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NINTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED IN 1902.

BY F. W. CLARKE.

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THE year 1901 has not been very prolific in researches upon atomic weights, at least so far as actual publications would seem to indicate. A fair amount of work, however, is announced from various sources, and doubtless it will appear in print during 1902. The investigations of current date are summarized in the following pages :

NITROGEN.

Scott[1] has carefully redetermined the ratios between ammonium bromide and silver. The silver was purified by various methods, and each experiment is cited with the proper details upon this point. The ammonium bromide was prepared from hydrobromic acid, with ammonia from different sources. It was brilliantly white, and remained so upon heating to 180°, whereas that used by Stas in his investigations became grayish. All weights were reduced to a vacuum, and calculations were made with $Ag = 107.93$. Results as follows, but for details the original paper should be consulted :

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[1] *J. Chem. Soc.*, **79**, 147 (1901).

Weight NH_4Br.	Weight Ag.	Molecular weight NH_4Br.
4.89631	5.39380	97.975
2.45925	2.70914	97.972
3.29478	3.62928	97.982
4.46957	4.92273	97.994
4.20661	4.63303	97.996
4.23664	4.66644	97.989
4.31464	4.75175	98.001
6.19233	6.82047	97.990
8.77664	9.66608	97.999
10.47233	11.53416	97.994
4.91997	5.41834	98.0028
5.00442	5.51164	97.997
5.17914	5.70390	98.000
4.84099	5.33177	97.995
5.10677	5.62515	97.984

Rejecting the first three experiments, in which the bromide was slightly acid, Scott's mean value for the molecular weight of NH_4Br is 97.995. Stas found 98.032, and Scott supposes that his salt may have contained traces of platinum, whence the grayness which appeared on heating.

As a further check on the determinations Scott collected and weighed the silver bromide produced, and so determined anew the ratio between Ag and AgBr. Data as follows :

Weight Ag.	Weight AgBr.	Ratio AgBr to 100 Ag.
6.82315	11.87733	174.074
9.66809	16.82816	174.059[1]
5.41906	9.43315	174.0735
5.51258	9.59596	174.074
5.70686	9.93346	174.062
5.33191	9.28093	174.064
5.62572	9.79254	174.067

Stas' value for this ratio is 174.080.

Two additional experiments were made upon the ratio between ammonium chloride and silver.

Weight NH_4Cl.	Weight Ag.	Molecular weight NH_4Cl.
4.78257	9.64484	53.519
5.51744	11.12810	53.513

In still another experiment connected with these two, the silver chloride was weighed. 4.7850 NH_4Cl gave 12.82048 AgCl. Hence $NH_4Cl = 53.5164$. Stas' value is 53.532. Further investigations are promised; but until they are complete Scott re-

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[1] 174.090 when corrected for a known impurity.

gards it as premature to compute the atomic weight of nitrogen from these data. As they stand they give:

From the bromide, $NH_4 = 18.040$.
From the chloride, $NH_4 = 18.059$.

CALCIUM.

The atomic weight of calcium has been redetermined by Hinrichsen.[1] The purest Iceland spar was ignited, and the ratio so determined between $CaCO_3$ and CaO. A correction is applied for 0.032 per cent. of Fe_2O_3, found by analysis, and assumed to represent $FeCO_3$ in the original mineral. Weights were reduced to a vacuum, and calculations were made with $O = 16$, and $C = 12$. The data are as follows, all corrections applied:

	Weight $CaCO_3$.	Weight CaO.	Atomic weight Ca.
	30.72157	17.22354	40.144
	32.77791	18.37587	40.141
	34.45625	19.31698	40.142
	33.36885	18.70723	40.141
Sum,	131.32458	73.62462	40.142

Herzfeld's determinations of the atomic weight of calcium, cited in the report of last year, have been reproduced in the *Berichte*,[2] and so made accessible to the general reader.

ARSENIC.

Somewhat elaborate determinations of the atomic weight of arsenic have been made by Ebaugh[3] under the guidance of Edgar F. Smith. First, silver arsenate was converted into silver chloride by heating in hydrochloric acid gas. All weights were reduced to a vacuum. The results are as follows, with $O = 16$, $Cl = 35.45$, and $Ag = 107.92$.

Weight Ag_3AsO_4.	Weight AgCl.		Atomic weight As.
0.23182	0.21547		74.987
0.47996	0.44615		74.944
0.52521	0.48820		74.956
0.80173	0.74517		74.996
0.94782	0.88083		75.061
1.02047	0.94830		75.083
1.03558	0.96258		74.974
1.05462	0.98014		75.033
		Mean,	75.004

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[1] *Ztschr. phys. Chem.*, **39**, 311.

[2] Vol. 34, p. 559.

[3] Doctoral thesis, University of Pennsylvania, 1901.

