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RAPID METHOD FOR THE ESTIMATION OF TITANIUM IN TITANIFEROUS IRON ORES.

By JOHN WADDELL, D.Sc.

In the analysis of titaniferous ore, fusion with sodium peroxide has recently come into practice in commercial laboratories; but, so far as I have seen, this method has not appeared in text-books, or in the literature, and it was only after I had used it myself for some time that I found it was being employed by others. The method is easy and satisfactory, at all events if the percentage of titanium only is desired.

Silver, copper, nickel, and iron crucibles were used. Nickel is least satisfactory, because in the later stage of filtering trouble with nickel sulphide is likely to arise. Copper and silver are little, if at all, superior to iron, except that their use avoids the filtration of iron sulphide.

The disintegration of the fused mass takes place readily when the crucible containing it is put into water. There is a large precipitate of ferric hydroxide, with or without other things. I have not determined how little sodium peroxide will serve for fusion, but eight times the amount of ore is certainly enough. The addition of sulphuric acid until there is an excess of about 2 c.c. will dissolve this hydroxide. Sometimes the addition of a little hydrogen peroxide assists solution.

Possibly there may be some black flakes of copper or iron oxide resulting from the action of sodium peroxide on the crucible. These probably do not contain titanium; but if desired they may easily be dissolved by a little hydrochloric acid after the supernatant liquid is poured off.

Instead of sodium peroxide, borax may be used for fusion, but I know of no advantage, except that a platinum crucible may be used. The fusion takes about the same length of time as with sodium peroxide, but the later disintegration and solution take longer.

W. M. Thornton (*Amer. J. Sci.*, 1914, **37**, 407; ANALYST, 1914, **39**, 332; 1916, **41**, 288) describes experiments on the precipitation of titanium by means of the ammonium salt of nitrosophenyl-hydroxy-lamine (cupferron), by which the compound $[C_6H_5.N(NO)O_4]Ti$ is thrown down as a yellow precipitate.

In this process it is necessary to precipitate the iron free from titanium. This may be done by the addition of tartaric acid to prevent titanium being thrown down by ammonia; the iron is then reduced to the ferrous state by a stream of sulphuretted hydrogen, and precipitated as sulphide by addition of ammonia and further passage of hydrogen sulphide. Thornton recommends four times as much tartaric acid as of the oxides it is required to keep in solution. A large quantity of tartaric acid, so far as I have found, does not affect the result, except as I shall point out later, and I have used four times as much as the total amount of ore.

Fresenius details regarding the filtration of iron sulphide cover the important points. After hydrogen sulphide had been passed to saturation of the ammonia originally introduced, more ammonia, equal to the first excess above neutralisation, was added, and the covered flask placed in a steam bath, which caused the precipitate to settle. Filtration was carried out under diminished pressure through a close paper in a Buchner funnel, and the precipitate washed with water containing a little ammonia in which less than the equivalent amount of hydrogen sulphide had been absorbed. About 40 c.c. of sulphuric acid (1 : 1) was added to the filtrate, making a large excess of free acid, and the whole boiled some time to drive off the hydrogen sulphide and to coagulate the sulphur which was removed by filtration. The solution, now approximately 300 c.c., can have the titanium precipitated by an aqueous 6 per cent. solution of "cupferron." The "cupferron" by calculation is found to be about fifteen times the titanium to be precipitated. Excess is indicated by the precipitation of a white substance instead of the yellow titanium compound. The precipitate after settling can be filtered in a Buchner funnel, and may be washed with water or dilute hydrochloric acid. The precipitate is ignited in the ordinary way in a platinum crucible and weighed as TiO_2.

Instead of precipitation with "cupferron" the solution may be made up to 500 c.c. and an aliquot portion removed, the amount of which will depend on the percentage of titanium in the ore. This portion is then oxidised by hydrogen peroxide, made up to 100 c.c., and compared with a standard solution of titanium made up in the same way. It was found, by a separate test, that 4 grms. of tartaric acid added to a solution containing 0·005 grm. of TiO_2 reduced the colour produced by hydrogen peroxide, the volume being 100 c.c., and in three or four days the solution was colourless.

For an ore containing 10 per cent. of TiO_2, only 25 c.c. of the 500 c.c. of solution would be required. This would contain only 0·2 grm. of tartaric acid, which would have very little, if any, influence. As a precaution, however, the same quantity of tartaric acid may be added to the standard.

In a standard magnetite of the Washington Bureau of Standards, said to contain 0·99 per cent. of TiO_2, 0·91 per cent. was found by the colorimetric method, no tartaric acid having been added to the standard solution of TiO_2 with which the ore was compared. If the tartaric acid added to the magnetite, which in the portion used amounted to 0·4 grm., had any effect, it would make the percentage found in the ore too low. In another estimation, where borax was used for fusion, 1·02 per cent. of TiO_2 was found. The "cupferron" estimation was made with what was left of the solution in each case after the portion for the colorimetric test had been removed, and was found in one case to give 0·86 per cent., and in the other 1·20 per cent. TiO_2. The actual loss of TiO_2 in the one case was a little less than 1 mgrm., and in the other case the gain almost 2 mgrms.

In an ore containing between 13 per cent. and 14 per cent. of TiO_2 I found from two separate samples by the colorimetric method 13·6 per cent. and 13·7 per cent. of TiO_2. One of the students in my laboratory in another sample found 13·67 per cent. by the "cupferron" precipitation. The time required for this estimation depends mainly upon the boiling with sulphuric acid and the settling of the "cupferron" precipitate. The actual work takes about two hours. If the colorimetric method is used, three or four hours should be enough.

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THE NECESSITY FOR A SUPPLY OF PURE AGRICULTURAL LIME.

BY G. S. ROBERTSON, M.Sc., A.I.C.

FROM time to time samples of ground lime, lump lime, and ground carbonate of lime have been received for analysis from farmers in Essex. The most striking feature of the samples is the very unsatisfactory nature of those purporting to be ground lime. Generally the farmer purchases the lime through a local agent, who in turn procures it from the burners. The local supply of agricultural lime for Essex is limited, so that most of it comes from neighbouring counties. The following table (see Table 1) shows a partial analysis of twenty samples of ground lime received:

These figures suggest that the ground lime which reaches the farmer is, in many cases, unsatisfactory. A first-class "lime" should contain at least 80 per cent. of quicklime, and it is not too much to expect that this standard should be maintained. Of the above twenty samples only three comply with this standard. Thirteen samples contain less than 70 per cent., whilst six samples contain less than 60 per cent. of calcium oxide.

Partly owing to the extensive breaking-up of grassland, and partly owing to other causes, the staff of the Agricultural Institute are frequently asked for advice as to the best means to adopt to secure good quality ground lime. As a rule ground lime is preferred to lump lime because of the saving of labour. The difficulty the farmer has is that, owing to the sale of lime not coming within the scope of the Fertiliser and Feeding Stuffs Act, he has no security that the ground lime he orders, no matter what price per ton is paid for it, will be of good quality, and he has no redress should he find that the ground lime supplied to him is a very inferior article. Most leaflets dealing with ground lime recommend the farmers to use lime containing at least 80 per cent. caustic lime, but nevertheless it is very seldom, in Essex, at all events, that he is able to secure such good quality lime.

TABLE I.

Sample Number.	Total Calcium Oxide.	Silica, Sand, etc.	Carbon Dioxide.	Equivalent of CO_2 as Calcium Carbonate.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	83·35	7·50	1·00	2·27
2	63·20	3·00	16·04	36·45
3	46·38	1·00	27·27	62·10
4	46·72	14·98	4·15	9·42
5	66·75	—	16·66	37·82
6	76·97	0·50	3·60	8·17
7	46·18	—	—	—
8	75·12	—	—	—
9	67·08	9·00	9·42	21·22
10	64·28	11·45	4·17	11·12
11	67·40	8·32	1·52	2·71
12	66·50	6·10	2·30	5·22
13	61·93	—	—	—
14	77·00	—	—	—
15	50·28	—	—	—
16	80·00	—	—	—
17	77·25	—	—	—
18	58·05	—	—	—
19	57·41	—	—	—
20	81·45	—	—	—

It is possible, of course, that the poor quality of the samples in Table I. may be due to the lime having been stored on the farm premises under unsuitable conditions before the sample was withdrawn and sent to the Institute. In order to clear up this point and obtain reliable information concerning the quality of the supplies, the following circular letter was sent out to all manufacturers who were in a position to supply ground lime, lump lime, or carbonate of lime for agricultural purposes in Essex :

"I understand that you supply lime in various forms for agricultural purposes, and should be extremely obliged if you would kindly let me have at your early convenience information on the following points :

"1. *Quicklime.*

"(*a*) The total percentage of calcium oxide.

"(*b*) The price per ton on Chelmsford Station.

"2. *Ground Quicklime.*

"The same as under No. 1 and in addition the degree of fineness of grinding.

"3. *Ground Limestone and Chalk.*

"(*a*) The percentage of calcium carbonate.

"(*b*) The price per ton on Chelmsford Station.

"I should also like to have a representative sample of any of these materials you are in a position to supply to farmers in Essex."

In due course samples of ground lime, lump lime, and ground carbonate of lime, and also a copy of the analyses the firm had had made of their materials, were received. In all cases, however, the manufacturers clearly stated that they did not guarantee these analyses, nor yet were they prepared to give any guarantee concerning the fineness of grinding of their ground lime and carbonate of lime. The following are three typical examples of the analyses sent out by the manufacturers, the material they were supplying purporting to be up to this standard, although, of course, they were not prepared to give a guarantee that such was the case:

TABLE II.

	Analysis No. 1.	No. 2.	No. 3.
	Per Cent.	Per Cent.	Per Cent.
Quick lime	85·5	91·76	95·57
Oxide of iron	2·6	—	—
Alumina	3·4	—	—
Magnesia	0·85	0·72	—
Moisture, etc.	2·05	—	2·68
Silica	5·6	—	1·75

The analysis of the samples of ground lime received from the burners is given in Table III.

