHANICS. With 253 Illustrations and numerous Examples. Crown 8vo., 6*s.*

A MANUAL OF MECHANICS: an Elementary Text-Book for Students of Applied Mechanics. With 138 Illustrations and Diagrams, and 188 Examples taken from the Science Department Examination Papers, with Answers. Fcp. 8vo., 2*s.* 6*d.*

GOODMAN.—MECHANICS APPLIED TO ENGINEERING. By JOHN GOODMAN, Wh.Sch., A.M.I.C.E., M.I.M.E., Professor of Engineering in the Yorkshire College, Leeds (Victoria University). With 620 Illustrations and numerous examples. Crown 8vo., 7*s.* 6*d.* net.

GRIEVE.—LESSONS IN ELEMENTARY MECHANICS. By W. H. GRIEVE, late Engineer, R.N., Science Demonstrator for the London School Board, etc.

1. With 165 Illustrations and a large number of Examples. Fcp. 8vo., 1*s.* 6*d.*

Stage 2. With 122 Illustrations. Fcp. 8vo., 1*s.* 6*d.*

Stage 3. With 103 Illustrations. Fcp. 8vo., 1*s.* 6*d.*

MECHANICS, DYNAMICS, STATICS, HYDROSTATICS, ETC.—*Continued.*

MAGNUS.—Works by SIR PHILIP MAGNUS, B.Sc., B.A.

LESSONS IN ELEMENTARY MECHANICS. Introductory to the study of Physical Science. Designed for the Use of Schools, and of Candidates for the London Matriculation and other Examinations. With numerous Exercises, Examples, Examination Questions, and Solutions, etc., from 1870-1895. With Answers, and 131 Woodcuts. Fcp. 8vo., 3*s.* 6*d.*

Key for the use of Teachers only, price 5*s.* 3½*d.*

HYDROSTATICS AND PNEUMATICS. Fcp. 8vo., 1*s.* 6*d.*; or, with Answers, 2*s.* The Worked Solutions of the Problems, 2*s.*

PULLEN.—MECHANICS: Theoretical, Applied, and Experimental. By W. W. F. PULLEN, Wh.Sch., M.I.M.E., A.M.I.C.E. With 318 Diagrams and numerous Examples. Crown 8vo., 4*s.* 6*d.*

ROBINSON.—ELEMENTS OF DYNAMICS (Kinetics and Statics). With numerous Exercises. A Text-book for Junior Students. By the Rev. J. L. ROBINSON, M.A. Crown 8vo., 6*s.*

SMITH.—Works by J. HAMBLIN SMITH, M.A.

ELEMENTARY STATICS. Crown 8vo., 3*s.*

ELEMENTARY HYDROSTATICS. Crown 8vo., 3*s.*

KEY TO STATICS AND HYDROSTATICS. Crown 8vo., 6*s.*

TARLETON.—AN INTRODUCTION TO THE MATHEMATICAL THEORY OF ATTRACTION. By FRANCIS A. TARLETON, LL.D., Sc.D., Fellow of Trinity College, and Professor of Natural Philosophy in the University of Dublin. Crown 8vo., 10*s.* 6*d*

TAYLOR.—Works by J. E. TAYLOR, M.A., B.Sc. (Lond.).

THEORETICAL MECHANICS, including Hydrostatics and Pneumatics. With 175 Diagrams and Illustrations, and 522 Examination Questions and Answers. Crown 8vo., 2*s.* 6*d.*

THEORETICAL MECHANICS—SOLIDS. With 163 Illustrations, 120 Worked Examples and over 500 Examples from Examination Papers, etc. Crown 8vo., 2*s.* 6*d.*

THEORETICAL MECHANICS.—FLUIDS. With 122 Illustrations, numerous Worked Examples, and about 500 Examples from Examination Papers, etc. Crown 8vo., 2*s.* 6*d.*

THORNTON.—THEORETICAL MECHANICS—SOLIDS. Including Kinematics, Statics and Kinetics. By ARTHUR THORNTON, M.A., F.R.A.S. With 200 Illustrations, 130 Worked Examples, and over 900 Examples from Examination Papers, etc. Crown 8vo., 4*s.* 6*d.*

MECHANICS, DYNAMICS, STATICS, HYDROSTATICS, ETC.—*Continued.*

TWISDEN.—Works by the Rev. JOHN F. TWISDEN, M.A.

PRACTICAL MECHANICS; an Elementary Introduction to their Study. With 855 Exercises, and 184 Figures and Diagrams. Crown 8vo., 10*s.* 6*d.*

THEORETICAL MECHANICS. With 172 Examples, numerous Exercises, and 154 Diagrams. Crown 8vo., 8*s.* 6*d.*

WILLIAMSON.—INTRODUCTION TO THE MATHEMATICAL THEORY OF THE STRESS AND STRAIN OF ELASTIC SOLIDS. By BENJAMIN WILLIAMSON, D.Sc., F.R.S. Crown 8vo., 5*s.*

WILLIAMSON AND TARLETON.—AN ELEMENTARY TREATISE ON DYNAMICS. Containing Applications to Thermodynamics, with numerous Examples. By BENJAMIN WILLIAMSON, D.Sc., F.R.S., and FRANCIS A. TARLETON, LL.D. Crown 8vo., 10*s.* 6*d.*

WORTHINGTON.—DYNAMICS OF ROTATION: an Elementary Introduction to Rigid Dynamics. By A. M. WORTHINGTON, M.A., F.R.S. Crown 8vo., 4*s.* 6*d.*

MENSURATION, SURVEYING, ETC.

BRABANT.—THE ELEMENTS OF PLANE AND SOLID MENSURATION. With Copious Examples and Answers. By F. G. BRABANT, M.A. Crown 8vo., 3*s.* 6*d.*

GRIBBLE.—PRELIMINARY SURVEY AND ESTIMATES. By THEODORE GRAHAM GRIBBLE, Civil Engineer. Including Elementary Astronomy, Route Surveying, Tacheometry, Curve Ranging, Graphic Mensuration, Estimates, Hydrography and Instruments. With 133 Illustrations, Quantity Diagrams, and a Manual of the Slide-Rule. Fcp. 8vo., 7*s.* 6*d.*

LODGE.—MENSURATION FOR SENIOR STUDENTS. By ALFRED LODGE, M.A., late Fereday Fellow of St. John's College, Oxford; Professor of Pure Mathematics at the Royal Indian Engineering College, Cooper's Hill. With Answers. Crown 8vo., 4*s.* 6*d.*

LUPTON.—A PRACTICAL TREATISE ON MINE SURVEYING. By ARNOLD LUPTON, Mining Engineer, Certificated Colliery Manager, Surveyor, Member of the Institution of Civil Engineers, etc. With 216 Illustrations. Medium 8vo., 12*s.* net.

NESBIT.—Works by A. NESBIT.

PRACTICAL MENSURATION. Illustrated by 700 Practical Examples and 700 Woodcuts. 12mo., 3*s.* 6*d.* KEY, 5*s.*

PRACTICAL LAND-SURVEYING, for the Use of Schools and Private Students. Edited by W. BURNESS, F.R.A.S. With 14 Plates, 221 Figures, and a Field-Book. 8vo., 12*s.*

SMITH.—CIRCULAR SLIDE RULE. By G. L. SMITH Fcp. 8vo., 1*s.* net.

ALGEBRA, ETC.

*** *For other Books, see Longmans & Co.'s Catalogue of Educational and School Books.*

ANNALS OF MATHEMATICS. (*PUBLISHED UNDER THE AUSPICES OF HARVARD UNIVERSITY.*) Issued Quarterly. 4to., 2*s.* net.

BURNSIDE AND PANTON.—Works by WILLIAM SNOW BURNSIDE, M.A., Fellow of Trinity College, Dublin; and ARTHUR WILLIAM PANTON, M.A., Fellow and Tutor of Trinity College, Dublin.

THE THEORY OF EQUATIONS. With an Introduction to the Theory of Binary Algebraic Forms. 2 vols. 8vo., 9*s.* 6*d.* each.

AN INTRODUCTION TO DETERMINANTS: being a Chapter from the Theory of Equations (being the First Chapter of the Second Volume of 'The Theory of Equations'). 8vo., sewed, 2*s.* 6*d.*

CRACKNELL.—PRACTICAL MATHEMATICS. By A. G. CRACKNELL, M.A., B.Sc., Sixth Wrangler, etc. With Answers to the Examples. Crown 8vo., 3*s.* 6*d.*

GRIFFIN.—Works by Rev. WILLIAM NATHANIEL GRIFFIN, B.D., sometime Fellow of St. John's College, Cambridge.

THE ELEMENTS OF ALGEBRA AND TRIGONOMETRY. Fcp. 8vo., 3*s.* 6*d.*

NOTES ON THE ELEMENTS OF ALGEBRA AND TRIGONOMETRY. With Solutions of the more Difficult Questions. Fcp. 8vo., 3*s.* 6*d.*

MELLOR.—HIGHER MATHEMATICS FOR STUDENTS OF CHEMISTRY AND PHYSICS. With special reference to Practical Work. By J. W. MELLOR, D.Sc., Research Fellow, The Owens College, Manchester. With 142 Diagrams. 8vo., 12*s.* 6*d.* net.

WELSFORD AND MAYO.—ELEMENTARY ALGEBRA. By J. W. WELSFORD, M.A., formerly Fellow of Gonville and Caius College, Cambridge, and C. H. P. MAYO, M.A., formerly Scholar of St. Peter's College, Cambridge; Assistant Masters at Harrow School. Crown 8vo., 3*s.* 6*d.*, or with Answers, 4*s.* 6*d.*

CONIC SECTIONS, ETC.

CASEY.—A TREATISE ON THE ANALYTICAL GEOMETRY OF THE POINT, LINE, CIRCLE, AND CONIC SECTIONS. By JOHN CASEY, LL.D., F.R.S. Crown 8vo., 12*s.*

RICHARDSON.—GEOMETRICAL CONIC SECTIONS. By G. RICHARDSON, M.A. Crown 8vo., 4*s.* 6*d.*

SALMON.—A TREATISE ON CONIC SECTIONS, containing an Account of some of the most Important Modern Algebraic and Geometric Methods. By G. SALMON, D.D., F.R.S. 8vo., 12*s.*

SMITH.—GEOMETRICAL CONIC SECTIONS. By J. HAMBLIN SMITH, M.A. Crown 8vo., 3*s.* 6*d.*

THE CALCULUS, LOGARITHMS, ETC.

BARKER.—GRAPHICAL CALCULUS. By ARTHUR H. BARKER, B.A., B.Sc. With an Introduction by JOHN GOODMAN, A.M.I.C.E. With 61 Diagrams. Crown 8vo., *4s. 6d.*

MURRAY.—AN INTRODUCTORY COURSE IN DIFFERENTIAL EQUATIONS. By DANIEL ALEXANDER MURRAY, Ph.D. Crown 8vo., *4s. 6d.*

O'DEA.—AN ELEMENTARY TREATISE ON LOGARITHMS, EXPONENTIAL AND LOGARITHMIC SERIES, UNDETERMINED CO-EFFICIENTS, AND THE THEORY OF DETERMINANTS. By JAMES J. O'DEA, M.A. Crown 8vo., *2s.*

TATE.—PRINCIPLES OF THE DIFFERENTIAL AND INTEGRAL CALCULUS. Applied to the Solution of Useful Problems in Mathematics and Mechanics. By THOMAS TATE. 12mo., *4s. 6d.*

TAYLOR.—Works by F. GLANVILLE TAYLOR.

AN INTRODUCTION TO THE DIFFERENTIAL AND INTEGRAL CALCULUS AND DIFFERENTIAL EQUATIONS. Crown 8vo., *9s.*

AN INTRODUCTION TO THE PRACTICAL USE OF LOGARITHMS, WITH EXAMPLES IN MENSURATION. With Answers to Exercises. Crown 8vo., *1s. 6d.*

WILLIAMSON.—Works by BENJAMIN WILLIAMSON, D.Sc.

AN ELEMENTARY TREATISE ON THE DIFFERENTIAL CALCULUS; containing the Theory of Plane Curves with numerous Examples. Crown 8vo., *10s. 6d.*

AN ELEMENTARY TREATISE ON THE INTEGRAL CALCULUS; containing Applications to Plane Curves and Surfaces, and also a Chapter on the Calculus of Variations, with numerous Examples. Crown 8vo., *10s. 6d.*

GEOMETRY AND EUCLID.

*** *For other Works, see Longmans & Co.'s Catalogue of Educational and School Books.*

ALLMAN.—GREEK GEOMETRY FROM THALES TO EUCLID. By G. J. ALLMAN. 8vo., *10s. 6d.*

CASEY.—Works by JOHN CASEY, LL.D., F.R.S.

THE ELEMENTS OF EUCLID, BOOKS I.-VI. and Propositions, I.-XXI. of Book XI., and an Appendix of the Cylinder, Sphere, Cone, etc. With Copious Annotations and numerous Exercises. Fcp. 8vo., *4s. 6d.* KEY to Exercises. Fcp. 8vo., *6s.*

A SEQUEL TO THE ELEMENTS OF EUCLID. Part I. Books I.-VI. With numerous Examples. Fcp. 8vo., *3s. 6d.*

A TREATISE ON THE ANALYTICAL GEOMETRY OF THE POINT, LINE, CIRCLE AND CONIC SECTIONS. Containing an Account of its most recent Extension. Crown 8vo., *12s.*

GEOMETRY AND EUCLID—*Continued.*

HAMILTON.—ELEMENTS OF QUATERNIONS. By the late Sir WILLIAM ROWAN HAMILTON, LL.D., M.R.I.A. Edited by CHARLES JASPER JOLY, M.A., Fellow of Trinity College, Dublin. 2 vols. 4to. 21*s.* net each.

HIME.—THE OUTLINES OF QUATERNIONS. By Lieut.-Colonel H. W. L. HIME, late Royal Artillery. Crown 8vo., 10*s.*

LOW.—TEXT-BOOK ON PRACTICAL, SOLID, AND DESCRIPTIVE GEOMETRY. By DAVID ALLAN LOW, Professor of Engineering, East London Technical College. Crown 8vo.