The silver chloride from seven of these experiments was next reduced by heating in hydrogen. The silver contained in the arsenate was thus determined, giving the following data:

Weight Ag_3AsO_4.	Weight Ag.	Atomic weight As.
0.23182	0.162175	75.027
0.47996	0.33583	74.950
0.52521	0.367525	74.907
0.80173	0.56099	74.936
0.94782	0.66318	74.959
1.02047	0.71400	74.964
1.05462	0.73771	75.082
		Mean, 74.975

Experiments upon the conversion of silver arsenate into bromide were unsatisfactory. The conversion of lead arsenate into lead chloride gave good results, however, as follows: Calculated with Pb = 206.92.

Weight $Pb_3As_2O_8$.	Weight $PbCl_2$.	Atomic weight As.
0.38152	0.35381	74.988
0.436197	0.40449	75.016
0.57218	0.53065	74.964
0.60085	0.55717	75.020
0.74123	0.68736	75.010
0.77107	0.71494	75.067
0.88282	0.81858	75.054
0.97779	0.90674	75.054
		Mean, 75.022

Three more determinations, based upon the conversion of lead arsenate into lead bromide by heating in gaseous hydrobromic acid, were also successful. Calculated with Br = 79.95.

Weight $Pb_3As_2O_8$.	Weight $PbBr_2$.	Atomic weight As.
0.59704	0.73092	75.066
0.61712	0.75567	74.967
0.65799	0.80569	74.980
		Mean, 75.004

The general mean of all twenty-six determinations is

As = 75.008.

Various other methods of determination were attempted, but unsuccessfully.

ANTIMONY.

Friend and Smith[1] have applied a new method to the deter-

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[1] This Journal, **23**, 502 (1901).

mination of the atomic weight of antimony. Potassium tartrylantimonite (tartar emetic), was heated in dry hydrochloric acid gas, the final residue of the operation being potassium chloride. All weights were reduced to a vacuum. The results were as follows, when $H = 1.008$, $C = 12$, $K = 39.11$, and $Cl = 35.45$.

Weight of salt.	Weight KCl.	Atomic weight Sb.
1.19481	0.27539	120.345
1.57004	0.36186	120.359
2.00912	0.46307	120.351
2.04253	0.47073	120.379
2.16646	0.49935	120.341
2.25558	0.51982	120.385
2.61255	0.602155	120.350
2.95272	0.68064	120.311
	Mean,	120.353

This value approximates to those found by Schneider and by Cooke from their studies of antimony trisulphide.

TELLURIUM.

An interesting contribution to our knowledge of tellurium is due to Steiner,[1] who has measured its atomic weight by partial analyses of diphenyl telluride. In this compound, by combustion, the carbon was determined, and from that determination the atomic weight of the metal was computed. The data, for two separate fractions of material, are as follows:

	Weight $C_{12}H_{10}Te$.	Weight CO_2.	Per cent. C.	Atomic weight.
1.	0.2295	0.5512	51.39	126.1
	0.2559	0.4811	51.28	126.7
	0.23065	0.4341	51.34	126.4
2.	0.2140	0.4031	51.38	126.2
	0.2578	0.4849	51.31	126.6
			Mean,	126.4

Calculated with $C = 12.003$, $H = 1.008$. The results are, of course, only approximate, and are intended by the author as an indication of a promising method, and as evidence that the atomic weight of tellurium falls below that of iodine, as demanded by the periodic law.

Steiner also gives two analyses of diphenyl selenide, with determinations of the atomic weight of selenium based upon them. The data are:

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[1] *Ber. d. chem. Ges.*, **34**, 570.

Weight $C_{12}H_{10}Se$.	Weight CO_2.	Per cent. C.	Atomic weight.
0.2812	0.6375	61.85	78.8
0.5371	1.2158	61.71	79.3

Another communication upon the atomic weight of tellurium is by Pellini[1], who employed the old methods of oxidation and reduction connecting Te with TeO_2. His material, however, was purified by means of two organic compounds, diphenyl telluride and diphenyl tellurium dibromide, from which the metal used in the determinations was finally obtained.

First, Te was oxidized to TeO_2 by means of nitric acid. In the first three determinations the dioxide was heated to 400° ; in the remaining four it was fused. The sixth experiment is only partially stated ; the figures in the third and fourth columns have been computed by your committee. The final mean result ($O = 16$) is that given by Pellini.