TABLE III.

Sample Number.	Total Calcium Oxide.	Carbon Dioxide.	Sand and Silica.	Equivalent as Calcium Carbonate.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	82·23	0·20	0·34	0·46
2	69·75	1·52	12·88	3·46
3	63·85	5·20	5·71	11·83
4	66·25	4·32	5·10	9·82
5	75·35	2·24	0·60	5·10
6	67·38	2·91	10·08	6·60
7	90·55	2·58	2·57	5·86
8	70·98	1·52	4·52	3·46
9	80·25	4·00	3·29	9·08
10	89·25	0·00	4·20	0·00
11	57·51	12·87	15·67	29·25
12	77·98	0·20	2·96	0·46
13	66·40	4·08	14·11	9·26
14	66·05	2·57	18·60	5·85
15	75·02	6·37	6·85	14·52
16	73·02	9·42	7·27	21·47
17	75·75	9·29	6·02	21·12
18	67·38	4·02	20·17	9·10

No. 8 in Table III. represents the actual analysis of the ground lime supplied by the firm who purported to sell lime corresponding to Analysis 1 in Table II. Similarly No. 2 in Table III. is representative of No. 2 in Table II. and sample No. 9 in Table III. of No. 3 in Table II.

The results recorded in Table III. are far from satisfactory, and show that there is a legitimate grievance against the manufacturers of ground agricultural lime. Out of 18 samples analysed only 4 samples, or 22 per cent., would be called first-class samples—that is, contain 80 per cent. or more of calcium oxide. Eight samples, or 44 per cent., contain less than 70 per cent. of calcium oxide, and this under conditions which are obviously favourable to the manufacturer.

No success whatever attended the attempts which were made to persuade the burners to consent to give a reasonable guarantee of the purity of their ground lime.

The matter was left at this stage for some months until the breaking-up of grass-land on an extensive scale brought the subject again into prominence. In July, 1917, a further circular letter was sent to the manufacturers, asking whether they were prepared to give a guarantee that the percentage of lime in the ground lime and lump lime should fall within certain limits—for example, between 80 and 90 per cent. of calcium oxide (lime) and, in the case of ground chalk or limestone, a guarantee as to the percentage of calcium carbonate.

This time the replies were more hopeful. One big firm expressed its readiness to give a guarantee of 90 per cent. purity with all the ground lime supplied to farmers, and stated that in their opinion it was not necessary to allow such a wide margin as that suggested—80 to 90 per cent. One other firm expressed its willingness to fulfil these conditions, and to supply ground lime to Essex if they could secure a permit from the Ministry of Munitions to enable them to put in working order new lime kilns.

Lump Lime.

Table IV. gives the analyses of the samples of lump lime received direct from the manufacturers at the same time as the samples of ground lime shown in Table III. :

TABLE IV.

Sample Number.	Total Calcium Oxide.	Carbon Dioxide.	Sand and Silica.	Equivalent as Calcium Carbonate.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	93·42	0·32	0·28	0·73
2	83·41	0·28	4·04	0·63
3	88·10	0·97	3·53	2·20
4	62·58	0·16	29·31	0·36
5	91·22	0·95	1·60	2·16
6	94·48	1·08	0·32	2·46
7	87·22	0·39	5·18	0·88
8	75·95	0·54	11·18	1·23
9	87·82	0·58	3·80	1·32
10	84·30	0·46	8·33	1·06

The quality of the lump lime is far superior to that of the ground lime. Only two of the samples contain less than 80 per cent. of calcium oxide, and only one, No. 4, is a really bad sample. The great disadvantage of lump lime is, of course, the labour entailed in slaking and spreading it on the land. It is, however, undoubtedly the purer material to purchase.

Ground Carbonate of Lime.

Five samples of ground carbonate of lime were received and examined, and in only one case did the material prove to be less than 90 per cent. pure. The fineness of grinding was, on the whole, quite satisfactory, but the price per unit of calcium oxide was more than that of ground lime, being, on an average, one-third greater.

The importance of an adequate and pure supply of ground lime and carbonate of lime for Essex soils may be judged from the following table, which gives the percentage of carbonate of lime in 93 samples of soil drawn from various parts of the county:

TABLE V.

26	samples of	soil, or	28·0 %,	contained	no carbonate of lime whatever.			
40	,,	,,	43·0 %	,,	less than	0·05 %	of carbonate	of lime.
50	,,	,,	53·8 %	,,	,,	0·10 %	,,	,,
60	,,	,,	64·5 %	,,	,,	0·25 %	,,	,,
63	,,	,,	67·7 %	,,	,,	0·50 %	,,	,,
78	,,	,,	83·9 %	,,	,,	1·00 %	,,	,,
15	,,	,,	16·1 %	,,	more than	1·00 %	,,	,,

The figures in Table V. may not represent an accurate survey of the county in this particular; but they are sufficient to show that a very large area of the county is in urgent need of lime, and until this need is met the continued growth of satisfactory crops will not be possible. In the writer's opinion many of the failures to secure satisfactory crops from freshly broken-up grass land in Essex are, in the main, due to a great deficiency or total absence of calcium carbonate in the soil.

Conclusions.

1. The purity of the ground lime supplied for agricultural purposes leaves much to be desired. It is the most economical and the most convenient form of lime to purchase, and it is therefore all the more necessary that a pure supply should be obtained.
2. The purity of the lump lime supplied for agricultural purposes is very satisfactory, and the cost per unit of lime is appreciably less than that in ground lime. The labour which is necessary for slaking and distributing the lump lime in the field is, however, a great disadvantage.
3. Ground carbonate of lime is generally a very pure material. The cost per unit of lime is appreciably more than that in ground lime, and this militates against its use as a substitute for ground lime.

Recommendations.

The sale of ground lime, lump lime, and chalk should be brought within the provision of the "Fertilisers and Feeding Stuffs Act." It is perhaps more difficult to give a guarantee of the purity of ground lime than of lump lime or chalk, but the difficulty is not insuperable, as fairly wide limits could be reasonably granted. It would be sufficient for the supplying firm to guarantee a purity of 85 to 90 per cent. or 80 to 85 per cent., or even 80 to 90 per cent., but some means should be evolved for preventing the sale of material containing only 60 to 70 per cent. of calcium oxide as pure lime.

A guarantee of the fineness of grinding is also desirable, but it is very difficult to lay down a standard test. Very fine grinding is not important for ground lime, if the lime is well burnt, whilst on the other hand it is essential to have ground limestone very finely ground. In other words, a fineness of grinding which would be satisfactory for ground lime might not be satisfactory for ground limestone, whilst the fineness of grinding which is essential for ground limestone would be more than was necessary for "ground lime." The guarantee given with basic slag—namely, 80 to 90 per cent. to pass a sieve with 10,000 holes to the square inch—would be eminently satisfactory as a standard for ground limestone, but it would not be reasonable to expect ground lime and ground chalk to conform to such a high standard.

For agricultural purposes it will suffice if the mechanical condition of ground lime and ground chalk is such that these materials will easily pass through the sowing drill—a condition which is best left to the practical judgment of the farmer.

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MILK CALCULATIONS: A REPLY.

By LESLIE J. HARRIS.

I am grateful to Mr. Richmond for his criticism (Analyst, 1919, 200) of a number of papers of mine, especially as the conclusions arrived at in two of the latter ("Additive Factors . . ." and "Table for Sorting . . .") are based on his formula.

With regard to the relative advantage, for purposes of general milk control, of the estimation (1) of fat by Gerber, and (2) of total solids, I can find no reason for varying my preference for the second course. In a recent critical examination of the Gerber process by Day and Grimes (Analyst, 1918, **43**, 123) it is noted that the individual variation between duplicates may reach so high a figure as 0·16 per cent.; hence it is not unlikely that an even greater error may become evident when Gerber readings (varying as they do between themselves) are compared with an exact gravimetric determination. The possible sources of error do not cease here, for it is to be supposed that Messrs. Day and Grimes took special precautions to limit all those sources of error which they enumerate in their paper. In an ordinary Gerber estimation these additional inaccuracies may further vitiate the result—viz., faulty graduation of butyrometers; deviation from standard temperature (of which several have been proposed); length of time in taking the reading and consequent rate of cooling of fat; allowance for meniscus and effects of parallax; impossibility of securing constant weights of milk, acid, and alcohol by means of volumetric measurements; and, lastly, time and speed of whirling, which have been shown to have a surprising effect on the extent of the fatty layer. Mr. Richmond himself, in a criticism of this paper, says, "*The conditions are not sufficiently defined to make it* [the Gerber] *a really accurate method.*"

I did not advocate, as Mr. Richmond suggested, "the use of a comparatively rough method" for the estimation of total solids; on the contrary, it was specified that 5 grms. of milk were to be weighed into a glazed porcelain dish provided with a counterpoise, the time of drying was to be limited to a fixed number of hours (found by experiment and varying with apparatus and type of dish), after which the total solids could be read off directly from the scale pan. Under these conditions a remarkable agreement will be found between duplicate samples; indeed no difference can be detected in the second place of decimals. Surely such accuracy is impossible with a calculation of total solids from a Gerber reading; indeed my experience has been that when the time of drying of the total solids is arbitrarily fixed in the manner described, the extent to which the calculated fat differs from the truth is no greater than the possible error of a Gerber estimation. Also, for dairy control work small variations between samples may be detected with much greater accuracy by this method than by a Gerber estimation.