Part I. With 114 Figures, 2*s.*

Part II. With 64 Figures, 3*s.*

MORRIS AND HUSBAND.—PRACTICAL PLANE AND SOLID GEOMETRY. By I. HAMMOND MORRIS and JOSEPH HUSBAND. Fully Illustrated with Drawings. Crown 8vo., 2*s.* 6*d.*

MORRIS.—GEOMETRICAL DRAWING FOR ART STUDENTS. Embracing Plane Geometry and its Applications, the Use of Scales, and the Plans and Elevations of Solids as required in Section I. of Science Subjects. By I. HAMMOND MORRIS. Crown 8vo., 2*s.*

SMITH.—ELEMENTS OF GEOMETRY. By J. HAMBLIN SMITH, M.A. Containing Books 1 to 6, and portions of Books 11 and 12, of Euclid, with Exercises and Notes. Crown 8vo., 3*s.* 6*d.* KEY, crown 8vo., 8s. 6*d.*

Books 1 and 2, limp cloth, 1*s.* 6*d.*, may be had separately.

SPOONER.—THE ELEMENTS OF GEOMETRICAL DRAWING: an Elementary Text-book on Practical Plane Geometry, including an Introduction to Solid Geometry. Written to include the requirements of the Syllabus of the Board of Education in Geometrical Drawing and for the use of Students preparing for the Military Entrance Examinations. By HENRY J. SPOONER, C.E., M.Inst.M.E.; Director of the Polytechnic School of Engineering, etc. Crown 8vo., 3*s.* 6*d.*

WATSON.—ELEMENTS OF PLANE AND SOLID GEOMETRY. By H. W. WATSON, M.A. Fcp. 8vo., 3*s.* 6*d.*

WILSON.—GEOMETRICAL DRAWING. For the use of Candidates for Army Examinations, and as an Introduction to Mechanical Drawing. By W. N. WILSON, M.A. Parts I. and II. Crown 8vo., 4*s.* 6*d.* each

WINTER.—ELEMENTARY GEOMETRICAL DRAWING. By S. H. WINTER.

Part I. Including Practical Plane Geometry, the Construction of Scales, the Use of the Sector, the Marquois Scales, and the Protractor. With 3 Plates and 1000 Exercises and Examination Papers. Post 8vo., 5*s.*

TRIGONOMETRY.

CASEY.—A TREATISE ON ELEMENTARY TRIGONOMETRY. By JOHN CASEY, LL.D., F.R.S., late Fellow of the Royal University of Ireland. With numerous Examples and Questions for Examination. 12mo., 3*s.*

CLARKE.—PLANE TRIGONOMETRY. Containing the more advanced Propositions, Solution of Problems and a complete Summary of Formulæ, Bookwork, etc., together with recent Examination Papers for the Army, Woolwich, etc. With Answers. By the Rev. A. DAWSON CLARKE, M.A., St. John's College, Cambridge. Crown 8vo., 5*s.*

GOODWIN.—Works by H. B. GOODWIN, M.A.

PLANE AND SPHERICAL TRIGONOMETRY. In Three Parts, comprising those portions of the subjects, theoretical and practical, which are required in the Final Examination for Rank of Lieutenant at Greenwich. 8vo., 8*s.* 6*d.*

ELEMENTARY PLANE TRIGONOMETRY. With numerous Examples and Examination Papers set at the Royal Naval College in recent years. With Answers. 8vo., 5*s.*

JONES.—THE BEGINNINGS OF TRIGONOMETRY. By A. CLEMENT JONES, M.A., Ph.D., late Open Scholar and Senior Hulme Exhibitioner of Brasenose College, Oxford; Senior Mathematical Master of Bradford Grammar School. Crown 8vo., 2*s.*

MURRAY.—Works by DANIEL A. MURRAY, B.A., Ph.D.

PLANE TRIGONOMETRY. Crown 8vo., 3*s.* 6*d.* With Logarithmic and Trigonometric Tables. Crown 8vo., 5*s.*

SPHERICAL TRIGONOMETRY. With Answers. Crown 8vo., 2*s.* 6*d.*

PLANE AND SPHERICAL TRIGONOMETRY. With Answers. Crown 8vo., 6*s.*

SMITH.—ELEMENTARY TRIGONOMETRY. By J. HAMBLIN SMITH, M.A. Crown 8vo., 4*s.* 6*d.* Key, 7*s.* 6*d.*

OPTICS, PHOTOGRAPHY, ETC.

ABNEY.—A TREATISE ON PHOTOGRAPHY. By Sir WILLIAM DE WIVELESLIE ABNEY, K.C.B., F.R.S., Principal Assistant Secretary of the Secondary Department of the Board of Education. With 134 Illustrations. Fcp. 8vo., 5*s.*

DRUDE.—THE THEORY OF OPTICS. By PAUL DRUDE, Professor of Physics at the University of Giessen. Translated from the German by C. RIBORG MANN and ROBERT A. MILLIKAN, Assistant Professors of Physics at the University of Chicago. With 110 Diagrams. 8vo., 15*s.* net.

GLAZEBROOK.—PHYSICAL OPTICS. By R. T. GLAZEBROOK, M.A., F.R.S., Principal of University College, Liverpool. With 183 Woodcuts of Apparatus, etc. Fcp. 8vo., 6*s.*

VANDERPOEL.—COLOR PROBLEMS: a Practical Manual for the Lay Student of Color. By EMILY NOYES VANDRRPOEL. With 117 Plates in Color. Square 8vo., 21*s.* net.

WRIGHT.—OPTICAL PROJECTION: a Treatise on the Use of the Lantern in Exhibition and Scientific Demonstration. By LEWIS WRIGHT, Author of 'Light: a Course of Experimental Optics'. With 232 Illustrations. Crown 8vo., 6*s.*

SOUND, LIGHT, HEAT, AND THERMODYNAMICS.

DEXTER.—ELEMENTARY PRACTICAL SOUND, LIGHT AND HEAT. By JOSEPH S. DEXTER, B.Sc. (Lond.), Physics Master, Technical Day School, The Polytechnic Institute, Regent Street. With 152 Illustrations. Crown 8vo., 2*s.* 6*d.*

EMTAGE.—LIGHT. By W. T. A. EMTAGE, M.A., Director of Public Instruction, Mauritius. With 232 Illustrations. Crown 8vo., 6*s.*

HELMHOLTZ.—ON THE SENSATIONS OF TONE AS A PHYSIOLOGICAL BASIS FOR THE THEORY OF MUSIC. By HERMANN VON HELMHOLTZ. Royal 8vo., 28*s.*

MAXWELL.—THEORY OF HEAT. By J. CLERK MAXWELL, M.A., F.R.SS., L. and E. With Corrections and Additions by Lord RAYLEIGH. With 38 Illustrations. Fcp. 8vo., 4*s.* 6*d.*

PLANCK.—TREATISE ON THERMODYNAMICS. By Dr. MAX PLANCK, Professor of Theoretical Physics in the University of Berlin. Translated, with the Author's sanction, by ALEXANDER OGG, M.A., B.Sc., Ph.D., late 1851 Exhibition Scholar, Aberdeen University; Assistant Master, Royal Naval Engineering College, Devonport. 8vo., 7*s.* 6*d.* net.

SMITH.—THE STUDY OF HEAT. By J. HAMBLIN SMITH, M.A., of Gonville and Caius College, Cambridge. Crown 8vo., 3*s.*

TYNDALL.—Works by JOHN TYNDALL, D.C.L., F.R.S. See p. 36.

WORMELL.—A CLASS-BOOK OF THERMODYNAMICS. By RICHARD WORMELL, B.Sc., M.A. Fcp. 8vo., 1*s.* 6*d.*

WRIGHT.—Works by MARK R. WRIGHT, M.A.

SOUND, LIGHT, AND HEAT. With 160 Diagrams and Illustrations. Crown 8vo., 2*s.* 6*d.*

ADVANCED HEAT. With 136 Diagrams and numerous Examples and Examination Papers. Crown 8vo., 4*s.* 6*d.*

STEAM, OIL, AND GAS ENGINES.

BALE.—A HAND-BOOK FOR STEAM USERS; being Rules for Engine Drivers and Boiler Attendants, with Notes on Steam Engine and Boiler Management and Steam Boiler Explosions. By M. POWIS BALE, M.I.M.E., A.M.I.C.E. Fcp. 8vo., 2*s.* 6*d.*

CLERK.—THE GAS AND OIL ENGINE. By DUGALD CLERK, Member of the Institution of Civil Engineers, Fellow of the Chemical Society, Member of the Royal Institution, Fellow of the Institute of Patent Agents. With 228 Illustrations. 8vo., 15*s.*

STEAM, OIL, AND GAS ENGINES—*Continued.*

HOLMES.—THE STEAM ENGINE. By GEORGE C. V. HOLMES, Chairman of the Board of Works, Ireland. With 212 Illustrations. Fcp. 8vo., 6*s.*

NEILSON.—THE STEAM TURBINE. By ROBERT M. NEILSON, Whitworth Exhibitioner, Associate Member of the Institute of Mechanical Engineers, Lecturer on Steam and the Steam Engine at the Heginbottom Technical School, Ashton-under-Lyne. With 145 Illustrations. 8vo., 7*s.* 6*d.* net.

NORRIS.—A PRACTICAL TREATISE ON THE 'OTTO' CYCLE GAS ENGINE. By WILLIAM NORRIS, M.I.Mech.E. With 207 Illustrations. 8vo., 10*s.* 6*d.*

RIPPER.—Works by WILLIAM RIPPER, Professor of Engineering in the Technical Department of University College, Sheffield.

STEAM. With 185 Illustrations. Crown 8vo., 2*s.* 6*d.*

STEAM ENGINE THEORY AND PRACTICE. With 438 Illustrations. 8vo., 9*s.*

SENNETT AND ORAM.—THE MARINE STEAM ENGINE: A Treatise for Engineering Students, Young Engineers and Officers of the Royal Navy and Mercantile Marine. By the late RICHARD SENNETT, Engineer-in-Chief of the Navy, etc.; and HENRY J. ORAM, Senior Engineer Inspector at the Admiralty, Inspector of Machinery in H.M. Fleet, etc. With 414 Diagrams. 8vo., 21*s.*

STROMEYER.—MARINE BOILER MANAGEMENT AND CONSTRUCTION. Being a Treatise on Boiler Troubles and Repairs, Corrosion, Fuels, and Heat, on the properties of Iron and Steel, on Boiler Mechanics, Workshop Practices, and Boiler Design. By C. E. STROMEYER, Chief Engineer of the Manchester Steam Users' Association, Member of Council of the Institution of Naval Architects, etc. With 452 Diagrams, etc. 8vo., 12*s.* net.

ARCHITECTURE, BUILDING CONSTRUCTION, ETC.

ADVANCED BUILDING CONSTRUCTION. By the Author of 'Rivingtons' Notes on Building Construction'. With 385 Illustrations. Crown 8vo., 4*s.* 6*d.*

BURRELL.—BUILDING CONSTRUCTION. By EDWARD J. BURRELL, Second Master of the People's Palace Technical School, London. With 303 Working Drawings. Crown 8vo., 2*s.* 6*d.*

GWILT.—AN ENCYCLOPÆDIA OF ARCHITECTURE. By JOSEPH GWILT, F.S.A. Revised (1888), with Alterations and Considerable Additions by WYATT PAPWORTH. With 1700 Engravings. 8vo., 21*s.* net.

PARKER AND UNWIN.—THE ART OF BUILDING A HOME: A Collection of Lectures and Illustrations. By BARRY PARKER and RAYMOND UNWIN. With 68 Full-page Plates. 8vo., 10*s.* 6*d.* net.

RICHARDS.—BRICKLAYING AND BRICKCUTTING. By H. W. RICHARDS, Examiner in Brickwork and Masonry to the City and Guilds of London Institute, Head of Building Trades Department, Northern Polytechnic Institute, London, N. With over 200 Illustrations. 8vo., 3*s.* 6*d.*

ARCHITECTURE, BUILDING CONSTRUCTION, ETC.—*Continued.*

SEDDON.—BUILDER'S WORK AND THE BUILDING TRADES. By Col. H. C. SEDDON, R.E. With numerous Illustrations. Medium 8vo., 16*s.*

THOMAS.—THE VENTILATION, HEATING AND MANAGEMENT OF CHURCHES AND PUBLIC BUILDINGS. By J. W. THOMAS, F.I.C., F.C.S., Author of 'Coal, Mine-Gases, and Ventilation,' etc. With 25 Illustrations. Crown 8vo., 2*s.* 6*d.*

VALDER.—BOOK OF TABLES, giving the Cubic Contents of from One to Thirty Pieces Deals, Battens and Scantlings of the Sizes usually imported or used in the Building Trades, together with an Appendix showing a large number of sizes, the Contents of which may be found by referring to the aforesaid Tables. By THOMAS VALDER. Oblong 4to., 6*s.* net.

RIVINGTONS' COURSE OF BUILDING CONSTRUCTION.

NOTES ON BUILDING CONSTRUCTION. Medium 8vo.

Part I. With 552 Illustrations, 9*s.* net.

Part II. With 479 Illustrations, 9*s.* net.

Part III. Materials. With 188 Illustrations, 18*s.* net.

Part IV. Calculations for Building Structures. With 551 Illustrations, 13*s.* net.

ELECTRICITY AND MAGNETISM.

ARRHENIUS.—A TEXT-BOOK OF ELECTROCHEMISTRY. By SVANTE ARRHENIUS, Professor at the University of Stockholm. Translated from the German Edition by JOHN MCCRAE, Ph.D. With 58 Illustrations. 8vo., 9*s.* 6*d.* net.

CARUS-WILSON.—ELECTRO-DYNAMICS: the Direct-Current Motor. By CHARLES ASHLEY CARUS-WILSON, M.A. Cantab. With 71 Diagrams, and a Series of Problems, with Answers. Crown 8vo., 7*s.* 6*d.*

CUMMING.—ELECTRICITY TREATED EXPERIMENTALLY. By LINNÆUS CUMMING, M.A. With 242 Illustrations. Cr. 8vo., 4*s.* 6*d.*

DAY.—EXERCISES IN ELECTRICAL AND MAGNETIC MEASUREMENTS, with Answers. By R. E. DAY. 12mo., 3*s.* 6*d.*

FITZGERALD.—THE SCIENTIFIC WRITINGS OF THE LATE GEORGE FRANCIS FITZGERALD, Sc.D., F.R.S., F.R.S.E., Fellow of Trinity College, Dublin. Collected and Edited, with an Historical Introduction, by JOSEPH LARMOR, Sec.R.S., Fellow of St. John's College, Cambridge. With Portrait. 8vo., 15*s.*

GORE.—THE ART OF ELECTRO-METALLURGY, including all known Processes of Electro-Deposition. By G. GORE, LL.D., F.R.S. With 56 Illustrations. Fcp. 8vo., 6*s.*

HENDERSON.—Works by JOHN HENDERSON, D.Sc., F.R.S.E.