Weight Te.	Weight TeO_2.	Per cent. Te in TeO_2.	Atomic weight.
1.0679	1.3353	79.968	127.70
1.5469	1.9354	79.926	127.41
2.2386	2.7980	80.007	128.05
2.4522	3.0665	79.967	127.73
2.0977	2.6239	79.945	127.56
2.0442	2.5575	79.929	127.43
2.0434	2.5556	79.957	127.66
		Mean,	127.65

The reduction experiments performed in hydrogen by Staudenmayer's method were only three in number, as follows :

Weight TeO_2.	Loss of weight.	Per cent. Te in TeO_2.	Atomic weight.
1.4680	0.2944	79.945	127.56
1.9968	0.3993	80.000	128.02
1.9575	0.3932	79.913	127.30
		Mean,	127.62

The figures obtained are not remarkably concordant, but they tend to confirm the older determinations, and to place tellurium *above* iodine.

Still a third memoir upon this atomic weight is due to Koethner,[2] whose work is more than ordinarily elaborate and thorough. His material was scrupulously purified, and studied spectroscopically; and the only (minute) impurities which seem to be possibly present are such as would tend to lower the observed atomic

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[1] *Ber. d. chem. Ges.*, **34**, 3807.

[2] *Ann. Chem.* (Liebig), **319**, 1.

weight. Several methods of determination were attempted, but the final results rest upon the study of the basic tellurium nitrate, $Te_2O_3.NO_3.OH$. This salt, on heating under proper precautions, is reduced to TeO_2. In the second series of determinations, as given below, the tellurium which served as the starting-point had been distilled *in vacuo*; in the first series that precaution was not taken. The weights were not reduced to a vacuum, and the calculations were based upon $O = 15.88$, $N = 14.93$, and $H = 1$.

SERIES I.

Weight of salt.	Weight TeO_2.	Atomic weight Te.
2.9373.	2.4522	126.39
2.7982	2.3361	126.40
2.8554	2.3840	126.46
		Mean, 126.41
		If $O = 16$, $Te = 127.36$

SERIES II.

Weight of salt.	Weight TeO_2.	Atomic weight Te
5.30270	4.42824	126.67
6.00600	5.01543	126.64
5.58039	4.65990	126.62
28.66904	23.94259	126.73
2.83859	3.20560	126.71
5.85449	4.88930	126.69
25.65029	21.42146	126.70
		Mean, 126.68
		If $O = 16$, $Te = 127.63$

These last values are essentially identical with those found by Pellini. The memoir contains criticisms of the recent work of others upon the atomic weight of tellurium, and is unusually complete.

TUNGSTEN.

Taylor[1], working under the direction of Edgar F. Smith, has made numerous experiments upon the reduction of WO_3 to W, and the reverse oxidation, and has obtained discordant data as to the atomic weight of tungsten. His material was prepared from wolfram, and purified by recrystallization as ammonium tungstate. The discrepancies are probably to be explained by the presence in the latter salt of small quantities of an ammonium-iron-manganese tungstate. Experiments were also carried out

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[1] Doctoral thesis, University of Pennsylvania, 1901.

upon the expulsion of CO_2 from Na_2CO_3 during solution in the latter of WO_3. This work was done somewhat imperfectly, and the results are not of absolute value; they are, however, encouraging, and show that the method has some presumptive merit. The thesis is essentially a study of methods, rather than of actual determinations of atomic weight. It has value, as showing some of the errors which have vitiated former work, and which may now be avoided.

URANIUM.

Aloy[1] has determined the atomic weight of uranium by a new method, which he proposes to apply to other metals as well. The pure nitrate, of unknown weight, was the material studied. Nitrogen was determined volumetrically, and in the same sample the metal was estimated as UO_2. From the ratio between these measurements the desired atomic weight was computed. The data given are as follows:

No.	Volume of N. cc.	Atomic weight U.
1	15.25	239.3
2	33.5	239.4
3	38.0	239.6
4	52.5	239.5
5	81.25	239.4
6	125.0	239.5
7	151.2	239.4
8	165.0	239.4

The value finally adopted was $U = 239.4$ when $N = 14.04$. The weights of UO_2 obtained are not published in the paper, so that the accuracy of the work cannot well be estimated. Data of this kind, which cannot be recomputed by the reader, are of very little value. It is to be hoped that the paper is only a preliminary statement, and that the full details of the research will appear later.

LANTHANUM.

Brauner and Pavlicek,[2] in determining the atomic weight of lanthanum by synthesis of the sulphate from the oxide, find that the sulphate is always contaminated by Wyrouboff's acid sulphate to a notable extent. The latter salt is so stable that even at 500° some of it remains undecomposed, while another portion

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[1] *Compt. rend.*, **132**, 551; also, more fully, in *Ann. chim. phys.*, (7), **24**, 418.

[2] *Proc. Chem. Soc.*, **17**, 63.

of sulphate in the same crucible may have been reduced to a basic compound. Hence all "equivalent" determinations of rare earths hitherto made by the sulphate method are vitiated by this error. Applying, by actual measurement, the necessary correction for excess of acid, and also correcting for the absorption of hygroscopic moisture by lanthanum sulphate, the authors find for the atomic weight of the metal in the most positive fraction of their material, the value La = 139.0. Ordinary lanthanum, however, the authors regard as a complex of this true lanthanum with another earth metal.