Whilst not questioning the great usefulness of the milk scale, nevertheless, for the particular purpose of calculating a long sequence of results, the use of my factors gives results in a fraction of the time, is less fatiguing, and there is no error due to computation of the last figure of decimals. The factors have been found more convenient than extended tables, because, for every one of the factors there is in the tables a whole column or row of figures; while in the more condensed tables only every tenth or fifth figure is given, the results are accurate only to one figure in five in the last place of decimals, and interpolation has to be adopted, and, as often as not, results in a further slight inaccuracy. On the other hand, the factors give the result correct to the last figure. [Also, Richmond's table, as given in "Dairy Chemistry" and Blyth's "Foods," is "For the Calculation of Total Solids" and *not* of fat.]

The criticism upon my formula for calculating added water is "that a public analyst might have considerable difficulty in convincing a magistrate of its accuracy." I imagine that the average magistrate is prepared to accept the report of a public analyst without requiring the latter to enter upon a convincing account of analytical technique. Indeed, my formula has been successfully employed in the county court, and I was not called upon to prove its accuracy.

Objection is taken to my Milk-Sorting Table and Phase Diagram because "the dairy analyst will soon learn to judge infallibly by inspection." I am at a loss to account for this statement. Were it possible to say when milk is below standard "by inspection," surely there would be no further need for dairy analysts. Is it possible to distinguish by inspection milk which has been judiciously dyed, watered, *and* skimmed, and of which the sp. gr. may be normal? Taking into account the comparative uselessness of a lactoscope, judgment by simple inspection would seem in the majority of cases to be worse than useless.

As to my formula being "too long" and "involving a laborious calculation," the mathematical expression connecting fat, solids-not-fat, and added water exists independently of my having demonstrated it, nor am I responsible for the complexity of it. On the other hand, unless some special standards are chosen, no more laborious calculation is required than (1) a sum in simple division *plus* reference to a very small table (515, p. 44); *or*, (2) placing a ruler across a chart and noting the point at which it intersects a line; *or*, (3) putting in coincidence two points on a slide rule.

Mr. Richmond has made an unfortunate error in his "exaggerated example" by which he seeks to illustrate the supposed erroneous result given by my formula. It can be demonstrated that my formula gives results absolutely accurate both by theory and in practice. If the original composition of a milk be known, the amount of water added to it may be calculated, no matter how great or small be its original content of fat or how much the cream may *subsequently* have accumulated or been removed. If the original composition of the milk be not known, some standard must be chosen, and then the formula will indicate how much water would have to be added to this standard to produce milk of the same composition as, or equivalent to, the sample. For legal purposes the Board of Agriculture has laid down the minimum standard of 3 per cent. fat and 8·5 per cent. solids-not-fat, and this is the only standard that can in fairness be adopted in such cases.

The following is the correct method of arriving at the added water (in strict accordance with my formula) *on the hypothetical sample* obtained by mixing equal weights of free butter fat and milk of minimum standard.

DATA.

(1) Original milk, fat	51·5 per cent.
,, ,, solids-not-fat	4·25 ,, ,,
(2) Watered sample, fat	25.75 ,, ,,
,, ,, solids-not-fat	2·125 ,, ,,

$$\text{Added water} = 100 - \frac{10{,}000 \times 2{\cdot}125}{51{\cdot}5 \times 2{\cdot}125 + 4{\cdot}25 \times 74{\cdot}25} = 50{\cdot}00.$$

The fact still remains that, if this "watered milk" were compounded from water and milk *of the minimum standard*, it would necessarily contain water 67 parts, milk 33 parts. Mr. Richmond says this is not a percentage on the sample examined, but on a hypothetical sample free from excess of fat. . This is quite true: the hypothetical sample is the Government standard.

Most genuine milk is considerably richer than fat 3 per cent. and solids-not-fat 8·5 per cent.; hence the calculated added water may be below the true figure if these values are used. But a legal minimum standard having been fixed, the analyst is not entitled to choose a higher one; he must assume that the milk prior to watering was of the Government standard. On this assumption my formula will indicate the precise amount of water subsequently added.

If, however, the analyst has reason to suppose that the original milk was not of the minimum (or other) standard, but that a rising of cream occurred prior to the addition of water, he may calculate the added water with equal accuracy by the formula indicated (see under "Notes," below). In all but the most extreme cases the two formulæ will give very similar results—*i.e.*, the compensation introduced for excess of fat will be commensurate.

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NOTES.

The Editor desires to point out that the pages of the Journal are open for the inclusion of short notes dealing with analytical practice and kindred matters. Such notes are submitted to the Publication Committee in the usual manner.

FORMULÆ FOR CALCULATION OF ADDED WATER IN MILK.

Added water in milk is usually calculated from the deficiency of solids-not-fat below 8·5 per cent., or some other standard. When the milk contains an excess of fat, added water may be calculated by the formula (Analyst, 1918, **43**, 346; *ibid.*, 1919, 43), which is based on the assumption that the milk before "watering" contained the *minima* of both fat and solids-not-fat, a due compensation being introduced for the rising of the cream and the corresponding depression of solids-not-fat.

In a recent paper by H. D. Richmond (Analyst, 1919, 200) an example is instanced where the milk, originally of minimum standard, receives a great accumulation of fat and a subsequent addition of water. The second formula mentioned above does not, strictly speaking, indicate the water added to the creamy milk, but to milk of the original quality—*i.e.*, free from excess of fat.

The difference is usually of a small degree, but it will be of interest to establish the theoretically correct formula for such a case. In the writer's opinion, an analyst is not justified, in the ordinary way, in assuming that the milk prior to the addition of water contained more than the standard of either fat or solids-not-fat, and he should, therefore, make use of the second formula mentioned above rather than the one deduced below.

Let milk of minimum standard stand until the percentage of fat in a given portion reaches F′.

In this portion there will be of

$$\text{solids-not-fat, } 8{\cdot}5 \times \frac{100 - F'}{100 - 3} \text{ per cent.}$$

After water, W per cent., has been added the mixture will contain:

$$\text{solids-not-fat} = N = 8{\cdot}5 \times \frac{100 - F'}{100 - 3} \times \frac{100 - W}{100};$$

$$\text{and fat} = F = F' \times \frac{100 - W}{100};$$

$$\text{substituting } N = \frac{8{\cdot}5 \times \left(100 - \frac{F \times 100}{100 - W}\right)(100 - W)}{(100 - 3) \times 100},$$

$$\text{whence } W = 100 - F - \frac{97}{8{\cdot}5} N. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad \text{(i.)}$$

The more general expression is

$$W = 100 - F - \frac{(100-f)}{n} N, \quad . \quad . \quad . \quad . \quad . \quad \text{(ii.)}$$

f and n being the standards for fat and solids-not-fat respectively.

Example (given by Richmond):

Fat	25·75
Solids-not-Fat	2·125

$$W = 100 - 25{\cdot}75 - \frac{97}{8{\cdot}5} \times 2{\cdot}125 = 50 \text{ per cent. of added water.}$$

"Milk" having the above composition would have a sp. gr. of 0·98862, or *minus* 11·38 lactometer degrees. The added water, as calculated by Richmond's G + F formula (ANALYST, 1891, **16**, 209), from this data is 58·3 per cent.

To recapitulate:

Formulæ.—I. For use when fat and solids-not-fat are present in normal ratio:

$$W = 100 - \frac{N}{8{\cdot}5} \times 100, \text{ or } 100 - \frac{N}{n} \times 100 \quad . \quad . \quad . \quad . \quad \text{(J. A. Wanklyn).}$$

II. For samples in which the rising of cream has caused a depression of the solids-not-fat:

$$W = 100 - \frac{10{,}000\ N}{8{\cdot}5(100 - F) + 3N}, \text{ or } 100 - \frac{10{,}000\ N}{n(100 - F) + fN} \quad \text{(L. J. Harris).}$$

III. Giving approximate results (ANALYST, 1918, **43**, 311):

$$W = 100 - \frac{G + F}{34{\cdot}5} \times 100, \text{ or } 100 - \frac{G + F}{36} \times 100 \ . \quad \text{(H. Droop Richmond).}$$

IV. When the sample prior to "watering" contained an excess or deficiency of fat caused by the separation of cream, and the extent of the change in composition is unknown:

$$W = 100 - F - \frac{97}{8{\cdot}5} N, \text{ or } 100 - F - \frac{(100-f)}{n} N \quad . \quad . \quad . \quad \text{(L. J. Harris)}$$

L. J. HARRIS.

27, ADDISON MANSIONS, W. 14.

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ABSTRACTS OF PAPERS PUBLISHED IN OTHER JOURNALS.

FOOD AND DRUGS ANALYSIS.

Presence of Aconitic Acid in Sugar-Cane Juice, and New Reaction for the Detection of the Acid. C. S. Taylor. (*J. Chem. Soc.*, 1919, **115**, 886-889.)—The presence of aconitic acid in sugar-cane juice was inferred by Behr (*Ber.*, 1877, **10**, 351) but not conclusively proved. In the author's experiments aconitic acid was isolated from both healthy and diseased sugar cane, though it could not be obtained in crystalline condition from the latter. It is present in the form of a salt and not in the free state in the cane juice. In addition to the usual qualitative tests it was found that aconitic acid when treated with acetic anhydride gives a pink coloration, which changes rapidly to deep red and then to magenta. On heating the mixture a bluish-green liquid is obtained, which becomes brown and almost opaque. The magenta liquid apparently consisted of two coloured substances, a red compound soluble in water, and a blue compound readily soluble in ether, but both were exceedingly unstable and were rapidly decomposed by water, acids or alkalis. Apparently the colour reaction is due to condensation of the carboxyl groups of the acid, with possibly elimination of water or addition of acetic anhydride. Applied as a test the reaction is capable of detecting 0·01 mgrm. of aconitic acid. None of the other acids in sugar-cane juice gives the reaction, but citric acid may be detected by melting it in a test-tube, when traces of aconitic acid are produced, which then react with the acetic anhydride. C. A. M.