PRACTICAL ELECTRICITY AND MAGNETISM. With 159 Illustrations and Diagrams. Crown 8vo., 6*s.* 6*d.*

PRELIMINARY PRACTICAL MAGNETISM AND ELECTRICITY. Crown 8vo., 1*s.*

ELECTRICITY AND MAGNETISM—*Continued.*

JENKIN.—ELECTRICITY AND MAGNETISM. By FLEEMING JENKIN, F.R.S., M.I.C.E. With 177 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

JOUBERT.—ELEMENTARY TREATISE ON ELECTRICITY AND MAGNETISM. By G. CAREY FOSTER, F.R.S., Fellow and Emeritus Professor of Physics in University College, London; and ALFRED W. PORTER, B.Sc., Fellow and Assistant Professor of Physics in University College, London. Founded on JOUBERT'S 'Traité Elémentairé d'Electricité'. Second Edition. With 374 Illustrations and Diagrams. 8vo., 10*s.* 6*d.* net.

JOYCE.—EXAMPLES IN ELECTRICAL ENGINEERING. By SAMUEL JOYCE, A.I.E.E. Crown 8vo., 5*s.*

MACLEAN AND MARCHANT.—ELEMENTARY QUESTIONS IN ELECTRICITY AND MAGNETISM. With Answers. Compiled by MAGNUS MACLEAN, D.Sc., M.I.E.E., and E. W. MARCHANT, D.Sc., A.I.E.E. Crown 8vo., 1*s.*

MERRIFIELD.—MAGNETISM AND DEVIATION OF THE COMPASS. By JOHN MERRIFIELD, LL.D., F.R.A.S., 18mo., 2*s.* 6*d.*

PARR.—PRACTICAL ELECTRICAL TESTING IN PHYSICS AND ELECTRICAL ENGINEERING. By G. D. ASPINALL PARR, Assoc. M.I.E.E. With 231 Illustrations. 8vo., 8*s.* 6*d.*

POYSER.—Works by A. W. POYSER, M.A.

MAGNETISM AND ELECTRICITY. With 235 Illustrations. Crown 8vo., 2*s.* 6*d.*

ADVANCED ELECTRICITY AND MAGNETISM. With 317 Illustrations. Crown 8vo., 4*s.* 6*d.*

RHODES.—AN ELEMENTARY TREATISE ON ALTERNATING CURRENTS. By W. G. RHODES, M.Sc. (Vict.), Consulting Engineer. With 80 Diagrams. 8vo., 7*s.* 6*d.* net.

SLINGO AND BROOKER.—Works by W. SLINGO and A. BROOKER.

ELECTRICAL ENGINEERING FOR ELECTRIC LIGHT ARTISANS AND STUDENTS. With 383 Illustrations. Crown 8vo., 12*s.*

PROBLEMS AND SOLUTIONS IN ELEMENTARY ELECTRICITY AND MAGNETISM. With 98 Illustrations. Cr. 8vo., 2*s.*

TYNDALL.—Works by JOHN TYNDALL, D.C.L., F.R.S. See p. 36.

TELEGRAPHY AND THE TELEPHONE.

HOPKINS.—TELEPHONE LINES AND THEIR PROPERTIES. By WILLIAM J. HOPKINS, Professor of Physics in the Drexel Institute, Philadelphia. Crown 8vo., 6*s.*

PREECE AND SIVEWRIGHT.—TELEGRAPHY. By Sir W. H. PREECE, K.C.B., F.R.S., V.P.Inst., C.E., etc., Consulting Engineer and Electrician, Post Office Telegraphs; and Sir J. SIVEWRIGHT, K.C.M.G., General Manager, South African Telegraphs. With 267 Illustrations. Fcp. 8vo., 6*s.*

ENGINEERING, STRENGTH OF MATERIALS, ETC.

ANDERSON.—THE STRENGTH OF MATERIALS AND STRUCTURES: the Strength of Materials as depending on their Quality and as ascertained by Testing Apparatus. By Sir J. ANDERSON, C.E., LL.D., F.R.S.E. With 66 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

BARRY.—RAILWAY APPLIANCES: a Description of Details of Railway Construction subsequent to the completion of the Earthworks and Structures. By Sir JOHN WOLFE BARRY, K.C.B., F.R.S., M.I.C.E. With 218 Illustrations. Fcp. 8vo., 4*s.* 6*d.*

DIPLOCK.—A NEW SYSTEM OF HEAVY GOODS TRANSPORT ON COMMON ROADS. By BRAHAM JOSEPH DIPLOCK. With 27 Illustrations. 8vo.

GOODMAN.—MECHANICS APPLIED TO ENGINEERING. By JOHN GOODMAN, Wh.Sch., A.M.I.C.E., M.I.M.E., Professor of Engineering in the Yorkshire College, Leeds (Victoria University). With 620 Illustrations and numerous Examples. Crown 8vo., 7*s.* 6*d.* net.

LOW.—A POCKET-BOOK FOR MECHANICAL ENGINEERS. By DAVID ALLAN LOW (Whitworth Scholar), M.I.Mech.E., Professor of Engineering, East London Technical College (People's Palace), London. With over 1000 specially prepared Illustrations. Fcp. 8vo., gilt edges, rounded corners, 7*s.* 6*d.*

PARKINSON.—LIGHT RAILWAY CONSTRUCTION. By RICHARD MARION PARKINSON, Assoc.M.Inst.C.E. With 85 Diagrams. 8vo., 10*s.* 6d. net.

SMITH.—GRAPHICS, or the Art of Calculation by Drawing Lines, applied especially to Mechanical Engineering. By ROBERT H. SMITH, Professor of Engineering, Mason College, Birmingham. Part I. With separate Atlas of 29 Plates containing 97 Diagrams. 8vo., 15*s.*

STONEY.—THE THEORY OF STRESSES IN GIRDERS AND SIMILAR STRUCTURES; with Practical Observations on the Strength and other Properties of Materials. By BINDON B. STONEY, LL.D., F.R.S., M.I.C.E. With 5 Plates and 143 Illust. in the Text. Royal 8vo., 36*s.*

UNWIN.—THE TESTING OF MATERIALS OF CONSTRUCTION. A Text-book for the Engineering Laboratory and a Collection of the Results of Experiment. By W. CAWTHORNE UNWIN, F.R.S., B.Sc. With 5 Plates and 188 Illustrations and Diagrams. 8vo., 16*s.* net.

WARREN.—ENGINEERING CONSTRUCTION IN IRON, STEEL, AND TIMBER. By WILLIAM HENRY WARREN, Challis Professor of Civil and Mechanical Engineering, University of Sydney. With 13 Folding Plates and 375 Diagrams. Royal 8vo., 16*s.* net.

WHEELER.—THE SEA COAST: Destruction, Littoral Drift, Protection. By W. H. WHEELER, M.Inst. C.E. With 38 Illustrations and Diagram. Medium 8vo., 10*s.* 6*d.* net.

LONGMANS' CIVIL ENGINEERING SERIES.

CIVIL ENGINEERING AS APPLIED TO CONSTRUCTION. By LEVESON FRANCIS VERNON-HARCOURT, M.A., M.Inst.C.E. With 368 Illustrations. Medium 8vo., 14*s.* net.

CONTENTS.—Materials, Preliminary Works, Foundations and Roads—Railway Bridge and Tunnel Engineering—River and Canal Engineering—Irrigation Works—Dock Works and Maritime Engineering—Sanitary Engineering.

NOTES ON DOCKS AND DOCK CONSTRUCTION. By C. COLSON, C.B., M.Inst.C.E. With 365 Illustrations. Medium 8vo., 21*s.* net

CALCULATIONS IN HYDRAULIC ENGINEERING: a Practical Text-Book for the use of Students, Draughtsmen and Engineers. By T. CLAXTON FIDLER, M.Inst.C.E.

Part I. Fluid Pressure and the Calculation of its Effects in Engineering Structures. With numerous Illustns. and Examples. 8vo., 6*s.* 6*d.* net.

Part II. Calculations in Hydro-Kinetics. With numerous Illustrations and Examples. 8vo., 7*s.* 6*d.* net.

RAILWAY CONSTRUCTION. By W. H. MILLS, M.I.C.E., Engineer-in-Chief of the Great Northern Railway of Ireland. With 516 Illustrations and Diagrams. 8vo., 18*s.* net.

PRINCIPLES AND PRACTICE OF HARBOUR CONSTRUCTION. By WILLIAM SHIELD, F.R.S.E., M.Inst.C.E. With 97 Illustrations. Medium 8vo., 15*s.* net.

TIDAL RIVERS: their (1) Hydraulics, (2) Improvement, (3) Navigation. By W. H. WHEELER, M.Inst.C.E. With 75 Illustrations. Medium 8vo., 16*s.* net.

MACHINE DRAWING AND DESIGN.

LOW.—Works by DAVID ALLAN LOW, Professor of Engineering, East London Technical College (People's Palace).

IMPROVED DRAWING SCALES. 6*d.* net in case.

AN INTRODUCTION TO MACHINE DRAWING AND DESIGN. With 153 Illustrations and Diagrams. Crown 8vo, 2*s.* 6*d.*

LOW AND BEVIS.—A MANUAL OF MACHINE DRAWING AND DESIGN. By DAVID ALLAN LOW and ALFRED WILLIAM BEVIS M.I.Mech.E. With 700 Illustrations. 8vo., 7*s.* 6*d.*

UNWIN.—THE ELEMENTS OF MACHINE DESIGN. By W. CAWTHORNE UNWIN, F.R.S.

Part I. General Principles, Fastenings, and Transmissive Machinery. With 345 Diagrams, etc. Fcp. 8vo., 7*s.* 6*d.*

Part II. Chiefly on Engine Details. With 259 Illustrations. Fcp. 8vo., 6*s.*

NAVAL ARCHITECTURE.

ATTWOOD.—TEXT-BOOK OF THEORETICAL NAVAL ARCHITECTURE: a Manual for Students of Science Classes and Draughtsmen Engaged in Shipbuilders' and Naval Architects' Drawing Offices. By EDWARD LEWIS ATTWOOD, Assistant Constructor, Royal Navy. With 114 Diagrams. Crown 8vo., *7s. 6d.*

WATSON.—NAVAL ARCHITECTURE: A Manual of Laying-off Iron, Steel and Composite Vessels. By THOMAS H. WATSON, Lecturer on Naval Architecture at the Durham College of Science, Newcastle-upon-Tyne. With numerous Illustrations. Royal 8vo., *15s.* net.

WORKSHOP APPLIANCES, ETC.

NORTHCOTT.—LATHES AND TURNING, Simple, Mechanical and Ornamental. By W. H. NORTHCOTT. With 338 Illustrations. 8vo., *18s.*

SHELLEY.—WORKSHOP APPLIANCES, including Descriptions of some of the Gauging and Measuring Instruments, Hand-cutting Tools, Lathes, Drilling, Planeing, and other Machine Tools used by Engineers. By C. P. B. SHELLEY, M.I.C.E. With an additional Chapter on Milling by R. R. LISTER. With 323 Illustrations. Fcp. 8vo., *5s.*

MINERALOGY, MINING, METALLURGY, ETC.

BAUERMAN.—Works by HILARY BAUERMAN, F.G.S.

SYSTEMATIC MINERALOGY. With 373 Illustrations. Fcp. 8vo., *6s.*

DESCRIPTIVE MINERALOGY. With 236 Illustrations. Fcp. 8vo., *6s.*

BREARLEY AND IBBOTSON. — THE ANALYSIS OF STEEL-WORKS MATERIALS. By HARRY BREARLEY and FRED IBBOTSON, B.Sc. (Lond.), Demonstrator of Micrographic Analysis, University College, Sheffield. With 85 Illustrations. 8vo., *14s.* net.

GORE.—THE ART OF ELECTRO-METALLURGY. By G. GORE, LL.D., F.R.S. With 56 Illustrations. Fcp. 8vo., *6s.*

HUNTINGTON AND M'MILLAN. —METALS: their Properties and Treatment. By A. K. HUNTINGTON, Professor of Metallurgy in King's College, London, and W. G. M'MILLAN, Lecturer on Metallurgy in Mason's College, Birmingham. With 122 Illustrations. Fcp. 8vo., *7s. 6d.*

LUPTON.—Works by ARNOLD LUPTON, M.I.C.E., F.G.S., etc.

MINING. An Elementary Treatise on the Getting of Minerals. With 596 Diagrams and Illustrations. Crown 8vo., *9s.* net.

A PRACTICAL TREATISE ON MINE SURVEYING. With 209 Illustrations. 8vo., *12s.* net.

RHEAD.—METALLURGY. By E. L. RHEAD, Lecturer on Metallurgy at the Municipal Technical School, Manchester. With 94 Illustrations. Fcp. 8vo., *3s. 6d.*

RHEAD AND SEXTON.—ASSAYING AND METALLURGICAL ANALYSIS for the use of Students, Chemists and Assayers. By E. L. RHEAD, Lecturer on Metallurgy, Municipal School of Technology, Manchester; and A. HUMBOLDT SEXTON, F.I.C., F.C.S., Professor of Metallurgy, Glasgow and West of Scotland Technical College. 8vo., *10s. 6d.* net.

RUTLEY.—THE STUDY OF ROCKS: an Elementary Textbook of Petrology. By F. RUTLEY, F.G.S. With 6 Plates and 88 other Illustrations. Fcp. 8vo., *4s. 6d.*

ASTRONOMY, NAVIGATION, ETC.

ABBOTT.—ELEMENTARY THEORY OF THE TIDES: the Fundamental Theorems Demonstrated without Mathematics and the Influence on the Length of the Day Discussed. By T. K. ABBOTT, B.D., Fellow and Tutor, Trinity College, Dublin. Crown 8vo., *2s.*

BALL.—Works by Sir ROBERT S. BALL, LL.D., F.R.S.

ELEMENTS OF ASTRONOMY. With 130 Figures and Diagrams. Fcp. 8vo., *6s. 6d.*

A CLASS-BOOK OF ASTRONOMY. With 41 Diagrams. Fcp. 8vo., *1s. 6d.*

GILL.—TEXT-BOOK ON NAVIGATION AND NAUTICAL ASTRONOMY. By J. GILL, F.R.A.S., late Head Master of the Liverpool Corporation Nautical College. 8vo., *10s. 6d.*

GOODWIN.—AZIMUTH TABLES FOR THE HIGHER DECLINATIONS. (Limits of Declination 24° to 30°, both inclusive.) Between the Parallels of Latitude 0° and 60°. With Examples of the Use of the Tables in English and French. By H. B. GOODWIN, Naval Instructor, Royal Navy. Royal 8vo., *7s. 6d.*

HERSCHEL.—OUTLINES OF ASTRONOMY. By Sir JOHN F. W. HERSCHEL, Bart., K.H., etc. With 9 Plates and numerous Diagrams. 8vo., *12s.*

LAUGHTON.—AN INTRODUCTION TO THE PRACTICAL AND THEORETICAL STUDY OF NAUTICAL SURVEYING. By JOHN KNOX LAUGHTON, M.A., F.R.A.S. With 35 Diagrams. Crown 8vo., *6s.*

LOWELL.—MARS. By PERCIVAL LOWELL, Fellow American Academy, Member Royal Asiatic Society, Great Britain and Ireland, etc. With 24 Plates. 8vo., *12s. 6d.*

MARTIN.—NAVIGATION AND NAUTICAL ASTRONOMY. Compiled by Staff Commander W. R. MARTIN, R.N. Royal 8vo., *18s.*

MERRIFIELD.—A TREATISE ON NAVIGATION. For the Use of Students. By J. MERRIFIELD, LL.D., F.R.A.S., F.M.S. With Charts and Diagrams. Crown 8vo., *5s.*

PARKER.—ELEMENTS OF ASTRONOMY. With Numerous Examples and Examination Papers. By GEORGE W. PARKER, M.A., of Trinity College, Dublin. With 84 Diagrams. 8vo., *5s. 6d.* net.

WEBB.—CELESTIAL OBJECTS FOR COMMON TELESCOPES. By the Rev. T. W. WEBB, M.A., F.R.A.S. Fifth Edition, Revised and greatly Enlarged by the Rev. T. E. ESPIN, M.A., F.R.A.S. (Two Volumes.) Vol. I., with Portrait and a Reminiscence of the Author, 2 Plates, and numerous Illustrations. Crown 8vo., *6s.* Vol. II., with numerous Illustrations. Crown 8vo., *6s. 6d.*

WORKS BY RICHARD A. PROCTOR.

THE MOON: Her Motions, Aspect, Scenery, and Physical Condition. With many Plates and Charts, Wood Engravings, and 2 Lunar Photographs. Crown 8vo., 3*s.* 6*d.*

OTHER WORLDS THAN OURS: the Plurality of Worlds Studied Under the Light of Recent Scientific Researches. With 14 Illustrations; Map, Charts, etc. Crown 8vo., 3*s.* 6*d.*

OUR PLACE AMONG INFINITIES: a Series of Essays contrasting our Little Abode in Space and Time with the Infinities around us. Crown 8vo., 3*s.* 6*d.*

MYTHS AND MARVELS OF ASTRONOMY. Crown 8vo., 3*s.* 6*d.*

LIGHT SCIENCE FOR LEISURE HOURS: Familiar Essays on Scientific Subjects, Natural Phenomena, etc. Crown 8vo., 3*s.* 6*d.*

THE ORBS AROUND US; Essays on the Moon and Planets, Meteors and Comets, the Sun and Coloured Pairs of Suns. Crown 8vo., 3*s.* 6*d.*

THE EXPANSE OF HEAVEN: Essays on the Wonders of the Firmament. Crown 8vo., 3*s.* 6*d.*

OTHER SUNS THAN OURS: a Series of Essays on Suns—Old, Young, and Dead. With other Science Gleanings. Two Essays on Whist, and Correspondence with Sir John Herschel. With 9 Star-Maps and Diagrams. Crown 8vo., 3*s.* 6*d.*

HALF-HOURS WITH THE TELESCOPE: a Popular Guide to the Use of the Telescope as a means of Amusement and Instruction. With 7 Plates. Fcp. 8vo., 2*s.* 6*d.*

NEW STAR ATLAS FOR THE LIBRARY, the School, and the Observatory, in Twelve Circular Maps (with Two Index-Plates). With an Introduction on the Study of the Stars. Illustrated by 9 Diagrams. Cr. 8vo., 5*s.*

THE SOUTHERN SKIES: a Plain and Easy Guide to the Constellations of the Southern Hemisphere. Showing in 12 Maps the position of the principal Star-Groups night after night throughout the year. With an Introduction and a separate Explanation of each Map. True for every Year. 4to., 5*s.*

HALF-HOURS WITH THE STARS: a Plain and Easy Guide to the Knowledge of the Constellations. Showing in 12 Maps the position of the principal Star-Groups night after night throughout the year. With Introduction and a separate Explanation of each Map. True for every Year. 4to., 3*s.* net.

LARGER STAR ATLAS FOR OBSERVERS AND STUDENTS. In Twelve Circular Maps, showing 6000 Stars, 1500 Double Stars, Nebulæ, etc. With 2 Index-Plates. Folio, 15*s.*

OVER.

WORKS BY RICHARD A. PROCTOR—*Continued.*

THE STARS IN THEIR SEASONS: an Easy Guide to a Knowledge of the Star-Groups. In 12 Large Maps. Imperial 8vo., 5*s.*

ROUGH WAYS MADE SMOOTH. Familiar Essays on Scientific Subjects. Crown 8vo., 3*s.* 6*d.*

PLEASANT WAYS IN SCIENCE. Crown 8vo., 3*s.* 6*d.*

NATURE STUDIES. By R. A. Proctor, Grant Allen, A. Wilson, T. Foster, and E. Clodd. Crown 8vo., 3*s.* 6*d.*

LEISURE READINGS. By R. A. Proctor, E. Clodd, A. Wilson, T. Foster, and A. C. Ranyard. Crown 8vo., 3*s.* 6*d.*

PHYSIOGRAPHY AND GEOLOGY.

BIRD.—Works by CHARLES BIRD, B.A.

ELEMENTARY GEOLOGY. With Geological Map of the British Isles, and 247 Illustrations. Crown 8vo., 2*s.* 6*d.*

ADVANCED GEOLOGY. A Manual for Students in Advanced Classes and for General Readers. With over 300 Illustrations, a Geological Map of the British Isles (coloured), and a set of Questions for Examination. Crown 8vo., 7*s.* 6*d.*

GREEN.—PHYSICAL GEOLOGY FOR STUDENTS AND GENERAL READERS. By A. H. Green, M.A., F.G.S. With 236 Illustrations. 8vo., 21*s.*

MORGAN.—Works by ALEX. MORGAN, M.A., D.Sc., F.R.S.E.

ELEMENTARY PHYSIOGRAPHY. Treated Experimentally. With 4 Maps and 243 Diagrams. Crown 8vo., 2*s.* 6*d.*

ADVANCED PHYSIOGRAPHY. With 215 Illustrations. Crown 8vo., 4*s.* 6*d.*

THORNTON.—Works by J. THORNTON, M.A.

ELEMENTARY PRACTICAL PHYSIOGRAPHY.

Part I. With 215 Illustrations. Crown 8vo., 2*s.* 6*d.*

Part II. With 98 Illustrations. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY PHYSIOGRAPHY: an Introduction to the Study of Nature. With 13 Maps and 295 Illustrations. With Appendix on Astronomical Instruments and Measurements. Crown 8vo., 2*s.* 6*d.*

ADVANCED PHYSIOGRAPHY. With 11 Maps and 255 Illustrations. Crown 8vo., 4*s.* 6*d.*

NATURAL HISTORY AND GENERAL SCIENCE.

BEDDARD.—THE STRUCTURE AND CLASSIFICATION OF BIRDS. By FRANK E. BEDDARD, M.A., F.R.S., Prosector and Vice-Secretary of the Zoological Society of London. With 252 Illus. 8vo., 21*s.* net.

FURNEAUX.—Works by WILLIAM FURNEAUX, F.R.G.S.

THE OUTDOOR WORLD; or, The Young Collector's Handbook. With 18 Plates, 16 of which are coloured, and 549 Illustrations in the Text. Crown 8vo., 6*s.* net.

LIFE IN PONDS AND STREAMS. With 8 Coloured Plates and 331 Illustrations in the Text. Crown 8vo., 6*s.* net.

BUTTERFLIES AND MOTHS (British). With 12 Coloured Plates and 241 Illustrations in the Text. Crown 8vo., 6*s.* net.

HUDSON.—BRITISH BIRDS. By W. H. HUDSON, C.M.Z.S. With 8 Coloured Plates from Original Drawings by A. THORBURN, and 8 Plates and 100 Figures by C. E. LODGE, and 3 Illustrations from Photographs. Crown 8vo., 6*s.* net.

MILLAIS.—THE NATURAL HISTORY OF THE BRITISH SURFACE-FEEDING DUCKS. By JOHN GUILLE MILLAIS, F.Z.S., etc. With 6 Photogravures and 66 Plates (41 in colours) from Drawings by the Author, ARCHIBALD THORBURN, and from Photographs. Royal 4to., £6 6*s.* net.

NANSEN.—THE NORWEGIAN NORTH POLAR EXPEDITION, 1893-1896: Scientific Results. Edited by FRIDTJOF NANSEN. Volume I. With 44 Plates and numerous Illustrations in the Text. Demy 4to., 40*s.* net.

CONTENTS: The *Fram*—The Jurassic Fauna of Cape Flora. With a Geological Sketch of Cape Flora and its Neighbourhood—Fossil Plants from Franz Josef Land—An Account of the Birds—Crustacea.

Volume II. With 2 Charts and 17 Plates. Demy 4to., 30*s.* net.

CONTENTS: Astronomical Observations—Terrestrial Magnetism—Results of the Pendulum—Observations and some Remarks on the Constitution of the Earth's Crust.

Volume III. With 33 Plates. Demy 4to., 32*s.* net.

CONTENTS: The Oceanography of the North Polar Basin—On Hydrometers and the Surface Tension of Liquids.

STANLEY.—A FAMILIAR HISTORY OF BIRDS. By E. STANLEY, D.D., formerly Bishop of Norwich. With 160 Illustrations. Crown 8vo., 3*s.* 6*d.*

MANUFACTURES, TECHNOLOGY, ETC.

BELL.—JACQUARD WEAVING AND DESIGNING. By F. T. BELL. With 199 Diagrams. 8vo., 12*s.* net.

CROSS AND BEVAN.—Works by C. F. CROSS and E. J. BEVAN.

CELLULOSE: an Outline of the Chemistry of the Structural Elements of Plants. With reference to their Natural History and Industrial Uses. (C. F. CROSS, E. J. BEVAN and C. BEADLE.) With 14 Plates. Crown 8vo., 12*s.* net.

RESEARCHES ON CELLULOSE, 1895-1900. Crown 8vo., 6*s.* net.

DODSON.—THE DOUBLING AND MANUFACTURE OF THREADS. By JOHN DODSON, Vice-President of the Bolton and District Mills Managers' Technical Association. With 134 Illustrations. 8vo., 10*s.* 6*d.* net.

MANUFACTURES, TECHNOLOGY, ETC.—*Continued.*

MORRIS AND WILKINSON.—THE ELEMENTS OF COTTON SPINNING. By JOHN MORRIS and F. WILKINSON. With a Preface by Sir B. A. DOBSON, C.E., M.I.M.E. With 169 Diagrams and Illustrations. Crown 8vo., *7s. 6d.* net.

RICHARDS.—BRICKLAYING AND BRICK-CUTTING. By H. W. RICHARDS, Examiner in Brickwork and Masonry to the City and Guilds of London Institute, Head of Building Trades Department, Northern Polytechnic Institute, London, N. With over 200 Illustrations. Med. 8vo., *3s. 6d.*

TAYLOR.—COTTON WEAVING AND DESIGNING. By JOHN T. TAYLOR. With 373 Diagrams. Crown 8vo., *7s. 6d.* net.

WATTS.—AN INTRODUCTORY MANUAL FOR SUGAR GROWERS. By FRANCIS WATTS, F.C.S., F.I.C. With 20 Illustrations. Crown 8vo., *6s.*

HEALTH AND HYGIENE.

ASHBY.—HEALTH IN THE NURSERY. By HENRY ASHBY, M.D., F.R.C.P. With 25 Illustrations. Crown 8vo., *3s.* net.

BUCKTON.—HEALTH IN THE HOUSE. By Mrs. C. M. BUCKTON. With 41 Woodcuts and Diagrams. Crown 8vo., *2s.*

CORFIELD.—THE LAWS OF HEALTH. By W. H. CORFIELD, M.A., M.D. Fcp. 8vo., *1s. 6d.*

FURNEAUX.—ELEMENTARY PRACTICAL HYGIENE.—Section I. By WILLIAM S. FURNEAUX. With 146 Illustrations. Cr. 8vo., *2s. 6d.*

NOTTER AND FIRTH.—Works by J. L. NOTTER, M.A., M.D., and R. H. FIRTH, F.R.C.S.

HYGIENE. With 95 Illustrations. Crown 8vo., *3s. 6d.*

PRACTICAL DOMESTIC HYGIENE. With 83 Illustrations. Crown 8vo., *2s. 6d.*

POORE.—Works by GEORGE VIVIAN POORE, M.D.

ESSAYS ON RURAL HYGIENE. With 12 Illustrations. Crown 8vo., *6s. 6d.*

THE DWELLING-HOUSE. With 36 Illustrations. Crown 8vo., *3s. 6d.*

COLONIAL AND CAMP SANITATION. With 11 Illustrations. Crown 8vo., *2s.* net.

THE EARTH IN RELATION TO THE PRESERVATION AND DESTRUCTION OF CONTAGIA: being the Milroy Lectures delivered at the Royal College of Physicians in 1899, together with other Papers on Sanitation. With 13 Illustrations. Crown 8vo., *5s.*

WILSON.—A MANUAL OF HEALTH-SCIENCE. By ANDREW WILSON, F.R.S.E., F.L.S., etc. With 74 Illustrations. Crown 8vo., *2s. 6d.*

MEDICINE AND SURGERY.

ASHBY AND WRIGHT.—THE DISEASES OF CHILDREN, MEDICAL AND SURGICAL. By HENRY ASHBY, M.D., Lond., F.R.C.P., Physician to the General Hospital for Sick Children, Manchester; and G. A. WRIGHT, B.A., M.B. Oxon., F.R.C.S., Eng., Assistant-Surgeon to the Manchester Royal Infirmary, and Surgeon to the Children's Hospital. Enlarged and Improved Edition. With 192 Illustrations. 8vo., 25*s.*

BENNETT.—Works by SIR WILLIAM BENNETT, K.C.V.O., F.R.C.S., Surgeon to St. George's Hospital; Member of the Board of Examiners, Royal College of Surgeons of England.