Purified Ether and the Variations in Commercial Samples. A. J. Jones. (*Pharm. J.*, 1919, **103**, 71-73.)—The B.P. prescribes tests for the permissible limits of aldehyde, vinyl alcohol and methyl compounds in purified ether, and, as a rule, commercial samples answer to these requirements. It is contended, however, that a comparison with a standard of definite purity would be more satisfactory than determining the absence of a class of compounds. Analyses are given of various commercial samples of ether, in which methyl compounds range from 0·02 to 0·06 per cent., sp. gr. from 0·7182 to 0·7211, and ketones (as acetone) from 0·09 to 5·0 parts per 10,000. It is suggested that an apparent 0·05 per cent. limit of methyl alcohol would be reasonable for purified ether made from methylated spirit. A few samples of commercial ether gave practically a negative result in the nitro-prusside test. One sample which had been made from rectified spirit and kept for some time contained formaldehyde. C. A. M.

Detection of Wheat, Rye, and Potato Starches in the Presence of each other. E. Unna. (*Zeitsch. Untersuch. Nahr. Genussm.*, 1918, **36**, 49.)—Ten grms. of the flour are mixed with 3 per cent. phenol solution and, after twenty-four hours, a portion is transferred to a microscope slide and allowed to dry at the ordinary temperature. The slide is then immersed for ten minutes in a mixture of water-blue-orcein solution (water-blue, 1, orcein, 1, glacial acetic acid, 5, glycerol, 20, alcohol, 50, and water, 23 parts) and eosin solution (eosin, 1, 60 per cent. alcohol, 99 parts), washed, immersed for fifteen minutes in 1 per cent. saffranin solution, well washed, and immersed for thirty minutes in 0·5 per cent. potassium bichromate solution. The preparation is finally washed with water, then with alcohol, treated with xylene, and mounted in Canada balsam. When thus prepared the potato starch is coloured dark red, the wheat starch pink, the rye starch yellow to brown, and the gluten blue. W. P. S.

Estimation of Water in Margarine. M. Monhaupt. (*Chem. Zeit.*, 1919 **43**, 385-386.)—Loss by spirting when the water is expelled by heating the sample in a basin over a flame may be prevented by the addition of a small quantity of sodium bicarbonate; about 0·03 grm. of the latter is sufficient for 10 grms. of margarine. The bicarbonate loses about 26 per cent. of its weight during the heating, a loss which is practically negligible under the circumstances. W. P. S.

Modification of Nessler and Barth's Method for the Estimation of Tannin in Wine. L. Meyer. (*Mitt. Lebensm. Untersuch. Hyg.*, 1918, **9**, 131; through *Chem. Zeit. Rep.*, 1919, **43**, 125.)—One hundred c.c. of the wine are treated with alcohol to precipitate pectins, filtered, the filtrate evaporated to a volume of 4 c.c., transferred to a sedimentation tube, diluted with water to 5 c.c., and 5 c.c. of saturated sodium chloride solution, ferric chloride solution, and 1 c.c. of 40 per cent. sodium acetate solution are added. After twelve hours, the volume of the sediment is observed and multiplied by 0·33 to obtain the quantity of tannin. In the case of acid wines, the acidity must be reduced, by neutralisation, to less than 0·5 per cent. before the tannin is estimated. W. P. S.

BACTERIOLOGICAL, PHYSIOLOGICAL, ETC.

Aerobic Spore-Forming Bacillus in Tinned Salmon. A. C. Hunter and C. Thom. (*J. Ind. and Eng. Chem.*, 1919, **11**, 655-657.)—Of five hundred and thirty tins of salmon, representing nine brands, examined bacteriologically, two hundred and thirty-seven were unsterile; two hundred and twenty-four of these tins contained the same organism of the mesentericus group either in pure culture or together with other species. Only thirteen of the tins showed signs of decomposition. The organism is an obligate ærobic spore-forming bacillus; it is motile, produces a dark red ring about a centimetre below the colony when grown in carbohydrate medium and decomposes fish rapidly. The spores are resistant to heat and in broth culture survive heating at 100° C. for one hour; under 15 lb. pressure in an autoclave, they survive for fifteen minutes but are killed after thirty minutes. It is evident that when the organisms are embedded in the centre of the salmon in the tin they may survive the ordinary sterilising process. Although tinned salmon may contain the living organism without showing any signs of decomposition or deterioration, actual sterility should be the proper aim of the packer. W. P. S.

Use of Lycopodium in Quantitative Microscopy. T. E. Wallis. (*Pharm. J.*, 1919, **103**, 75-76.)—Samples of lycopodium powder contained from 4·25 to 5·2 per cent. of moisture. The number of spores per mgrm. was estimated by measurement and from the sp. gr. (1·086), and also by mixing a weighed quantity (about 0·1 grm.) with olive oil or tragacanth mucilage (10 to 12 grms.), weighing a drop of the mixture on a microscope slide and counting the number of spores in the drop. The results obtained by the first method showed about 95,000 spores per mgrm., and by the second averaged 93,000, so that 94,000 may be accepted as the average number. The use of these results in quantitative microscopy are illustrated by the following example: Commercial rice starch (0·05 grm.) was mixed with 0·2 grm. of lycopodium, and counts made under the microscope showed 2,761 starch granules for each 100 lycopodium spores. Whence, 2,761 × 94,000 ÷ 100 = 2,595,000 starch granules for each mgrm. of lycopodium. Since the mixture contains 4 times as much lycopodium as starch there are 10,380,000 granules in 1 mgrm. of air-dried starch, or 12,351,000 in starch dried at 100° C. The microscopic appearance of lycopodium spores is not altered by boiling with 2 per cent. acid or alkali, and advantage of this fact may be taken in preparing crude fibre from a mixture of starchy powder and lycopodium. The mixture of crude fibre and lycopodium is collected on a cloth strainer over a watch-glass, mixed with tragacanth mucilage, and counts of the preparation made under the microscope (*cf.* ANALYST, 1916, **41**, 357). C. A. M.

Supposed Occurrence of Methylguanidine in Meat. I. Greenwald. (*J. Amer. Chem. Soc.*, 1919, **41**, 1109-1115.)—Methylguanidine, which has been isolated from decomposed flesh, has been regarded as one of the toxic substances occurring in fresh meat which has caused poisoning. Ewins (*Biochem. J.*, 1916, **10**, 103) showed that creatine was oxidised by silver oxide to methylguanidine, but concluded that precipitation with mercuric acetate was not attended by risk of such oxidation. It has been found, however, by Baumann and Ingvaldsen (*J. Biol. Chem.*, 1918, **35**, 277) that creatinine is oxidised by mercuric acetate, with the formation of methylguanidine oxalic acid, and an intermediate product methylguanido-glyoxylic acid, $CH_3NHC(:NH)NHCOCOOH$, which melts at 203° C. The author has confirmed these results and concludes that there is no evidence of the occurrence of methylguanidine in meat which is in a fair state of preservation. C. A. M.

ORGANIC ANALYSIS.

Chlorination of Benzene. Analysis of Mixtures of Benzene, Chlorobenzene and Dichlorobenzene, etc. P. F. Frankland, S. R. Carter, and D. Webster. (*J. Soc. Chem. Ind.*, 1919, **38**, 153-154 T.)—The method which was devised for determining the composition of the reaction mixtures resulting from the chlorination of benzene on the industrial scale is briefly as follows: 100 c.c. of the sample are distilled under uniform conditions in an Engler flask, and the distillates are collected in measuring cylinders. Three fractions are obtained by interrupting the distillation at 122° C. and at 142° C. The volumes of liquid distilling below 122° C. and above 142° C. are noted, and the percentages of benzene and chlorobenzene present in the original mixture are found from a graph constructed from experiments with mixtures of known composition. The dichlorobenzene is found by difference. The graph and full details as to procedure are given in the original paper. Benzene hexachloride is sometimes formed during the chlorination of benzene, and it may be estimated by taking advantage of its sparing solubility. The fraction boiling above 142° C. contains all the hexachloride, and that portion which crystallises from this at room temperature is collected, washed with light petroleum, dried, and weighed; a further quantity may be obtained when the mother-liquor is concentrated. W. P. S.

Estimation of Carbon Disulphide. A Critical Examination of the Various Methods usually Employed. P. E. Spielman and F. B. Jones. (*J. Soc. Chem. Ind.*, 1919, **38**, 185-187 T.)—The methods examined were those chiefly intended for the estimation of carbon disulphide in benzene. Change in the specific gravity of the benzene, before and after extraction with alcoholic potassium hydroxide solution, gives a trustworthy measure of the amount of carbon disulphide present; if the specific gravities are determined accurately to the fourth decimal place, the accuracy of the estimation is about 0·03 per cent. Oxidation of the extracted carbon disulphide with bromine and estimation of the sulphuric acid as barium sulphate is also trustworthy, provided that the oxidation is efficient. Volumetric estimation of the xanthate by titration with copper sulphate solution, or gravimetrically by precipitation as copper xanthate, yield unsatisfactory results. Precipitation by phenylhydrazine of phenylhydrazine phenylsulphocarbazide failed to yield quantitative results. W. P. S.

Formation of Cyanic Acid during the Oxidation of Organic Substances. R. Fosse. (*Comptes rend.*, 1919, **169**, 91-93.)—On oxidising organic substances, such as proteins, dextrose, glycerol or glycocoll, by means of potassium permanganate and ammonia, ammonium cyanate is obtained as an intermediate product of the oxidation. The cyanic acid may be identified by converting it into the silver salt, which can be purified by recrystallisation. On heating the salt for an hour on the water-bath at about 92° C., with ammonium chloride dissolved in ammonia, it is decomposed with the formation of its equivalent of urea. Both the silver chloride and the urea are estimated in the usual way, the urea being estimated in an aliquot portion of the solution. C. A. M.

Estimation of Halogens in Organic Compounds by the Liquid Ammonia-Sodium Method. C. W. Clifford. (*J. Amer. Chem. Soc.*, 1919, **41**, 1051-1060.)—The following modification of the liquid ammonia-sodium method is recommended: From 0·05 to 0·25 grm. of the solid compound (or of the liquid sealed up in a thin-walled glass bulb, which is broken after the addition of the ammonia) is treated in a Dewar flask with liquid ammonia, and metallic sodium introduced little by little with constant stirring until a blue coloration persisting for fifteen minutes is obtained. This completely removes the whole of the halogen from the organic compound, but also frequently forms a small but variable amount of cyanide.

The ammonia is evaporated, the excess of sodium taken up with a little alcohol, and the liquid diluted to about 150 c.c. with water, and filtered if necessary. It is then rendered neutral to phenolphthaleïn by the addition of $6N$ acetic acid, and an excess of about one c.c. is added. A few glass beads are introduced, and the liquid boiled for about an hour, more water being added if more than about 75 c.c. evaporate. Under these conditions the hydrocyanic acid is quantitatively expelled. The solution is cooled, and the halogen estimated by precipitation with silver nitrate, followed by filtration in most cases, and titration with sodium thiocyanate. In the case of chlorine compounds, the cyanogen formed may be removed by boiling the nitric acid solution. C. A. M.

Estimation of Lactic Acid by Oxidation. O. Schuppli. (*Trav. Chim. Aliment. Suisse de Hyg. Pub.*, 1919, 44; *Ann. Chim. anal. Appl.*, 1919, **1**, 222.)—Szeberenyi has devised a method of estimating lactic acid by oxidising it by chromic acid into acetic acid, carbon dioxide and water, distilling the acetic acid in a current of steam, and titrating the distillate with standard alkali solution. Other organic acids, including malic, tartaric, and oxalic acids, are completely oxidised to carbon dioxide and water. In test experiments it was found that 97 per cent. of lactic acid was oxidised into acetic acid, carbon dioxide, and water, and 3 per cent. completely oxidised to carbon dioxide and water. The author finds that this method gives satisfactory results with solutions of pure organic acids, but that when applied to wines it gives higher results than those obtained with Möslinger's method, owing to some of the other constituents undergoing incomplete oxidation, and yielding volatile acids. This was confirmed by experiments with cane sugar. C. A. M.

Effect of Exposure on Raw Linseed Oil. E. J. Sheppard. (*J. Ind. and Eng. Chem.*, 1919, **11**, 637-639.)—The effect of exposure on the iodine value, acid value, and specific gravity was determined over a limited range of gain in weight (about 6 per cent. in 85 to 157 days). The thickness of the exposed layer appeared to affect only the rate of change in the constants, and, for any given increase in weight, the changes occurring in the constants seemed to be independent of the rate of such increase. W. P. S.

Analytical Examination of Mercury Fulminate. A. Langhans. (*Zeitsch. anal. Chem.*, 1918, **57**, 401; through *Chem. Zeit. Rep.*, 1919, **43**, 127.)—(1) *Ferrous ammonium sulphate-thiosulphate reaction.*—If 3 grms. of mercury fulminate are dissolved in 60 c.c. of 10 per cent. thiosulphate solution, and 5 per cent. ferrous ammonium sulphate solution is added, a red coloration is obtained; this soon changes to green, and a yellowish precipitate forms. (2) *Sodium nitrite reaction.*—A blue-green coloration is obtained when a few drops of a solution of mercury fulminate in potassium cyanide solution are added to a 2 per cent. sodium nitrite solution, and the mixture then acidified with dilute hydrochloric acid. (3) *Hypobromite reaction.*—See following abstract. (4) *Vanadate reaction.*—A blue coloration developes when mercury fulminate is dissolved in 20 per cent. hydrochloric acid, and the solution heated with the addition of 1 per cent. ammonium metavanadate solution. (5) *Iron-*

alum reaction.—If 0·3 grm. of fulminate is dissolved in 9 c.c. of 20 per cent. hydrochloric acid, the solution mixed with 1 grm. of iron alum dissolved in 30 c.c. of water containing 0·5 c.c. of dilute hydrochloric acid, and the mixture diluted with six times its volume of water, a bright cherry-red or blue-red coloration is produced. The reaction may be obtained with 1 part of fulminate dissolved in 8,000 parts of dilute hydrochloric acid. For the estimation of fulminate the latter is converted into hydroxylamine, formic acid, and mercuric chloride by treatment with hydrochloric acid, and the hydroxylamine is estimated iodimetrically, or by titration with iron alum and permanganate; 0·3 grm. of fulminate requires 21·12 c.c. of $\frac{N}{10}$ iodine solution or 84·48 c.c. of $\frac{N}{20}$ permanganate solution. W. P. S.

Reactions of Mercury Fulminate with Chlorate, Bromate, and Hypobromite. Langhans. (*Jour. prakt. Chem.*, 1918, **98**, 255; through *Chem. Zeit. Rep.*, 1919, **43**, 127.)—Potassium chlorate alone does not react with mercury fulminate, but in the presence of hydrochloric acid it yields traces of a blue-coloured product. With potassium bromate much better results are obtained: if 2·5 grms. of the fulminate are dissolved in 3 c.c. of 20 per cent. hydrochloric acid, and 15 c.c. of 5 per cent. potassium bromate solution are added, blue oily drops separate within one hour. Concentration is a factor in the reaction of fulminate and hypobromite. A solution of 10 grms. of potassium hydroxide and 4 c.c. of bromine in 100 c.c. of water decomposes fulminate with the evolution of gas and the formation of red mercuric oxide; with 12 grms. of potassium hydroxide and 4·2 c.c. of bromine per 100 c.c., the fulminate dissolves with a rapid evolution of gas and yields a green solution. If the fulminate is shaken with a solution containing 10 grms. of potassium hydroxide and 6 c.c. of bromine per 100 c.c. of water, a blue-coloured oil is obtained which is soluble in ether. This is possibly bromonitrosomethane, CH_2BrNO.

W. P. S.

Use of Pyramidone in Analysis. Eschaïch. (*J. Pharm. Chim.*, 1919, **20**, 49-52.)—Nitrates, ferric chloride, etc., give a coloration with pyramidone, and the latter is not, therefore, a specific reagent for the detection of reductase in blood, mlik, and the like; *cf.*, Thevenon and Rolland, ANALYST, 1917, **42**, 280). If, however, pyridine is also added, pyramidone is a reliable substance to use for the detection of blood, raw milk, etc. A blue coloration is obtained when a few drops of a liquid containing blood, or 2 c.c. of raw milk, are added to a mixture of 1 c.c. of pyridine, 1 c.c. of 10 per cent. pyramidone solution, and 2 drops of hydrogen peroxide. The further addition of a few drops of acetic acid renders the coloration more stable. Pyramidone may be used for the detection of cyanides. One c.c. of the reagent, 1 c.c. of 0·25 per cent. copper sulphate solution, and 10 drops of acetic acid, yield a blue coloration and turbidity when treated with a dilute solution of a cyanide.

W. P. S.

Tannin Content of Redwood. C. C. Scalione and D. R. Merrill. (*J. Ind. and Eng. Chem.*, 1919, **11**, 643-644.)—Various parts of the wood of the Pacific coast redwood (*Sequoia sempervirens*) contain the following quantities of tannin, etc.:

	Bark.	Sapwood.	Heartwood.
	Per Cent.	Per Cent.	Per Cent.
Soluble solids	2·76	4·77	25·7
Non-tannins	1·89	3·62	13·5
Tannin	0·86	1·15	12·2

The only part of the wood which has any possible value as a source of tannin is the heartwood; the chief available raw material would be the sawdust. The tannin imparts a dark purplish-brown colour to the outside of hides, but the leather produced might be satisfactory as a heavy sole leather. The liquor which collects on steam-kilning the wood contains from 7 to 10 per cent. of tannin. W. P. S.

Estimation of Thiophene. P. E. Spielmann and S. P. Schotz. (*J. Soc. Chem. Ind.*, 1919, **38**, 188-189T.)—The authors have examined various methods which have been suggested for the estimation of thiophene in benzene, and recommend the following modifications of the basic mercuric sulphate and acetate methods: *Basic Mercuric Sulphate Method.*—Two c.c. of the benzene and 20 c.c. basic mercuric sulphate solution (sulphuric acid 20 c.c., water 100 c.c., and mercuric oxide 5 grms.) are shaken in a closed tube for three hours; the white precipitate which is formed is collected, washed with hot water, dried at 110° C., and weighed. The weight multiplied by 0·0757 gives the amount of thiophene in 2 c.c. of benzene. *Basic Mercuric Acetate Method.*—Ten c.c. of the benzene and 4 grms. of basic mercuric acetate (mercuric oxide, 1 part, glacial acetic acid, 2 parts, the mixture being filtered and the salt washed with ether) are heated on a water-bath under a reflux condenser for fifteen minutes; after cooling, the precipitate is collected, washed with water, dried at 100° C., and weighed. The weight is multiplied by 0·07516 to obtain the corresponding amount of thiophene. W. P. S.

INORGANIC ANALYSIS.

Modified Method of Estimating Arsenic as Ammonium Magnesium Arsenate. O. Bailly. (*J. Pharm. Chim.*, 1919, **20**, 55-58.)—Ammonium magnesium arsenate, precipitated in the usual way and washed first with ammonia and then with alcohol, is mixed with water and titrated with standard sulphuric acid, using methyl-orange as indicator. W. P. S.