CLINICAL LECTURES ON VARICOSE VEINS OF THE LOWER EXTREMITIES. With 3 Plates. 8vo., 6*s.*

ON VARICOCELE; A PRACTICAL TREATISE. With 4 Tables and a Diagram. 8vo., 5*s.*

CLINICAL LECTURES ON ABDOMINAL HERNIA: chiefly in relation to Treatment, including the Radical Cure. With 12 Diagrams in the Text. 8vo., 8*s.* 6*d.*

ON VARIX, ITS CAUSES AND TREATMENT, WITH ESPECIAL REFERENCE TO THROMBOSIS. 8vo., 3*s.* 6*d.*

THE PRESENT POSITION OF THE TREATMENT OF SIMPLE FRACTURES OF THE LIMBS. 8vo., 2*s.* 6*d.*

LECTURES ON THE USE OF MASSAGE AND EARLY PASSIVE MOVEMENTS IN RECENT FRACTURES AND OTHER COMMON SURGICAL INJURIES: The Treatment of Internal Derangements of the Knee Joint and Management of Stiff Joints. With 17 Illustrations. 8vo., 6*s.*

BENTLEY.—A TEXT-BOOK OF ORGANIC MATERIA MEDICA. Comprising a Description of the Vegetable and Animal Drugs of the British Pharmacopœia, with some others in common use. Arranged Systematically, and Especially Designed for Students. By ROBERT BENTLEY, M.R.C.S. Eng., F.L.S. With 62 Illustrations on Wood. Crown 8vo., 7*s.* 6*d.*

CABOT.—A GUIDE TO THE CLINICAL EXAMINATION OF THE BLOOD FOR DIAGNOSTIC PURPOSES. By RICHARD C. CABOT, M.D., Physician to Out-patients, Massachusetts General Hospital. With 3 Coloured Plates and 28 Illustrations in the Text. 8vo., 16*s.*

CARR, PICK, DORAN, AND DUNCAN.—THE PRACTITIONER'S GUIDE. By J. WALTER CARR, M.D. (Lond.), F.R.C.P.; T. PICKERING PICK, F.R.C.S.; ALBAN H. G. DORAN, F.R.C.S.; ANDREW DUNCAN, M.D., B.Sc. (Lond.), F.R.C.S., M.R.C.P. 8vo., 21*s.* net.

CELLI.—MALARIA, ACCORDING TO THE NEW RESEARCHES. By Prof. ANGELO CELLI, Director of the Institute of Hygiene, University of Rome. Translated from the Second Italian Edition by JOHN JOSEPH EYRE, M.R.C.P., L.R.C.S. Ireland, D.P.H. Cambridge. With an Introduction by Dr. PATRICK MANSON, Medical Adviser to the Colonial Office. 8vo., 10*s.* 6*d.*

MEDICINE AND SURGERY—*Continued.*

CHEYNE AND BURGHARD.—A MANUAL OF SURGICAL TREATMENT. By W. WATSON CHEYNE, C.B., M.B., F.R.C.S., F.R.S., Professor of Surgery in King's College, London, Surgeon to King's College Hospital, etc.; and F. F. BURGHARD, M.D. and M.S., F.R.C.S., Teacher of Practical Surgery in King's College, London, Surgeon to King's College, Hospital (Lond.), etc.

Part I. The Treatment of General Surgical Diseases, including Inflammation, Suppuration, Ulceration, Gangrene, Wounds and their Complications, Infective Diseases and Tumours; the Administration of Anæsthetics. With 66 Illustrations. Royal 8vo., 10*s.* 6*d.*

Part II. The Treatment of the Surgical Affections of the Tissues, including the Skin and Subcutaneous Tissues, the Nails, the Lymphatic Vessels and Glands, the Fasciæ, Bursæ, Muscles, Tendons and Tendon-sheaths, Nerves, Arteries and Veins. Deformities. With 141 Illustrations. Royal 8vo., 14*s.*

Part III. The Treatment of the Surgical Affections of the Bones. Amputations. With 100 Illustrations. Royal 8vo., 12*s.*

Part IV. The Treatment of the Surgical Affections of the Joints (including Excisions) and the Spine. With 138 Illustrations. Royal 8vo., 14*s.*

Part V. The Treatment of the Surgical Affections of the Head, Face, Jaws, Lips, Larnyx and Trachea; and the Intrinsic Diseases of the Nose, Ear and Larynx, by H. LAMBERT LACK, M.D. (Lond.), F.R.C.S., Surgeon to the Hospital for Diseases of the Throat, Golden Square, and to the Throat and Ear Department, The Children's Hospital, Paddington Green. With 145 Illustrations. Royal 8vo., 18*s.*

Part VI. Section I. The Treatment of the Surgical Affections of the Tongue and Floor of the Mouth, the Pharynx, Neck, Œsophagus, Stomach and Intestines. With 124 Illustrations. Royal 8vo., 18*s.*

Section II. The Treatment of the Surgical Affections of the Rectum, Liver, Spleen, Pancreas, Throat, Breast and Genito-urinary Organs. With 113 Illustrations. Royal 8vo., 21*s.*

CLARKE.—POST-MORTEM EXAMINATIONS IN MEDICO-LEGAL AND ORDINARY CASES. With Special Chapters on the Legal Aspects of Post-mortems, and on Certificates of Death. By J. JACKSON CLARKE, M.B. Lond., F.R.C.S., Assistant Surgeon at the North-west London and City Orthopædic Hospitals, etc. Fcp. 8vo., 2*s.* 6*d.*

COATS.—A MANUAL OF PATHOLOGY. By JOSEPH COATS, M.D., late Professor of Pathology in the University of Glasgow. Fourth Edition. Revised throughout and Edited by LEWIS R. SUTHERLAND, M.D., Professor of Pathology, University of St. Andrews. With Illustrations. 8vo., 28*s.* net.

COOKE.—Works by THOMAS COOKE, F.R.C.S. Eng., B.A., B.Sc., M.D., Paris.

TABLETS OF ANATOMY. Being a Synopsis of Demonstrations given in the Westminster Hospital Medical School. Eleventh Edition in Three Parts, thoroughly brought up to date, and with over 700 Illustrations from all the best Sources, British and Foreign. Post 4to.

Part I. The Bones. 7*s.* 6*d.* net.

Part II. Limbs, Abdomen, Pelvis. 10*s.* 6*d.* net.

Part III. Head and Neck, Thorax, Brain. 10*s.* 6*d.* net.

MEDICINE AND SURGERY—*Continued.*

COOKE.—Works by THOMAS COOKE (*continued*).

APHORISMS IN APPLIED ANATOMY AND OPERATIVE SURGERY. Including 100 Typical *vivâ voce* Questions on Surface Marking, etc. Crown 8vo., 3*s.* 6*d.*

DAKIN.—A HANDBOOK OF MIDWIFERY. By WILLIAM RADFORD DAKIN, M.D., F.R.C.P., Obstetric Physician and Lecturer on Midwifery at St. George's Hospital, etc. With 394 Illustrations. Large crown 8vo., 18*s.*

DICKINSON.—Works by W. HOWSHIP DICKINSON, M.D. Cantab., F.R.C.P.

ON RENAL AND URINARY AFFECTIONS. With 12 Plates and 122 Woodcuts. Three Parts. 8vo., £3 4*s.* 6*d.*

THE TONGUE AS AN INDICATION OF DISEASE: being the Lumleian Lectures delivered March, 1888. 8vo., 7*s.* 6*d.*

OCCASIONAL PAPERS ON MEDICAL SUBJECTS, 1855-1896. 8vo., 12*s.*

MEDICINE OLD AND NEW. An Address Delivered on the Occasion of the Opening of the Winter Session, 1899-1900, at St. George's Hospital Medical School, on 2nd October, 1899. Crown 8vo., 2*s.* 6*d.*

DUCKWORTH.—Works by SIR DYCE DUCKWORTH, M.D., LL.D., Fellow and Treasurer of the Royal College of Physicians, etc.

THE SEQUELS OF DISEASE: being the Lumleian Lectures, 1896. 8vo., 10*s.* 6*d.*

THE INFLUENCE OF CHARACTER AND RIGHT JUDGMENT IN MEDICINE: the Harveian Oration, 1898. Post 4to., 2*s.* 6*d.*

ERICHSEN.—THE SCIENCE AND ART OF SURGERY; a Treatise on Surgical Injuries, Diseases, and Operations. By Sir JOHN ERIC ERICHSEN, Bart., F.R.S., LL.D. Edin., Hon. M.Ch. and F.R.C.S. Ireland. Illustrated by nearly 1000 Engravings on Wood. 2 vols. Royal 8vo., 48*s.*

FOWLER AND GODLEE.—THE DISEASES OF THE LUNGS. By JAMES KINGSTON FOWLER, M.A., M.D., F.R.C.P., Physician to the Middlesex Hospital and to the Hospital for Consumption and Diseases of the Chest, Brompton, etc.; and RICKMAN JOHN GODLEE, Honorary Surgeon in Ordinary to His Majesty, M.S., F.R.C.S., Fellow and Professor of Clinical Surgery, University College, London, etc. With 160 Illustrations. 8vo., 25*s.*

MEDICINE AND SURGERY—*Continued.*

GARROD.—Works by SIR ALFRED BARING GARROD, M.D., F.R.S., etc.

A TREATISE ON GOUT AND RHEUMATIC GOUT (RHEUMATOID ARTHRITIS). With 6 Plates, comprising 21 Figures (14 Coloured), and 27 Illustrations engraved on Wood. 8vo., 21*s.*

THE ESSENTIALS OF MATERIA MEDICA AND THERAPEUTICS. Crown 8vo., 12*s.* 6*d.*

GOADBY.—THE MYCOLOGY OF THE MOUTH : a Text-Book of Oral Bacteria. By KENNETH W. GOADBY, L.D.S. (Eng.), D.P.H. (Camb.), L.R.C.P., M.R.C.S., Bacteriologist and Lecturer on Bacteriology, National Dental Hospital, etc. With 82 Illustrations. 8vo., 8*s.* 6*d.* net.

GOODSALL AND MILES.—DISEASES OF THE ANUS AND RECTUM. By D. H. GOODSALL, F.R.C.S., Senior Surgeon, Metropolitan Hospital; Senior Surgeon, St. Mark's Hospital; and W. ERNEST MILES, F.R.C.S., Assistant Surgeon to the Cancer Hospital, Surgeon (out-patients), to the Gordon Hospital, etc. (In Two Parts.) Part I. With 91 Illustrations. 8vo., 7*s.* 6*d.* net.

GRAY.—ANATOMY, DESCRIPTIVE AND SURGICAL. By HENRY GRAY, F.R.S., late Lecturer on Anatomy at St. George's Hospital Medical School. The Fifteenth Edition Enlarged, edited by T. PICKERING PICK, F.R.C.S., Consulting Surgeon to St. George's Hospital, etc., and by ROBERT HOWDEN, M.A., M.B., C.M., Professor of Anatomy in the University of Durham, etc. With 772 Illustrations, a large proportion of which are Coloured, the Arteries being coloured red, the Veins blue, and the Nerves yellow. The attachments of the muscles to the bones, in the section on Osteology, are also shown in coloured outline. Royal 8vo., 32*s.* net.

HALLIBURTON.—Works by W. D. HALLIBURTON, M.D., F.R.S., Professor of Physiology in King's College, London.

A TEXT-BOOK OF CHEMICAL PHYSIOLOGY AND PATHOLOGY. With 104 Illustrations. 8vo., 28*s.*

ESSENTIALS OF CHEMICAL PHYSIOLOGY. With 77 Illustrations. 8vo., 5*s.*

LANG.—THE METHODICAL EXAMINATION OF THE EYE. Being Part I. of a Guide to the Practice of Ophthalmology for Students and Practitioners. By WILLIAM LANG, F.R.C.S. Eng., Surgeon to the Royal London Ophthalmic Hospital, Moorfields, etc. With 15 Illustrations. Crown 8vo., 3*s.* 6*d.*

LUFF.—TEXT-BOOK OF FORENSIC MEDICINE AND TOXICOLOGY. By ARTHUR P. LUFF, M.D., B.Sc. (Lond.), Physician in Charge of Out-Patients and Lecturer on Medical Jurisprudence and Toxicology in St. Mary's Hospital. With 13 full-page Plates (1 in colours) and 33 Illustrations in the Text. 2 vols. Crown 8vo., 24*s.*

MEDICINE AND SURGERY—*Continued.*

LIVERPOOL UNIVERSITY PRESS PUBLICATIONS, THE.

The Thomson Yates Laboratories Reports. Physiology; Pathology; Bacteriology; Tropical Medicine; Hygiene. Edited by RUPERT BOYCE and C. S. SHERRINGTON. With Plates and Illustrations in the text. Demy 4to. Vol I., 1898-9, 10*s.* 6*d.*; Vol. II., 1898-9, 25*s.*; Vol. III., Part I., 1900, 7*s.* 6*d.*; Vol. III., Part II., 1901, 12*s.* 6*d.*; Vol. IV., Part I., 1901, 20*s.*; Vol. IV., Part II., 1902, 21*s.*

THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE MEMOIRS.

With Plates and Illustrations in the text. Demy 4to.

I. Malarial Fever: Its Cause, Prevention and Treatment. Containing full details for the use of Travellers, Sportsmen, Soldiers, and Residents in Malarious Places. By RONALD ROSS, C.B., F.R.S., F.R.C.S. With Frontispiece. 8vo., 2*s.* 6*d.*

II. Report of the Malaria Expedition to West Africa, August, 1899. By RONALD ROSS, C.B., F.R.S., F.R.C.S., H. E. ANNETT, M.D., D.P.H. and E. E. AUSTEN. With Supplementary Reports by Major G. M. GILES, M.B. and R. FIELDING-OULD, M.B. 21*s.*

III. Report of the Malaria Expedition to Nigeria. Part I. Malarial Fever, etc. By H. E. ANNETT, M.D., J. EVERETT DUTTON, M.B. and J. H. ELLIOTT, M.D. 10*s.* 6*d.*

V. Part I. First Progress Report of the Campaign against Mosquitoes in Sierra Leone (1901). By RONALD ROSS, C.B., F.R.C.S., F.R.S. 8vo., 1*s.*

V. Part II. Second Progress Report of the Campaign against Mosquitoes in Sierra Leone. By M. LOGAN TAYLOR, M.B. 8vo., 1*s.*

VII. Report of the Yellow Fever Expedition to Pará (1900). By H. E. DURHAM, M.B., F.R.C.S., and the late WALTER MYERS, M.B. 4to., 7*s.* 6*d.*

VIII. Report on the Sanitary Conditions of Cape Coast Town, with Suggestions as to Improvement of same. By M. LOGAN TAYLOR, M.B. 8vo., sewed, 1*s.*

IX. Report on Malaria at Ismailia and Suez. By RONALD ROSS, C.B., F.R.C.S. 8vo., sewed, 1*s.*

X. Report of the Malaria Expedition to the Gambia, 1902. By J. EVERETT DUTTON, M.B., B.Ch. Vict., and an Appendix by F. V. THEOBALD, M.A. Demy 4to., 10*s.* 6*d.* net.