Estimation of Bismuth by the Formaldehyde Process. S. B. Tallantyre. (*Pharm. J.*, 1919, **103**, 81.)—The bismuth compound or preparation is heated for a few minutes with about 10 per cent. of dilute hydrochloric acid until all the bismuth has dissolved. It is then treated with a large amount of formaldehyde solution and an excess of 10 per cent. sodium hydroxide solution, and boiled until all the bismuth has separated. The supernatant liquid is treated with a further quantity of the reagents and again boiled to ensure complete reduction. The deposit of bismuth is washed by decantation with hot water containing a little formaldehyde, and stirred until it coagulates into a compact mass. If necessary, the coagulation may be promoted by reboiling the bismuth with formaldehyde and sodium hydroxide. Finally the bismuth is transferred to a tared filter or Gooch crucible, washed with absolute alcohol, dried for an hour or two at 105° C. and weighed. The method is applicable to recent preparations of bismuth, such as *liquor bismuthi et ammonii citratis*, bismuth phenate, etc. In the case of xeroform (bismuth tribromophenolate) a residue of tribromophenol is left when the bismuth dissolves. This should be removed, and washed free from bismuth with 10 per cent. hydrochloric acid. C. A. M.

Estimation of Cerium in the Presence of other Rare Earths by Precipitation as Ceric Iodate. P. H. M. P. Brinton and C. James. (*J. Amer. Chem. Soc.*, 1919, **41**, 1080-1085.)—A method of estimating cerium has been based upon its oxidation by means of potassium bromate in nitric acid solution, followed by precipitation with potassium iodate, and direct conversion of the ceric iodate into cerous iodate. Other elements of the rare earths are not oxidised to a higher valency under these conditions. In making an estimation the solution, which contains the rare-earth metals in the form of nitrates, and from which any thorium has previously been removed, is treated with about 25 c.c. of strong nitric acid, so as to bring the total volume of liquid up to about 75 c.c. About 0·5 grm. of solid potassium bromate is added, and after it has dissolved, sufficient potassium iodate in nitric acid solution (100 grms. of iodate and 333 c.c. of strong nitric acid per litre) to exceed by ten to fifteen times the amount equivalent to the cerium present is introduced slowly and with constant stirring. To avoid having too bulky a precipitate it is advisable that the quantity of cerium present should not exceed about 0·15 grm. The precipitated ceric iodate is separated, washed on the filter with a solution of 8 grms. of potassium iodate and 50 c.c. of strong nitric acid per litre, washed back into the beaker with hot water, the liquid heated to boiling, and strong nitric acid added little by little, with constant stirring until the precipitate dissolves. It is essential to avoid an excess of acid. To this solution is added about 0·25 grm. of potassium bromate, and about the same amount of potassium iodate as was used in the first precipitation. After cooling and settling, the precipitate is separated and washed with the nitric acid iodate solution, as before, returned to the beaker, and mixed with about 5 to 8 grms. of oxalic acid crystals and 50 c.c. of water. The beaker is covered, and its contents heated first gently and then boiled until all iodine has been volatilised. The resulting cerous oxalate is allowed to stand for several hours, washed on the filter with cold water, ignited to ceric oxide in a platinum crucible over the blow-pipe flame, and weighed. C. A. M.

New Method of Estimating Chromium. A. Terni and P. Malaguti. (*Gazz. Chim. Ital.*, 1919, **49**, 251-256.)—A method of estimating chromium is based on its precipitation as lead chromate, solution of the precipitate in sodium hydroxide solution, and iodimetric estimation of the chromium. The solution containing the chromic salt is boiled with concentrated nitric acid (sp. gr. 1·4) and about 1 grm. of lead dioxide until the liquid has been concentrated to a few c.c. From 40 to 50 c.c. of water are added, and sufficient 25 to 30 per cent. sodium hydroxide solution to dissolve the precipitated lead chromate. The solution is heated nearly to boiling-point and filtered, and the residue is washed with water rendered slightly alkaline with sodium hydroxide. The filtrate is diluted to 150 or 200 c.c., and sufficient nitric acid (sp. gr. 1·2), free from nitrous acid, is added to redissolve the precipitated lead chromate, and, when only a slight turbidity remains, 25 c.c. of the same acid are added. From 5 to 10 c.c. of 10 per cent. potassium iodide are added to the acid solution, and the liberated iodine is titrated with thiosulphate solution, which has been standardised against $\frac{N}{10}$ potassium dichromate solution in the presence of 25 c.c. of nitric acid (sp. gr. 1·2). Iron and manganese, if present, are precipitated as hydroxides by the sodium hydroxide, and are separated with the excess of lead oxide, whilst aluminium remains in solution as sodium aluminate, and does not interfere with the final titration. C. A. M.

Sulphur Dioxide Method for Estimating Copper Minerals in Partly Oxidised Ores. C. E. van Barneveld and E. S. Leaver. (*Techn. Paper*, 198, *Dept. of the Interior*, *Bureau of Mines*, *U.S.A.*, 1918, 1-12.)—The methods commonly used for the rapid estimation of copper in sulphide form, or in the form of combined oxides, carbonates, silicates, and native or metallic copper, are treatment with 5 per cent. sulphuric, or with 5 per cent. ammonia, or of ammonia and ammonium carbonate, to dissolve "oxidised copper." Both of these are untrustworthy, since they also dissolve more or less copper in the sulphide form, whilst any metallic iron present renders the first method inaccurate. These drawbacks are obviated by the use of sulphur dioxide solution as a solvent for copper in the oxidised form. Two grms. of pulp, ground to a fineness of 100 to 150 meshes per inch, are mechanically shaken for one-half to two hours in a closed bottle with 100 c.c. of 3 per cent. sulphur dioxide solution. The liquid is filtered and the residue washed with the sulphur dioxide solution. The filtrate and washings, which will contain all oxides, carbonates, and silicates of copper, and all metallic copper, are treated with 5 to 10 c.c. of nitric acid, evaporated to 20 c.c., and then diluted to 150 c.c., and the copper estimated electrolytically. The residue, containing unaltered and undissolved copper sulphides, is boiled with 5 c.c. of sulphuric acid and 10 c.c. of nitric acid until white fumes appear, then treated with 5 c.c. of nitric acid, and diluted to 150 c.c., and the copper estimated electrolytically. This method of analysing the residue is not suitable for heavy sulphide ores containing bases which interfere, and the standard methods should be used in such cases. Metallic iron, up to 2 per cent. is rapidly dissolved, and does not affect the results provided that there is a large excess of sulphur dioxide. No gelatinisation of silica occurs, and the loss of copper from this cause is thus prevented. It is essential that the ore should be finely crushed, and if any notable proportion of chrysocolla is present the powder should be reduced to pass a 150-mesh sieve.

C. A. M.

Influence of Fluorides on the Oxidimetric Estimation of Nitrous Acid. J. Bellucci. (*Gazz. Chim. Ital.*, 1919, **49**, 209-216.)—It was found by Müller and

Koppe (*Zeitsch. anorg. Chem.*, 1910, **68**, 160) that in using Volhard's oxidimetric method of estimating manganous manganese the oxidation followed a different course when fluorides were present. In the absence of fluorides the permanganate is decomposed as follows:

$$2MnO_4' + 3Mn^{\cdot\cdot} + 2H_2O = 5MnO_2 + 4H$$

whilst when fluorides are present the reaction is as follows:

$$2MnO_4' + 8Mn^{\cdot\cdot} + 7H_2O = 5Mn_2O_3 + 14H$$

For the same reason in using Lunge's method of estimating nitrous acid by oxidation with potassium permanganate in presence of sulphuric acid the results are anomolous when fluorides are present. This may be obviated by combining an iodimetric method with the oxidation method. The nitrous acid is treated with a measured excess of standard potassium permanganate solution, in the presence of sulphuric acid, and after two minutes alkali iodide is added, and the liberated iodine titrated with standard thiosulphate solution. At the same time a blank estimation is made by adding alkali iodide to the same quantity of potassium permanganate solution as was used to oxidise the nitrous acid, and titrating the iodine. C. A. M.

Rapid Estimation of Perchlorates alone or in Presence of Chlorates and Chlorides. J. G. Williams. (*Chem. News*, 1919, **119**, 8.)—In using Knecht and Hibbert's method of oxidising titanous chloride in sulphuric acid solution by perchlorates it was found that in acid solution the oxidation was very slow in cold but rapid in hot solutions. To secure complete reaction the solution must contain 30 per cent. by volume of acid. The weighed quantity of perchlorate (about 0·1 grm.) is dissolved in 15 c.c. of water, 10 c.c. of 15 per cent. titanous chloride, and 10 c.c. of sulphuric acid added, and the liquid boiled, cooled, and titrated with ferric ammonium sulphate, using potassium thiocyanate as an outside indicator. The solution of ferric ammonium sulphate contains 100 grms. per litre, and is standardised by heating 15 c.c. of ammonium perchlorate solution of known strength, with 10 c.c. of 15 per cent. titanous chloride solution and 10 c.c. of sulphuric acid, and titrating the cooled liquid. A blank estimation is made on the ferric ammonium sulphate solution required by the 10 c.c. of the titanous chloride solution. C. A. M.

Separation of Tin, Antimony, and Arsenic by Plato's Method. W. Hartmann. (*Zeitsch. anal. Chem.*, 1919, **58**, 148-156.)—In Plato's method of separating tin, arsenic, and antimony (ANALYST, 1910, **35**, 451) the solution of the three metals in sulphuric acid is decomposed with phosphoric acid, and the arsenic and antimony distilled in a current of carbon dioxide, while hydrochloric acid is continually dropped into the flask. The distillate is treated with tartaric acid and again distilled, to separate arsenic trichloride, leaving the antimony behind. The tin which is left in the residue from the first distillation is distilled as bromide in a current of sulphur dioxide. Experiments with this method have shown that a large amount of sulphuric acid is unnecessary, and is apt to cause the deposition of sulphur in the condenser. All the arsenic and the bulk of the antimony distil at 155° to 165° C., but from two to three hours are required to remove the last traces of antimony. Distillation of the tin with hydrobromic acid is more satisfactory than Plato's method of distilling it with bromine hydrochloric acid. A simplified form of apparatus is described for carrying out the following modification of the method: 1 grm. of the finely divided alloy is heated in the distillation flask with 6 c.c. of strong sulphuric acid until completely decomposed, and all carbon eliminated. When cold the liquid is treated with 7 c.c. of phosphoric acid solution (sp. gr. 1·70), and again cooled, 10 c.c. of hydrochloric acid introduced, and the flask connected with a vertical condenser delivering into a flask which contains water, and has an outlet tube connected with an absorption column charged with fragments of wet marble. The arsenic and antimony are then distilled in a current of carbon dioxide at 155° to 165° C. until all the antimony has passed over. The dropping funnel supplying the distillation flask is then charged with a mixture of 1 part of hydrobromic acid (sp. gr. 1·40) and 3 parts of hydrochloric acid (sp. gr. 1·17), the receiver changed, and the tin distilled at 130° to 140° C. in a slow current of carbon dioxide, without any further addition of sulphuric acid, until the distillate ceases to give a reaction with hydrogen sulphide. In the absence of bismuth the distillation may be carried out at a higher temperature. C. A. M.