MISCELLANEOUS.

Notes on Sanitary Conditions obtaining in Pará. By the MEMBERS OF THE YELLOW FEVER EXPEDITION. 8vo., 1*s.*

PAGET.—Edited by STEPHEN PAGET.

SELECTED ESSAYS AND ADDRESSES. By Sir JAMES PAGET. 8vo., 12*s.* 6*d.* net

MEMOIRS AND LETTERS OF SIR JAMES PAGET, BART., F.R.S., D.C.L., late Sergeant-Surgeon to Her Majesty Queen Victoria. With Portrait. 8vo., 6*s.* net.

PICK.—SURGERY: a Treatise for Students and Practitioners. By T. PICKERING PICK, Consulting Surgeon to St. George's Hospital; Senior Surgeon to the Victoria Hospital for Children; H.M. Inspector of Anatomy in England and Wales. With 441 Illustrations. Medium 8vo., 25*s.*

POOLE.—COOKERY FOR THE DIABETIC. By W. H. and Mrs. POOLE. With Preface by Dr. PAVY. Fcap. 8vo., 2*s.* 6*d.*

MEDICINE AND SURGERY—*Continued.*

PROBYN-WILLIAMS.—A PRACTICAL GUIDE TO THE ADMINISTRATION OF ANÆSTHETICS. By R. J. PROBYN-WILLIAMS, M.D., Anæsthetist and Instructor in Anæsthetics at the London Hospital; Lecturer in Anæsthetics at the London Hospital Medical College, etc. With 34 Illustrations. Crown 8vo., 4*s.* 6*d.* net.

QUAIN.—QUAIN'S (SIR RICHARD) DICTIONARY OF MEDICINE. By Various Writers. Third Edition. Edited by H. MONTAGUE MURRAY, M.D., F.R.C.P., Joint Lecturer on Medicine, Charing Cross Medical School, and Physician to Out-Patients, Charing Cross Hospital; assisted by JOHN HAROLD, M.B., B.Ch., B.A.O., Physician to St. John's and St. Elizabeth's Hospital; and W. CECIL BOSANQUET, M.A., M.D., M.R.C.P., Physician to Out-Patients, Victoria Hospital for Children, Chelsea. With 21 Plates (14 in Colour) and numerous Illustrations in the Text. 8vo., 21*s.* net, buckram; or 30*s.* net, half-morocco.

QUAIN.—QUAIN'S (JONES) ELEMENTS OF ANATOMY. The Tenth Edition. Edited by EDWARD ALBERT SCHÄFER, F.R.S., Professor of Physiology in the University of Edinburgh; and GEORGE DANCER THANE, Professor of Anatomy in University College, London.

VOL. I., PART I. EMBRYOLOGY. By E. A. SCHÄFER, F.R.S. With 200 Illustrations. Royal 8vo., 9*s.*

VOL. I., PART II. GENERAL ANATOMY OR HISTOLOGY. By E. A. SCHÄFER, F.R.S. With 291 Illustrations. Royal 8vo., 12*s.* 6*d.*

VOL. II., PART I. OSTEOLOGY—ARTHROLOGY. By G. D. THANE. With 224 Illus. Royal 8vo., 11*s.*

VOL. II., PART II. MYOLOGY—ANGEIOLOGY. By G. D. THANE. With 199 Illustrations. Royal 8vo., 16*s.*

VOL. III., PART I. THE SPINAL CORD AND BRAIN. By E. A. SCHÄFER, F.R.S. With 139 Illustrations. Royal 8vo., 12*s.* 6*d.*

VOL. III., PART II. THE NERVES. By G. D. THANE. With 102 Illustrations. Royal 8vo., 9*s.*

VOL. III., PART III. THE ORGANS OF THE SENSES. By E. A. SCHÄFER, F.R.S. With 178 Illustrations. Royal 8vo., 9*s.*

VOL. III., PART IV. SPLANCHNOLOGY. By E. A. SCHÄFER, F.R.S., and JOHNSON SYMINGTON, M.D. With 337 Illustrations. Royal 8vo., 16*s.*

APPENDIX. SUPERFICIAL AND SURGICAL ANATOMY. By Professor G. D. THANE and Professor R. J. GODLEE, M.S. With 29 Illustrations. Royal 8vo., 6*s.* 6*d.*

SCHÄFER.—Works by E. A. SCHÄFER, F.R.S., Professor of Physiology in the University of Edinburgh.

THE ESSENTIALS OF HISTOLOGY. Descriptive and Practical. For the Use of Students. With 463 Illustrations. 8vo., 9*s.* net.

DIRECTIONS FOR CLASS WORK IN PRACTICAL PHYSIOLOGY: Elementary Physiology of Muscle and Nerve and of the Vascular and Nervous Systems. With 48 Diagrams and 24 pages of plain paper at end for Notes. 8vo., 3*s.* net.

SMALE AND COLYER.—DISEASES AND INJURIES OF THE TEETH, including Pathology and Treatment. By MORTON SMALE, M.R.C.S., L.S.A., L.D.S., Dental Surgeon to St. Mary's Hospital, Dean of the School, Dental Hospital of London, etc.; and J. F. COLYER, L.R.C.P., M.R.C.S., L.D.S., Dental Surgeon to Charing Cross Hospital and to the Dental Hospital of London. Second Edition Revised and Enlarged by J. F. COLYER. With 640 Illustrations. Large crown 8vo., 21*s.* net.

MEDICINE AND SURGERY—*Continued.*

SMITH (*H. F.*).—THE HANDBOOK FOR MIDWIVES. By HENRY FLY SMITH, B.A., M.B. Oxon., M.R.C.S. 41 Woodcuts. Cr. 8vo., 5*s.*

STEVENSON.—WOUNDS IN WAR: the Mechanism of their Production and their Treatment. By Surgeon-Colonel W. F. STEVENSON (Army Medical Staff), A.B., M.B., M.Ch. Dublin University, Professor of Military Surgery, Army Medical School, Netley. With 86 Illustrations. 8vo., 18*s.*

TAPPEINER. — INTRODUCTION TO CHEMICAL METHODS OF CLINICAL DIAGNOSIS. By Dr. H. TAPPEINER, Professor of Pharmacology and Principal of the Pharmacological Institute of the University of Munich. Translated by EDMOND J. MCWEENEY, M.A., M.D. (Royal Univ. of Ireland), L.R.C.P.I., etc. Crown 8vo., 3*s.* 6*d.*

WALLER.—Works by AUGUSTUS D. WALLER, M.D., Lecturer on Physiology at St. Mary's Hospital Medical School, London; late External Examiner at the Victorian University.

AN INTRODUCTION TO HUMAN PHYSIOLOGY. Third Edition, Revised. With 314 Illustrations. 8vo., 18*s.*

LECTURES ON PHYSIOLOGY. First Series. On Animal Electricity. 8vo., 5*s.* net.

VETERINARY MEDICINE, ETC.

FITZWYGRAM.—HORSES AND STABLES. By Lieut.-General Sir F. FITZWYGRAM, Bart. With 56 pages of Illustrations. 8vo., 3*s.* net.

STEEL.—Works by JOHN HENRY STEEL, F.R.C.V.S., F.Z.S., A.V.D., late Professor of Veterinary Science and Principal of Bombay Veterinary College.

A TREATISE ON THE DISEASES OF THE DOG; being a Manual of Canine Pathology. Especially adapted for the use of Veterinary Practitioners and Students. With 88 Illustrations. 8vo., 10*s* 6*d.*

A TREATISE ON THE DISEASES OF THE OX; being a Manual of Bovine Pathology. Especially adapted for the use of Veterinary Practitioners and Students. With 2 Plates and 117 Woodcuts. 8vo. 15*s.*

A TREATISE ON THE DISEASES OF THE SHEEP; being a Manual of Ovine Pathology for the use of Veterinary Practitioners and Students. With Coloured Plate and 99 Woodcuts. 8vo., 12*s.*

YOUATT.—Works by WILLIAM YOUATT.

THE HORSE. With 52 Wood Engravings. 8vo., 7*s.* 6*d.*

THE DOG. With 33 Wood Engravings. 8vo., 6*s.*

PHYSIOLOGY, BIOLOGY, ZOOLOGY, ETC.

(And see *MEDICINE AND SURGERY*, page 25.)

ANNANDALE AND ROBINSON.—FASCICULI MALAYENSES: Anthropological and Zoological Results of an Expedition to Perak and the Siamese Malay States, 1901-2. Undertaken by NELSON ANNANDALE and HERBERT C. ROBINSON, under the auspices of the University of Edinburgh and University College, Liverpool. With 17 Plates and 15 Illustrations in the text. Part I. 4to., 15*s.* net.

ASHBY.—NOTES ON PHYSIOLOGY FOR THE USE OF STUDENTS PREPARING FOR EXAMINATION. By HENRY ASHBY, M.D. Lond., F.R.C.P., Physician to the General Hospital for Sick Children, Manchester. With 148 Illustrations. 18mo., 5*s.*

BARNETT.—THE MAKING OF THE BODY: a Children's Book on Anatomy and Physiology. By Mrs. S. A. BARNETT. With 113 Illustrations. Crown 8vo., 1*s.* 9*d.*

BEDDARD.—Works by FRANK E. BEDDARD, M.A. Oxon.

ELEMENTARY PRACTICAL ZOOLOGY. With 93 Illustrations. Crown 8vo., 2*s.* 6*d.*

THE STRUCTURE AND CLASSIFICATION OF BIRDS. With 252 Illustrations. 8vo., 21*s.* net.

BIDGOOD.—A COURSE OF PRACTICAL ELEMENTARY BIOLOGY. By JOHN BIDGOOD, B.Sc., F.L.S. With 226 Illustrations. Crown 8vo., 4*s.* 6*d.*

BOSE.—RESPONSE IN THE LIVING AND NON-LIVING. By JAGADIS CHUNDER BOSE, M.A. (Cantab.), D.Sc. (Lond.), Professor, Presidency College, Calcutta. With 117 Illustrations. 8vo., 10*s.* 6*d.*

BRODIE.—THE ESSENTIALS OF EXPERIMENTAL PHYSIOLOGY. For the Use of Students. By T. G. BRODIE, M.D., Lecturer on Physiology, St. Thomas's Hospital Medical School. With 2 Plates and 177 Illustrations in the Text. 8vo., 6*s.* 6*d.*

CHAPMAN.—THE FORAMINIFERA: An Introduction to the Study of the Protozoa. By FREDERICK CHAPMAN, A.L.S., F.R.M.S. With 14 Plates and 42 Illustrations in the Text. 8vo., 9*s.* net.

FURNEAUX.—HUMAN PHYSIOLOGY. By W. FURNEAUX, F.R.G.S. With 218 Illustrations. Crown 8vo., 2*s.* 6*d.*

HUDSON AND GOSSE.—THE ROTIFERA, or 'WHEEL-ANIMACULES'. By C. T. HUDSON, LL.D., and P. H. GOSSE, F.R.S. With 30 Coloured and 4 Uncoloured Plates. In 6 Parts. 4to., 10*s.* 6*d.* each. Supplement 12*s.* 6*d.* Complete in 2 vols., with Supplement, 4to., £4 4*s.*

MACALISTER.—Works by ALEXANDER MACALISTER, M.D.

AN INTRODUCTION TO THE SYSTEMATIC ZOOLOGY AND MORPHOLOGY OF VERTEBRATE ANIMALS. With 41 Diagrams. 8vo., 10*s.* 6*d.*

ZOOLOGY OF THE INVERTEBRATE ANIMALS. With 77 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

ZOOLOGY OF THE VERTEBRATE ANIMALS. With 59 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

PHYSIOLOGY, BIOLOGY, ZOOLOGY, ETC.—*Continued.*

MACDOUGAL. — Works by DANIEL TREMBLY MACDOUGAL, Ph.D., Director of the Laboratories of the New York Botanical Garden.

PRACTICAL TEXT-BOOK OF PLANT PHYSIOLOGY. With 159 Illustrations. 8vo., 7*s.* 6*d.* net.

ELEMENTARY PLANT PHYSIOLOGY. With 108 Illustrations. Crown 8vo., 3*s.*

MOORE.—ELEMENTARY PHYSIOLOGY. By BENJAMIN MOORE, M.A., Lecturer on Physiology at the Charing Cross Hospital Medical School. With 125 Illustrations. Crown 8vo., 3*s.* 6*d.*

MORGAN.—ANIMAL BIOLOGY: an Elementary Text-Book. By C. LLOYD MORGAN, F.R.S., Principal of University College, Bristol. With 103 Illustrations. Crown 8vo., 8*s.* 6*d.*

SCHÄFER.—DIRECTIONS FOR CLASS WORK IN PRACTICAL PHYSIOLOGY: Elementary Physiology of Muscle and Nerve and of the Vascular and Nervous Systems. By E. A. SCHÄFER, LL.D., F.R.S., Professor of Physiology in the University of Edinburgh. With 48 Diagrams. 8vo., 3*s.* net.

THORNTON.—Works by JOHN THORNTON, M.A.

HUMAN PHYSIOLOGY. With 267 Illustrations, some Coloured. Crown 8vo., 6*s.*

ELEMENTARY BIOLOGY, Descriptive and Experimental. With numerous Illustrations. Crown 8vo., 3*s.* 6*d.*

BACTERIOLOGY.

CURTIS.—THE ESSENTIALS OF PRACTICAL BACTERIOLOGY: An Elementary Laboratory Book for Students and Practitioners. By H. J. CURTIS, B.S. and M.D. (Lond.), F.R.C.S. With 133 Illustrations. 8vo., 9*s.*

DHINGRA.—ELEMENTARY BACTERIOLOGY. By M. L. DHINGRA, M.D., C.M. Edin., Diplomate in State Medicine, University of Cambridge, etc. With Coloured Frontispiece and 26 Illustrations in the Text. Crown 8vo., 3*s.* net.

FRANKLAND.—MICRO-ORGANISMS IN WATER. Together with an Account of the Bacteriological Methods involved in their Investigation. Specially designed for the use of those connected with the Sanitary Aspects of Water-Supply. By PERCY FRANKLAND, Ph.D., B.Sc. (Lond.), F.R.S., and Mrs. PERCY FRANKLAND. With 2 Plates and Numerous Diagrams. 8vo., 16*s.* net.

FRANKLAND.—BACTERIA IN DAILY LIFE. By Mrs. PERCY FRANKLAND, F.R.M.S. Crown 8vo., 5*s.* net.

GOADBY.—THE MYCOLOGY OF THE MOUTH: A Text-Book of Oral Bacteria. By KENNETH W. GOADBY, L.D.S. Eng., etc.; Bacteriologist and Lecturer on Bacteriology, National Dental Hospital, etc. With 82 Illustrations. 8vo., 8*s.* 6*d.* net,

BACTERIOLOGY—*Continued.*

PLIMMER.—THE CHEMICAL CHANGES AND PRODUCTS RESULTING FROM FERMENTATION. By R. H. ADERS PLIMMER, D.Sc., Lond., Grocers' Research Student, Jenner Institute of Preventive Medicine. 8vo., 6*s.* net.

BOTANY.

AITKEN.—ELEMENTARY TEXT-BOOK OF BOTANY. By EDITH AITKEN, late Scholar of Girton College. With 400 Diagrams. Crown 8vo., 4*s.* 6*d.*

BENNETT AND MURRAY.—HANDBOOK OF CRYPTOGAMIC BOTANY. By ALFRED W. BENNETT, M.A., B.Sc., F.L.S., Lecturer on Botany at St. Thomas's Hospital; and GEORGE MURRAY, F.L.S., Keeper of Botany, British Museum. With 378 Illustrations. 8vo., 16*s.*

CROSS AND BEVAN.—Works by C. F. CROSS, E. J. BEVAN and C. BEADLE.

CELLULOSE: an Outline of the Chemistry of the Structural Elements of Plants. With Reference to their Natural History and Industrial Uses. With 14 Plates. Crown 8vo., 12*s.* net.

RESEARCHES ON CELLULOSE, 1895-1900. Cr. 8vo., 6*s.* net.

EDMONDS.—Works by HENRY EDMONDS, B.Sc., London.

ELEMENTARY BOTANY. With 342 Illustrations. Cr. 8vo., 2*s.* 6*d.*

BOTANY FOR BEGINNERS. With 85 Illustrations. Fcp. 8vo., 1*s.* 6*d.*

FARMER.—A PRACTICAL INTRODUCTION TO THE STUDY OF BOTANY: Flowering Plants. By J. BRETLAND FARMER, F.R.S., M.A., Professor of Botany in the Royal College of Science, London. With 121 Illustrations. Crown 8vo., 2*s.* 6*d.*

HOFFMANN.—ALPINE FLORA: for Tourists and Amateur Botanists. By Dr. JULIUS HOFFMANN. Translated by E. S. BARTON (Mrs. A. GEPP). With 40 Plates, containing 250 Coloured Figures, from Water-Colour Sketches by HERMANN FRIESE. With Text descriptive of the most widely distributed and attractive of Alpine Plants. 8vo., 7*s.* 6*d.* net.

KITCHENER.—A YEAR'S BOTANY. Adapted to Home and School Use. By FRANCES A. KITCHENER. With 195 Illustrations. Cr. 8vo., 5*s.*

LINDLEY AND MOORE.—THE TREASURY OF BOTANY. Edited by J. LINDLEY, M.D., F.R.S., and T. MOORE, F.L.S. With 20 Steel Plates and numerous Woodcuts. Two parts. Fcp. 8vo., 12*s.*

McNAB.—CLASS-BOOK OF BOTANY. By W. R. MCNAB.

MORPHOLOGY AND PHYSIOLOGY. With 42 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

CLASSIFICATION OF PLANTS. With 118 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

SORAUER.—A POPULAR TREATISE ON THE PHYSIOLOGY OF PLANTS. By Dr. PAUL SORAUER. Translated by F. E. WEISS, B.Sc., F.L.S. With 33 Illustrations. 8vo., 9*s.* net.

BOTANY—*Continued.*

THOMÉ AND BENNETT.—STRUCTURAL AND PHYSIOLOGICAL BOTANY. By OTTO WILHELM THOMÉ and by ALFRED W. BENNETT, B.Sc., F.L.S. With Coloured Map and 600 Woodcuts. Fcp. 8vo., 6*s.*

TUBEUF.—DISEASES OF PLANTS INDUCED BY CRYPTOGAMIC PARASITES. Introduction to the Study of Pathogenic Fungi, Slime Fungi, Bacteria and Algæ. By Dr. KARL FREIHERR VON TUBEUF, Privatdocent in the University of Munich. English Edition by WILLIAM G. SMITH, B.Sc., Ph.D., Lecturer on Plant Physiology, University of Edinburgh. With 330 Illustrations. Royal 8vo., 18*s.* net.

WATTS.—A SCHOOL FLORA. For the use of Elementary Botanical Classes. By W. MARSHALL WATTS, D.Sc. Lond. Cr, 8vo., 2*s.* 6*d.*

AGRICULTURE AND GARDENING.

ADDYMAN.—AGRICULTURAL ANALYSIS. A Manual of Quantitative Analysis for Students of Agriculture. By FRANK T. ADDYMAN, B.Sc. (Lond.), F.I.C. With 49 Illustrations. Crown 8vo., 5*s.* net.

COLEMAN AND ADDYMAN.—PRACTICAL AGRICULTURAL CHEMISTRY. By J. BERNARD COLEMAN, A.R.C.Sc., F.I.C., and FRANK T. ADDYMAN, B.Sc. (Lond.), F.I.C. With 24 Illustrations. Crown 8vo., 1*s* 6*d.* net.

HAGGARD.—Works by H. RIDER HAGGARD.

A FARMER'S YEAR: being his Commonplace Book for 1898. With 36 Illustrations by G. LEON LITTLE and three others. Crown 8vo., 7*s.* 6*d.* net.

RURAL ENGLAND: being an Account of Agricultural and Social Researches carried out in the years 1901 and 1902. With 23 Agricultural Maps and 75 Illustrations from Photographs. 2 vols. 8vo., 36*s.* net.

JEKYLL.—Works by GERTRUDE JEKYLL.

HOME AND GARDEN: Notes and Thoughts, Practical and Critical, of a Worker in both. With 53 Illustrations from Photographs. 8vo., 10*s.* 6*d.* net.

WOOD AND GARDEN: Notes and Thoughts, Practical and Critical, of a Working Amateur. With 71 Photographs. 8vo., 10*s.* 6*d.* net.

WEATHERS.—A PRACTICAL GUIDE TO GARDEN PLANTS. Containing Descriptions of the Hardiest and most Beautiful Annuals and Biennials, Hardy Herbaceous and Bulbous Perennials, Hardy Water and Bog Plants, Flowering and Ornamental Trees and Shrubs, Conifers, Hardy Ferns, Hardy Bamboos and other Ornamental Grasses; and also the best kinds of Fruit and Vegetables that may be grown in the Open Air in the British Islands, with Full and Practical Instructions as to Culture and Propagation. By JOHN WEATHERS, F.R.H.S., late Assistant Secretary to the Royal Horticultural Society, formerly of the Royal Gardens, Kew, etc. With 163 Diagrams. 8vo., 21*s.* net.

WEBB.—Works by HENRY J. WEBB, Ph.D., B.Sc. (Lond.).

ELEMENTARY AGRICULTURE. A Text-Book specially adapted to the requirements of the Board of Education, the Junior Examination of the Royal Agricultural Society, and other Elementary Examinations. With 34 Illustrations. Crown 8vo., 2*s.* 6*d.*

AGRICULTURE. A Manual for Advanced Science Students. With 100 Illustrations. Crown 8vo., 7*s.* 6*d.* net.

WORKS BY JOHN TYNDALL, D.C.L., LL.D., F.R.S.

LECTURES ON SOUND. With Frontispiece of Fog-Syren, and 203 other Woodcuts and Diagrams in the Text. Crown 8vo., 10*s.* 6*d.*

HEAT, A MODE OF MOTION. With 125 Woodcuts and Diagrams. Crown 8vo., 12*s.*

LECTURES ON LIGHT DELIVERED IN THE UNITED STATES IN 1872 AND 1873. With Portrait, Lithographic Plate, and 59 Diagrams. Crown 8vo., 5*s.*

FRAGMENTS OF SCIENCE: a Series of Detached Essays, Addresses, and Reviews. 2 vols. Crown 8vo., 16*s.*

Vol. I.—The Constitution of Naturé—Radiation—On Radiant Heat in Relation to the Colour and Chemical Constitution of Bodies—New Chemical Reactions produced by Light—On Dust and Disease—Voyage to Algeria to observe the Eclipse—Niagara—The Parallel Roads of Glen Roy—Alpine Sculpture—Recent Experiments on Fog-Signals—On the Study of Physics—On Crystalline and Slaty Cleavage—On Paramagnetic and Diamagnetic Forces—Physical Basis of Solar Chemistry—Elementary Magnetism—On Force—Contributions to Molecular Physics—Life and Letters of Faraday—The Copley Medallist of 187*c*—The Copley Medallist of 1871—Death by Lightning—Science and the Spirits.

Vol. II.—Reflections on Prayer and Natural Law—Miracles and Special Providences—On Prayer as a Form of Physical Energy—Vitality—Matter and Force—Scientific Materialism—An Address to Students—Scientific Use of the Imagination—The Belfast Address—Apology for the Belfast Address—The Rev. James Martineau and the Belfast Address—Fermentation, and its Bearings on Surgery and Medicine—Spontaneous Generation—Science and Man—Professor Virchow and Evolution—The Electric Light.

NEW FRAGMENTS. Crown 8vo., 10*s.* 6*d.*

Contents.—The Sabbath—Goethe's 'Farbenlehre'—Atoms, Molecules, and Ether Waves—Count Rumford—Louis Pasteur, his Life and Labours—The Rainbow and its Congeners—Address delivered at the Birkbeck Institution on October 22, 1884—Thomas Young—Life in the Alps—About Common Water—Personal Recollections of Thomas Carlyle—On Unveiling the Statue of Thomas Carlyle—On the Origin, Propagation, and Prevention of Phthisis—Old Alpine Jottings—A Morning on Alp Lusgen.

ESSAYS ON THE FLOATING MATTER OF THE AIR IN RELATION TO PUTREFACTION AND INFECTION. With 24 Woodcuts. Crown 8vo., 7*s.* 6*d.*

RESEARCHES ON DIAMAGNETISM AND MAGNECRYSTALLIC ACTION; including the Question of Diamagnetic Polarity. Crown 8vo., 12*s.*

NOTES OF A COURSE OF NINE LECTURES ON LIGHT, delivered at the Royal Institution of Great Britain, 1869. Crown 8vo., 1*s.* 6*d.*

NOTES OF A COURSE OF SEVEN LECTURES ON ELECTRICAL PHENOMENA AND THEORIES, delivered at the Royal Institution of Great Britain, 1870. Crown 8vo., 1*s.* 6*d.*

LESSONS IN ELECTRICITY AT THE ROYAL INSTITUTION 1875-1876. With 58 Woodcuts and Diagrams. Crown 8vo., 2*s.* 6*d.*

THE GLACIERS OF THE ALPS: being a Narrative of Excursions and Ascents. An Account of the Origin and Phenomena of Glaciers, and an Exposition of the Physical Principles to which they are related. With 7 Illustrations. Crown 8vo., 6*s.* 6*d.* net.

HOURS OF EXERCISE IN THE ALPS. With 7 Illustrations. Crown 8vo., 6*s.* 6*d.* net.

FARADAY AS A DISCOVERER. Crown 8vo., 3*s.*, 6*d.*

TEXT-BOOKS OF SCIENCE.

PHOTOGRAPHY. By Sir WILLIAM DE WIVELESLIE ABNEY, K.C.B., F.R.S. With 134 Illustrations. Fcp. 8vo., 5*s.*

THE STRENGTH OF MATERIALS AND STRUCTURES. By Sir J. ANDERSON, C.E. With 66 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

RAILWAY APPLIANCES. By Sir JOHN WOLFE BARRY, K.C.B., F.R.S., M.I.C.E. With 218 Illustrations. Fcp. 8vo., 4*s.* 6*d.*

INTRODUCTION TO THE STUDY OF INORGANIC CHEMISTRY. By WILLIAM ALLEN MILLER, M.D., LL.D., F.R.S. With 72 Illustrations. 3*s.* 6*d.*

QUANTITATIVE CHEMICAL ANALYSIS. By T. E. THORPE, C.B., F.R.S., Ph.D. With 88 Illustrations. Fcp. 8vo., 4*s.* 6*d.*

QUALITATIVE ANALYSIS AND LABORATORY PRACTICE. By T. E. THORPE, C.B., Ph.D., F.R.S., and M. M. PATTISON MUIR, M.A. and F.R.S.E. With Plate of Spectra and 57 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

INTRODUCTION TO THE STUDY OF CHEMICAL PHILOSOPHY. By WILLIAM A. TILDEN, D.Sc., London, F.R.S. With Illustrations. Fcp. 8vo., 5*s.* With Answers to Problems. Fcp. 8vo., 5*s.* 6*d.*

ELEMENTS OF ASTRONOMY. By Sir R. S. BALL, LL.D., F.R.S. With 130 Illustrations. Fcp. 8vo., 6*s.* 6*d.*

SYSTEMATIC MINERALOGY. By HILARY BAUERMAN, F.G.S. With 373 Illustrations. Fcp. 8vo,, 6*s.*

DESCRIPTIVE MINERALOGY. By HILARY BAUERMAN, F.G.S., etc. With 236 Illustrations. Fcp. 8vo., 6*s.*

METALS: THEIR PROPERTIES AND TREATMENT. By A. K. HUNTINGTON and W. G. MCMILLAN. With 122 Illustrations. Fcp. 8vo., 7*s.* 6*d.*

THEORY OF HEAT. By J. CLERK MAXWELL, M.A., LL.D., Edin., F.R.SS., L. & E. With 38 Illustrations. Fcp. 8vo., 4*s.* 6*d.*

PRACTICAL PHYSICS. By R. T. GLAZEBROOK, M.A., F.R.S., and W. N. SHAW, M.A. With 134 Illustrations. Fcp. 8vo., 7*s.* 6*d.*

PRELIMINARY SURVEY AND ESTIMATES. By THEODORE GRAHAM GRIBBLE, Civil Engineer. Including Elementary Astronomy, Route Surveying, Tacheometry, Curve-ranging, Graphic Mensuration, Estimates, Hydrography and Instruments. With 133 Illustrations. Fcp. 8vo., 7*s.* 6*d.*

ALGEBRA AND TRIGONOMETRY. By WILLIAM NATHANIEL GRIFFIN, B.D. 3*s.* 6*d.* Notes on, with Solutions of the more difficult Questions. Fcp. 8vo., 3*s.* 6*d.*

THE STEAM ENGINE. By GEORGE C. V. HOLMES, Secretary of the Institution of Naval Architects. With 212 Illustrations. Fcp. 8vo., 6*s.*

ELECTRICITY AND MAGNETISM. By FLEEMING JENKIN, F.R.SS., L. & E. With 177 Illustrations. Fcp. 8vo., 3*s.* 6*d.*

THE ART OF ELECTRO-METALLURGY. By G. GORE, LL.D., F.R.S. With 56 Illus. Fcp. 8vo., 6*s.*

TELEGRAPHY. By Sir W. H. PREECE, K.C.B., F.R.S., M.I.C.E., and Sir J. SIVEWRIGHT, M.A., K.C.M.G. With 267 Illustrations. Fcp. 8vo., 6*s.*

PHYSICAL OPTICS. By R. T. GLAZEBROOK, M.A., F.R.S. With 183 Illustrations. Fcp. 8vo., 6*s.*

TECHNICAL ARITHMETIC AND MENSURATION. By CHARLES W. MERRIEFIELD, F.R.S. 3*s.* 6*d.* Key, by the Rev. JOHN HUNTER, M.A. Fcp. 8vo., 3*s.* 6*d.*

THE STUDY OF ROCKS. By FRANK RUTLEY, F.G.S. With 6 Plates and 88 Illustrations Fcp. 8vo., 4*s.* 6*d.*

WORKSHOP APPLIANCES, including Descriptions of some of the Machine Tools used by Engineers. By C. P. B. SHELLEY, M.I.C.E. With 323 Illustrations. Fcp. 8vo., 5*s.*

ELEMENTS OF MACHINE DESIGN. By W. CAWTHORNE UNWIN, F.R.S., B.Sc., M.I.C.E.