Estimation of Vanadium in Steels by Electrometric Titration. G. L. Kelley, J. A. Wiley, R. T. Bohn, and W. C. Wright. (*J. Ind. and Eng. Chem.*, 1919, **11**, 632-634).—The method described is based on the selective oxidation of vanadium by nitric acid, followed by electrometric titration with ferrous sulphate; it permits of the rapid estimation of vanadium without interference by chromium or any other element at present used as a constituent of steel. When the amount of vanadium is less than 0·5 per cent., 2 grms. of the sample are dissolved in 100 c.c. of sulphuric acid (sp. gr. 1·20); with higher percentages 1 grm. of the sample is dissolved in 80 c.c. of sulphuric acid. The solution is treated with 2 c.c. of nitric acid, added drop by drop, boiled until nitrogen oxides are expelled and the tungstic acid, if present, is yellow, then diluted with hot water to 125 c.c., and boiled gently for one hour with the addition of 40 c.c. of concentrated nitric acid. After cooling, the solution is diluted to 300 c.c. and titrated electrometrically at 20° C. with ferrous sulphate and bichromate solutions. The method yields 99 per cent. of the vanadium present. To estimate chromium in chromo-vanadium steels, 1 grm. of the sample (containing not more than 5 per cent. of chromium) is dissolved in 70 c.c. of sulphuric acid (sp. gr. 1·20), the solution is diluted to 70 c.c., treated with 2 c.c. of nitric acid, and boiled for five minutes. It is then diluted to 300 c.c with hot water, boiled, and 10 c.c. of 0·25 per cent. silver nitrate solution and 20 c.c. of 10 per cent. ammonium persulphate solution are added. After boiling for at least eight minutes, the solution is treated with 5 c.c. of dilute hydrochloric acid, boiled for a further five minutes, then cooled, and titrated with ferrous sulphate and bichromate solutions. Chromium and vanadium are thus titrated together.

W. P. S.

APPARATUS, ETC.

Trustworthiness of the Balance over Long Periods of Time. G. Dean. (*J. Chem. Soc.*, 1919, **115**, 826-828.)—In view of Blount's conclusions (ANALYST, 1918, **43**, 72) that weighings of the same object extended over several months may show differences as great as 1·6 mgrms., the author records the results of a series of experiments extending over a period of two years. A silica flask was used and weighed at irregular intervals in a short beam balance which was practically unused for other purposes. Between the weighings the flask was left in a desiccator. In the weighing the method of recording the swings of the pointer was used, and the point of equilibrium on the scale calculated. The total variation in the weight of a flask weighing 40·65 grms. was +0·000123 grm. in two years, this being made up of 0·000062 grm. in the first ten months, 0·000041 grm. in the next four months, and 0·000020 grm. in the final ten months. This slight but steady increase in the weight, supports Blount's view that it is due to displacement of the central knife edge. For practical purposes, however, the error introduced is negligible.

C. A. M.

Use of Freezing-Point Determinations in Quantitative Analysis. C. E. Fawsitt. (*J. Chem. Soc.*, 1919, **115**, 801-808.)—Drapier (*Comptes rend.*, 1915, **161**, 461) has suggested a method of estimating one ingredient, A_1, in a mixture, A, from the depression of the freezing point when the mixture A (solute) is dissolved in A_1 (solvent), and also in some other solvent, S, which is not an ingredient of A. The author has worked out the following formula to be applied to the calculation, embodying the necessary correction factors :

$$A_1 = \frac{100.m'_1[K_2\Delta_s U(P+\delta a) - K_1\Delta_{A1}\{Q+y(b-b_1)\}\,r.V]}{aK_1[1{,}000K_2+\Delta_{A1}m'_1]}$$

Here a represents a small quantity of the substance, A dissolved in P grms. of the solvent S, and Δ_s the depression in the freezing point of S noted; b represents the weight of the mixture A dissolved in Q grms. of the solvent A_1, and Δ_{A1} the observed depression of the freezing point. Further, $a = a_1 + a_2 + a_3 \ldots$, where a_1, a_2, etc., are the weights of the different ingredients A_1, A_2, etc., in a; and $b = b_1 + b_2 + b_3 \ldots$, where b_1, b_2, etc., are the weights of the ingredients A_1, A_2, etc., in b. K_1 represents the cryoscopic constant for the solvent S, and K_2 that for the solvent A_1; m_1, m_2, m_3 . . ., the molecular weights of the constituents A_1, A_2, A_3, whilst $r = a/b$. A correction δ, the average value of constants of the several ingredients of the solute A, is added to the weight of the solvent P, whilst γ is the average value of the correction value to be added to Q. The values U and V are correction factors (constants), experimentally determined, to be applied to observed depressions Δ_s and Δ_{A1}. The applicability of the method to the estimation of benzene in light coal-tar oils and of cineole in eucalyptus oils was tested. It was found that better results were obtained by the use of 3 to 4 grms. than by the use of smaller quantities. In dealing with special cases where the constituents are known, the percentage results are accurate within about two units, but in the case of mixtures which may contain ingredients of unknown molecular weight the error may be considerably greater.

C. A. M.

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REVIEWS.

Boiler Chemistry and Feed Water Supplies. By J. H. Paul, B.Sc., F.I.C., Pp. x. + 242. 1919. London: Longmans, Green and Co. Price 14s. net.

The author prefaces this book with the questionable statement that a more or less perfunctory analysis of the feed water, made with a view of dealing with the scale-forming constituents, is all that has hitherto been generally considered necessary for boiler work. He further states that little or no investigation has been made of the innumerable reactions that take place when natural waters are heated to some 400° F. under a pressure of fifteen to twenty atmospheres. Yet Fischer and others, forty years ago, did useful work on this subject.

Further on in the preface we are told that "instead of quoting authorities the principle has been here adopted of giving the evidence itself for statements not generally recognised as common knowledge. It has been felt that the principle of giving authorities is a subterfuge for passing on to others a responsibility an author has not the courage to assume on his own account. This method may not be acceptable to the few, but to the majority it may prove more convenient and satisfactory than the method of referring to some authority in an obscure publication, of which the majority of readers have never heard, and have neither the means nor time to consult." As a result of this curious attitude not a single reference is made in the book to any authority or publication. The volume is, in fact, an essay on boiler chemistry, interspersed with a large number of analyses of natural waters and the materials from which they derive their impurities, boiler-incrustations, deposits, etc., made by the author in the course of his practice, with a deal of speculative matter quite interesting to read, but based upon very slender experimental evidence.

We are further told in the preface that "so far as possible, technical language and expressions have been avoided. The facts stated and the conclusions drawn have been described in the language of everyday life, so that those without more than a very limited acquaintance with chemistry may be able to understand and appreciate the results, and a chapter has been added explaining and illustrating such technical expressions as it has been found necessary to use." It is not very clear which chapter is referred to, but in Chapter II. the author sets out to explain "in the language of everyday life" the nature of acids, bases, and salts, and when he proceeds to deal with the behaviour of indicators his difficulty becomes apparent, and leads him into statements which are misleading, if not incorrect. He states, for example, that when methyl orange is added to a water, and does not turn pink, "the only inference which can be correctly drawn is that the water is not acid." Yet on the next page he shows that it may be acid to phenolphthalein.

The use throughout the book of ancient terms such as "nitrate of lime" for calcium nitrate is another instance of the endeavour to avoid scientific language, but when the author comes to explain his speculative views on the chemical changes which take place in steam boilers, he has to use modern chemical formulæ and even structural formulæ. The non-chemical reader will skip all these formulæ, which can only be understood by the chemist, and he would probably have understood all the rest just as well if it had been expressed in the language of modern chemistry.

This book has presumably been written for the engineer in charge of steam boilers, and not for the expert chemist, and yet there is matter in it which appeals only to the chemist, such as the author's idea of formates, formaldehyde, and sugar being formed in the boiler from carbon dioxide as a starting-point. The evidence of the existence of these bodies appears to be based mainly upon the destruction of permanganate, which, of course, is no evidence at all. It is, however, a fact which must have been noticed by all who have made analyses of concentrated water from boilers that the bases generally are in excess of the acids commonly estimated, and in any case the author's ideas are ingenious and worth consideration. He points out as a curious fact that in condensing engines the condensed water contains very little carbon dioxide, but is always saturated, and sometimes supersaturated, with oxygen; and this he attributes to a regrouping of the carbon and oxygen atoms of the carbonates, leading to the production of a formate, free oxygen, and caustic alkali.

On p. 70 the author gives figures, presumably Marignac's, showing the solubility of calcium sulphate in water up to 212° F., but, following his practice of not quoting authorities, he makes no reference to the work of Tilden and Shenstone, who continued the table up to 473° F., and showed that even at that temperature water still retains in solution 12·6 grains of calcium sulphate per gallon. There is, therefore, no difficulty in explaining the fact that calcium sulphate is frequently found in concentrated boiler waters, which seems to be puzzling to the author. The chapter on "Softening" is very elementary, and the method of calculating the quantities of lime and soda ash required is not one which any chemist familiar with the subject would use.