PART I. General Principles, Fastenings and Transmissive Machinery. With 345 Illustrations. Fcp. 8vo., 7*s.* 6*d.*

PART II. Chiefly on Engine Details. With 259 Illustrations. Fcp. 8vo., 6*s.*

STRUCTURAL AND PHYSIOLOGICAL BOTANY. By OTTO WILHELM THOMÉ, and A. W. BENNETT, M.A., B.Sc., F.L.S. With 600 Illustrations. Fcp. 8vo., 6*s.*

PLANE AND SOLID GEOMETRY. By H. W. WATSON, M.A. Fcp. 8vo., 3*s.* 6*d.*

ADVANCED SCIENCE MANUALS.

BUILDING CONSTRUCTION. By the Author of 'Rivington's Notes on Building Construction'. With 385 Illustrations and an Appendix of Examination Questions. Crown 8vo., *4s. 6d.*

THEORETICAL MECHANICS. Solids, including Kinematics, Statics, and Kinetics. By A. THORNTON, M.A., F.R.A.S. With 220 Illustrations, 130 Worked Examples, and over 900 Examples from Examination Papers, etc. Crown 8vo., *4s. 6d.*

HEAT. By MARK R. WRIGHT, Hon. Inter. B.Sc. (Lond.). With 136 Illustrations and numerous Examples and Examination Papers. Crown 8vo., *4s. 6d.*

LIGHT. By W. J. A. EMTAGE, M.A. With 232 Illustrations. Cr. 8vo., *6s.*

MAGNETISM AND ELECTRICITY. By ARTHUR WILLIAM POYSER, M.A. With 317 Illustrations. Crown 8vo., *4s. 6d.*

INORGANIC CHEMISTRY, THEORETICAL AND PRACTICAL. By WILLIAM JAGO, F.C.S., F.I.C. With Plate of Spectra and 78 Woodcuts. Crown 8vo., *4s. 6d.*

GEOLOGY: a Manual for Students in Advanced Classes and for General Readers. By CHARLES BIRD, B.A. (Lond.), F.G.S. With over 300 Illustrations, a Geological Map of the British Isles (coloured), and a set of Questions for Examination. Crown 8vo., *7s. 6d.*

HUMAN PHYSIOLOGY: a Manual for Students in advanced Classes of the Science and Art Department. By JOHN THORNTON, M.A. With 268 Illustrations, some of which are Coloured, and a set of Questions for Examination. Crown 8vo., *6s.*

PHYSIOGRAPHY. By JOHN THORNTON, M.A. With 11 Maps, 255 Illustrations, and Coloured Map of Ocean Deposits. Crown 8vo., *4s. 6d.*

AGRICULTURE. By HENRY J. WEBB, Ph.D., B.Sc. With 100 Illustrations. Crown 8vo., *7s. 6d.* net.

HYGIENE. By J. LANE NOTTER, M.A., M.D., Professor of Hygiene in the Army Medical School, Netley, Colonel, Royal Army Medical Corps; and R. H. FIRTH, F.R.C.S., late Assistant Professor of Hygiene in the Army Medical School, Netley, Major, Royal Army Medical Corps. With 95 Illustrations. Crown 8vo., *3s. 6d.*

ELEMENTARY SCIENCE MANUALS.

PRACTICAL, PLANE, AND SOLID GEOMETRY. By I. H. MORRIS and JOSEPH HUSBAND. Fully Illustrated with Drawings. Crown 8vo., *2s. 6d.*

GEOMETRICAL DRAWING FOR ART STUDENTS. Embracing Plane Geometry and its Applications, the Use of Scales, and the Plans and Elevations of Solids. By I. H. MORRIS. Crown 8vo., *2s.*

TEXT-BOOK ON PRACTICAL, SOLID, OR DESCRIPTIVE GEOMETRY. By DAVID ALLAN LOW (Whitworth Scholar). Part I. Crown 8vo., *2s.* Part II. Crown 8vo., *3s.*

AN INTRODUCTION TO MACHINE DRAWING AND DESIGN. By DAVID ALLAN LOW. With 153 Illustrations. Crown 8vo., *2s. 6d.*

BUILDING CONSTRUCTION AND DRAWING. By EDWARD J. BURRELL. With 308 Illustrations and Working Drawings. Crown 8vo., *2s. 6d.*

AN ELEMENTARY COURSE OF MATHEMATICS. Containing Arithmetic; Euclid (Book I., with Deductions and Exercises); and Algebra. Crown 8vo., *2s. 6d.*

ELEMENTARY SCIENCE MANUALS—*Continued.*

THEORETICAL MECHANICS. Including Hydrostatics and Pneumatics. By J. E. TAYLOR, M.A., B.Sc. With numerous Examples and Answers, and 175 Diagrams and Illustrations. Crown 8vo., *2s. 6d.*

THEORETICAL MECHANICS—SOLIDS. By J. E. TAYLOR, M.A., B.Sc. (Lond.). With 163 Illustrations, 120 Worked Examples, and over 500 Examples from Examination Papers, etc. Crown 8vo., *2s. 6d.*

THEORETICAL MECHANICS—FLUIDS. By J. E. TAYLOR, M.A., B.Sc. (Lond.). With 122 Illustrations, numerous Worked Examples, and about 500 Examples from Examination Papers, etc. Crown 8vo., *2s. 6d.*

A MANUAL OF MECHANICS. With 138 Illustrations and Diagrams, and 188 Examples taken from Examination Papers, with Answers. By T. M. GOODEVE, M.A. Crown 8vo., *2s. 6d.*

SOUND, LIGHT, AND HEAT. By MARK R. WRIGHT, M.A. With 160 Diagrams and Illustrations. Crown 8vo., *2s. 6d.*

METALLURGY: an Elementary Text-Book. By E. L. RHEAD. With 94 Illustrations. Crown 8vo., *3s. 6d.*

PHYSICS. Alternative Course. By MARK R. WRIGHT, M.A. With 242 Illustrations. Crown 8vo., *2s. 6d.*

MAGNETISM AND ELECTRICITY. By A. W. POYSER, M.A. With 235 Illustrations. Crown 8vo., *2s. 6d.*

PROBLEMS AND SOLUTIONS IN ELEMENTARY ELECTRICITY AND MAGNETISM. By W. SLINGO and A. BROOKER. Embracing a Complete Set of Answers to the South Kensington Papers for the years 1885-1899, and a Series of Original Questions. With 67 Original Illustrations. Crown 8vo., *2s.*

ELEMENTARY PHYSIOGRAPHY. By J. THORNTON, M.A. With 13 Maps and 295 Illustrations. With Appendix on Astronomical Instruments and Measurements. Crown 8vo., *2s. 6d.*

ORGANIC CHEMISTRY: the Fatty Compounds. By R. LLOYD WHITELEY, F.I.C., F.C.S. With 45 Illustrations. Crown 8vo., *3s. 6d.*

INORGANIC CHEMISTRY, THEORETICAL AND PRACTICAL By WILLIAM JAGO, F.C.S., F.I.C. With 63 Illustrations and numerous Questions and Exercises. Fcp. 8vo., *2s. 6d.*

AN INTRODUCTION TO PRACTICAL INORGANIC CHEMISTRY. By WILLIAM JAGO, F.C.S., F.I.C. Crown 8vo., *1s. 6d.*

PRACTICAL CHEMISTRY: the Principles of Qualitative Analysis. By WILLIAM A. TILDEN, D.Sc. Fcp. 8vo., *1s. 6d.*

ELEMENTARY INORGANIC CHEMISTRY. By WILLIAM FURNEAUX, F.R.G.S. Crown 8vo., *2s. 6d.*

ELEMENTARY GEOLOGY. By CHARLES BIRD, B.A., F.G.S. With Coloured Geological Map of the British Islands, and 247 Illustrations. Crown 8vo., *2s. 6d.*

HUMAN PHYSIOLOGY. By WILLIAM FURNEAUX, F.R.G.S. With 218 Illustrations. Crown 8vo., *2s. 6d.*

A COURSE OF PRACTICAL ELEMENTARY BIOLOGY. By J. BIDGOOD, B.Sc. With 226 Illustrations. Crown 8vo., *4s. 6d.*

ELEMENTARY BOTANY, THEORETICAL AND PRACTICAL. By HENRY EDMONDS, B.Sc. With 342 Illustrations. Crown 8vo., *2s. 6d.*

STEAM. By WILLIAM RIPPER, Member of the Institution of Civil Engineers. With 185 Illustrations. Crown 8vo., *2s. 6d.*

AGRICULTURE. By HENRY J. WEBB, Ph.D. With 34 Illustrations. Crown 8vo., *2s. 6d.*

THE LONDON SCIENCE CLASS-BOOKS.

Edited by G. CAREY FOSTER, F.R.S., and by Sir PHILIP MAGNUS, B.Sc., B.A., of the City and Guilds of London Institute.

ASTRONOMY. By Sir ROBERT STAWELL BALL, LL.D., F.R.S With 41 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

MECHANICS. By SIR ROBERT STAWELL BALL, LL.D., F.R.S. With 89 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

THE LAWS OF HEALTH. By W. H. CORFIELD, M A., M.D., F.R.C.P. With 22 Illustrations. Fcp. 8vo., 1*s.* 6*d.*

MOLECULAR PHYSICS AND SOUND. By FREDERICK GUTHRIE, F.R.S. With 91 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

GEOMETRY, CONGRUENT FIGURES. By O. HENRICI, Ph.D., F.R.S. With 141 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

ZOOLOGY OF THE INVERTEBRATE ANIMALS. By ALEXANDER MACALISTER, M.D. With 77 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

ZOOLOGY OF THE VERTEBRATE ANIMALS. By ALEXANDER MACALISTER, M.D. With 59 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

HYDROSTATICS AND PNEUMATICS. By Sir PHILIP MAGNUS, B.Sc., B.A. With 79 Diagrams. Fcp. 8vo., 1*s.* 6*d.* (To be had also *with Answers*, 2*s.*) The Worked Solutions of the Problems. 2*s.*

BOTANY. Outlines of the Classification of Plants. By W. R. MCNAB, M.D. With 118 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

BOTANY. Outlines of Morphology and Physiology. By W. R. MCNAB, M.D. With 42 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

THERMODYNAMICS. By RICHARD WORMELL, M.A., D.Sc. With 41 Diagrams. Fcp. 8vo., 1*s.* 6*d.*

PRACTICAL ELEMENTARY SCIENCE SERIES.

ELEMENTARY PRACTICAL PHYSIOGRAPHY. (Section I.) By JOHN THORNTON, M.A. With 215 Illustrations and a Coloured Spectrum. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY PRACTICAL PHYSIOGRAPHY. (Section II.). A Course of Lessons and Experiments in Elementary Science for the King's Scholarship Examination. By JOHN THORNTON, M.A. With 98 Illustrations and a Series of Questions. Crown 8vo., 2*s.* 6*d.*

PRACTICAL DOMESTIC HYGIENE. Stage I. By J. LANE NOTTER, M.A., M.D., and R. H. FIRTH, F.R.C.S. With 83 Illustrations. Crown 8vo., 2*s.* 6*d.*

A PRACTICAL INTRODUCTION TO THE STUDY OF BOTANY: Flowering Plants. By J. BRETLAND FARMER, F.R.S., M.A. With 121 Illustrations. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY PRACTICAL HYGIENE. Section I. By WILLIAM S. FURNEAUX. With Appendix to meet the requirements of the 1902 Syllabus of the Board of Education. With 146 Illustrations. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY PRACTICAL SOUND, LIGHT, AND HEAT. Stage I. By JOSEPH S. DEXTER. With 152 Illustrations. Crown 8vo., 2*s.* 6*d.*

PRACTICAL MATHEMATICS. Stage I. By A. G. CRACKNELL, M.A., B.Sc. Crown 8vo., 3*s.* 6*d.*

ELEMENTARY PRACTICAL CHEMISTRY. Stage I. By G. S. NEWTH, F.I.C., F.C.S. With 108 Illustrations and 254 Experiments. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY PRACTICAL PHYSICS. Stage I. By W. WATSON, D.Sc. With 120 Illustrations and 193 Exercises. Crown 8vo., 2*s.* 6*d.*

ELEMENTARY BIOLOGY. By JOHN THORNTON, M.A. With 108 Illustrations. Crown 8vo., 3*s.* 6*d.*

THE ELEMENTS OF GEOMETRICAL DRAWING: an Elementary Text-book on Practical Plane Geometry, including an Introduction to Solid Geometry. By HENRY J. SPOONER, C.E., M. Inst. M.E. Crown 8vo., 3*s.* 6*d.*

5,000/9/03.