Although this book has been written for the non-chemical reader, no doubt those chemists who have to advise in such matters will find in its pages material which is both interesting and useful. The valuable matter to the non-chemist is that in which the author clearly explains the fact that natural water is an impure liquid, containing in solution and suspension substances which attack the boiler plates, encrust them with material which hinders the transmission of heat, and are carried forward with the steam into the engines, and that unless steps are taken by selecting suitable waters, and treating others so as to counteract these impurities, trouble will ensue.

L. ARCHBUTT.

Coal-Tar Dyes and Intermediates. By E. de Barry Barnett. Pp. xviii. + 213 1919. Baillière, Tindall and Cox. Price 10s. 6d. net.

This book is one of a series of volumes on Industrial Chemistry, giving a comprehensive survey of the chemical industries. As stated in the general preface, the subjects are treated from the chemical rather than the engineering standpoint, and the industrial aspect is more prominent than that of the laboratory. The ideal book on industrial chemistry should deal with all these aspects. The problem to be solved should be clearly stated, the preliminary work in the laboratory described, the alterations in procedure and apparatus rendered necessary in changing from the laboratory to the factory scale should be explained, the design and material of the plant in the factory, the connections of the various parts, the making of gas- and liquid-tight joints, the calculation of the amount of heat to be supplied or removed, and the best designs of apparatus for these purposes, should receive thorough treatment, and so on. Of course, only a few problems could be thus treated in any one book, but even if only half a dozen were described, such a book would be of far greater value than one containing a multitude of bald statements of chemical facts, which, after all, are of comparatively little use when one is faced with the problem of turning out tons of a dyestuff or a drug in the most economical way in a given time.

The author has by no means reached this ideal standard, but he is to be congratulated on having written a book parts of which, particularly the sections on Intermediates, are replete with information of real practical value. Take such statements as these: "The nitrators should be cast from a good close-grain iron, high in fixed carbon, but low in graphite, sulphur, and phosphorus. Acid-proof irons, containing about 15 per cent. of silicon, are sometimes used, but they are costly, fragile, and cannot be machined. . . . They are very useful, however, when straight nitric acid has to be handled."—"1,000 lbs. of naphthalene are dissolved by gently warming with 15,000 lbs. of sulphuric acid monohydrate and about 500 lbs. of mercuric sulphate in a cast-iron sulphonation kettle. The solution is then pumped into another cast-iron kettle of considerably larger size, which is provided with a condenser, and is arranged for heating by direct fire. The solution is heated slowly, and oxidation sets in at 200° C. and is brisk at 250° C. Torrents of carbon dioxide and sulphur dioxide are evolved, and these are led back to the contact chambers of the oleum plant, where the sulphur dioxide is reconverted into sulphuric acid."—"100 kilos. of naphthalene is shaken through a $\frac{1}{2}$-mm. mesh sieve into 200 kilos. of R.O.V., and the whole maintained at 40-60° C. for several hours until the whole of the naphthalene has disappeared. Naphthalene-α-sulphonic acid is formed, and as it is insoluble in acid of medium strength, it separates out, and although its melting-point when pure is 80-85° C., the crude acid remains liquid even at 40° C. in absence of the solid phase." How much more illuminating than the bald information that nitrators are generally made of cast-iron, phthalic acid is manufactured by heating naphthalene with sulphuric acid and a mercury salt, and naphthalene-α-sulphonic acid is made by warming naphthalene with concentrated sulphuric acid!

Part I., dealing with intermediates, is divided into sections on nitration, amidation, sulphonation, hydroxylation, and miscellaneous intermediates, and under the various sections the usual nitro-compounds, bases, sulphonic acids, and phenols are described. The pages show that care has been taken in the compilation, and there are very few statements with which one would quarrel. The sentence "continuous nitration processes have been described but have never come into general use" is literally true, but is somewhat misleading in view of the thousands of tons of T.N.T. which have been manufactured during the war by the counter-current method.

Part II., dealing with the dyestuffs, contains little that is novel. The practical touches which render Part I. so valuable are far too infrequent, the paucity being camouflaged by constitutional formulæ and text-book chemistry. The list of references and literature at the end of each section bristles with D. R.-P.'s, and, as the author states in his preface, patent literature is designed to disguise the processes actually in use.

The sections on nitroso-dyes, nitro-dyes, indamines, and indophenols are commendably brief, whilst triphenylmethane dyes, thiazines, indigoid and anthraquinonoid dyes receive adequate treatment. Perhaps the best section is that on azo-dyes; the relation between colour and constitution, however, deserves more than the one and a half pages allocated to it.

The concluding chapter gives information regarding the steps taken by the Government to establish a national dyestuff industry in this country.

CLARENCE SMITH.

OUTLINES OF THEORETICAL CHEMISTRY. BY F. H. GETMAN, PH.D. Second edition, Pp. xv + 539. 1919. London: Chapman and Hall. Price 16s. net.

In the five years which have elapsed since the appearance of the first edition of this book the author has had the advantage of criticism and of experience in the use of the book by students. The second edition which is now published consequently includes many new features. Of these the chief are new chapters on radio-active phenomena and on the modern conception of the atom, a discussion of the relations of crystalline form and X-ray spectra, a chapter on the Brownian movement and Perrin's experiments, and an account of the more important theories of photochemistry. Also the chapter on Colloids has been entirely rewritten and others have been revised and brought up-to-date.

To produce within this relatively small compass a profitable account of such a wide subject as theoretical chemistry and the contiguous branches of physics is by no means an easy task, but the author has successfully accomplished it. In this he evidently has been aided by long experience in teaching the subject, moreover his style is well adapted to the purpose. There is little unnecessary matter in the book, the author's arguments are to the point and his style is clear. The general criticism may be made that in some respects the treatment is too brief. Even though the book deals merely with an outline of the subject and is primarily intended for those beginning the study of Theoretical Chemistry, in some chapters more mention of recent work might stimulate interest and the addition of fuller references would certainly make the book more useful as a guide for further reading. For example, in the section dealing with Refractive Index the recent work of Eisenlohr is not mentioned, the early values of Brühl for atomic refractivities being those quoted. In connection with optical activity, phosphorus, selenium, and silicon are omitted from the list of elements which act as centres of activity and no reference is made to the optically active metallic complexes. Such omissions as these are perhaps of minor importance, but in the opinion of the reviewer a more serious defect is the lack of any mention of Werner's theories of the nature of valency and of the efforts made by Stark, by Ramsay, and by Falk and Nelson to apply the electronic hypothesis to the phenomena of chemical combination. A chapter on this subject would be a valuable addition to the book. Nevertheless, those beginning to study the subject will find the book as a whole very useful; the problems quoted at the end of most chapters cover a large part of the subject and are carefully chosen. Misprints are rare, in fact the reviewer has met with only one. SAMUEL SMILES.

TABLES OF CHEMICAL AND PHYSICAL CONSTANTS. By P. E. SPIELMANN, PH.D., B.SC., F.I.C., A.R.C.SC., and E. G. WHEELER, B.SC., F.I.C. 1918. London: H.M. Stationery Office. Price 4s. 6d. net.

This book, of special interest to the light naphtha section of the coal-tar and coke-oven industries, does not lend itself to review. One can do little more than paraphrase the table of contents to show the ground covered. The authors' names will be a sufficient guarantee to most readers of the ANALYST that the data presented have been carefully checked in those cases where the authors are compilers, and accurately determined where they rest on experiments made expressly for the purpose of this book. There is a table of chemical and physical characteristics of the more important substances occurring in light naphtha, a table of boiling-points of nearly one hundred substances which may be present in such naphtha, and a useful set of barometric tables for correction for temperature and meniscus and for conversion from inches to millimetres. Under the heading "Thermometry" are tables of liquids of known boiling-points suitable for ascertaining thermometer corrections, interconversion tables of degrees Centigrade and Fahrenheit, and a graph for stem correction. There are tables showing the vapour pressure of benzene, toluene, the xylenes and carbon disulphide, from 0° C. to b.-p., the boiling-points of these substances from 680 to 800 mm. pressure, and the boiling-points of mixtures of benzene and toluene, toluene and xylene, and benzene and xylene. There are tables of weight, length and volume of general utility, followed by a table of volume per ton of light naphtha fractions, and this again by tables of more general utility—such as the density and specific volume of water from m.-p. to b.-p., equivalence between water and mercury columns, and equivalence between water column in feet, pounds per square inch, pounds per square foot, and inches of mercury. There is a short table of flash-points, and a very useful one—not easy to compile—of the explosive limits of mixtures of air with acetylene, benzene vapour, blast furnace gas, carbon monoxide, coal gas, ether, hydrogen, natural gas, petrol vapour and water gas.

A bibliography of recent methods of analysis of light naphtha fractions is followed by some miscellaneous notes on benzole forerunnings, the solubility of phenol in various solutions, and on other points, whilst Part II. of the work consists of conversion tables for calculating the contents of tank waggons and for calculating tons to gallons according to specific gravity. It will be seen from the above that, though of special interest to a particular industry, more than half the book makes a much wider appeal.

The authors are to be congratulated on the execution of the printing. Unless well printed, a book such as this would lose half its value. The numerous graphs are on a large scale, and have necessarily to be folded. This work has been executed just as well as possible, as though the printer and binder had been making a book for his own use. G. Cecil Jones.

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INSTITUTE OF CHEMISTRY.

In the July examinations for the Associateship of the Institute (A.I.C.) held recently, one candidate passed in Branch (*a*) Mineral Chemistry: Lieut. Cecil William Wood, King's College, London; two candidates passed in Branch (*d*) Organic Chemistry: Lewis Guy Peirson, B.A. (Cantab.), and John Edwin Pollock, B.Sc. (Lond.), University College, Reading; and one candidate in Branch (*g*) Chemical Technology, with Textile Chemistry as special subject: Percy Edward Stanhope, Royal Technical Institute, Salford.