PRASEODYMIUM.

Brauner[1] determines the atomic weight of this metal by four methods. First, by analysis of the anhydrous sulphate, whence Pr = 140.95. Second by the analysis of the oxalate, whence Pr = 140.95. Third, by synthesis of the sulphate from the oxide, which gave Pr = 140.78. Fourth, a series like the third, but with corrections for the presence of acid sulphate and hygroscopic moisture, gave Pr = 140.93. The mean result adopted is Pr = 140.94. Detailed weighings are not given. An ebullioscopic determination of the molecular weight of praseodymium chloride confirmed the foregoing value.

NEODYMIUM.

Also determined by Brauner[2] by means of the sulphate method. Result, corrected for the presence of acid sulphate, Nd = 143.80.

THORIUM.

By the hydrolysis of thorium oxalate Brauner[3] claims to have decomposed commercial thoria into two earths which he calls Th_α and Th_β. For thorium alpha the atomic weight determinations by the oxalate method gave 233.5, and by the sulphate method 233.3 to 233.7. The most negative fractions of his material, the thorium beta, first gave the value 232.5, which, by further purification, was reduced to 232 and 231.9. By continued fractionation an oxide was obtained, giving an atomic weight of $Th_\beta = 220$. This decrease was accompanied by a reduction in the density of the oxide from 10.2 to 9.6. The complex nature of the thorium heretofore known may therefore be regarded as proved.

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[1] *Proc. Chem. Soc.*, **17**, 65.

[2] *Ibid.*, **17**, 66.

[3] *Ibid.*, **17**, 68.

Similar results to those announced by Brauner, were independently and almost simultaneously obtained by Baskerville.[1] Oxides were prepared, ranging in specific gravity from 8.47 to 11.26, the most definite or real thorium oxide giving values from 9.188 to 9.253. The lowest figures represent an oxide which occurs in small amount in ordinary thoria, the higher to a new earth. The purest thorium compound prepared was a tetrachloride, upon which atomic weight determinations were made, ThO_2 and chlorine being both estimated. Two determinations gave $Th = 223.2$ and 223.3, or about ten units below the accepted figures. In another sample the value 222.13 was found. To the unknown contamination, which raises the atomic weight of the metal and increases the density of the oxide, an atomic weight of from 260 to 280 must be attributed. This element Baskerville proposes to name carolinium. His paper is confessedly a preliminary communication, and further investigation is in progress. Since his methods of research differ from those of Brauner, the convergence of the results is all the more suggestive.

OLDER DATA.

In Bolton's "Index to Academic Dissertations," published by the Smithsonian Institution, I find the titles of four Russian theses which seem to have escaped the attention of all other writers on atomic weights. Of their value I can say nothing, but as they form part of the literature of the subject I reproduce the titles (as translated in Bolton's work) here.

Dobrovolsky, V. "Contributions to the Chemistry of Boron and Its Compounds. 1. The Atomic Weight of Boron." Kiev, 1869.

Einbrodt, Paul. "On the Atomic Weight of Nitrogen." Kharkov, 1840.

Struve, H. "Dissertation on the Determination of the Atomic Weight of Some Elements." St. Petersburg, 1850.

Viluef, V. "Dissertation on the Atomic Weight of Bismuth." St. Petersburg, 1849.

It is to be hoped that some scholar, having access to Russian literature, may prepare abstracts of these documents, and thereby make the data which are contained in them available for general use.

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[1] This Journal, **23**, 761.

THE STANDARD OF ATOMIC WEIGHTS.

Over this question, controversy still continues. The international committee of the German Chemical Society publishes its table for 1901 according to both standards; first with O = 16, and then in response to a demand from teachers giving a "didactic table" based upon H = 1. Both tables are given in this report, at the end. In their third general report[1] the same committee publish many letters from individual chemists, the final outcome from all sources being 106 voices in favor of H = 1, and 78 for O = 16. This preponderance is offset by the fact that five societies expressed their views as societies, four for O = 16, and only one for the hydrogen basis. The committee, therefore, continues to recommend the oxygen standard. The members of the Verein deutscher Chemiker who protested against the oxygen standard, also publish the results of their canvass among the teachers of chemistry in German-speaking countries[2], and give the names of the respondents. 104 favored the hydrogen unit; 19 preferred the oxygen standard. Erdman[3] has printed a table of atomic weights with H = 1, which is in most points identical with that of your committee, only it is carried out uniformly to two decimal places. The two values in which it varies essentially from ours is in Co = 58.80, or about $\frac{1}{4}$ unit higher, and in Pd = 106 or $\frac{2}{10}$ lower.

In favor of the oxygen standard there is a paper by Richards,[4] and the incidental remarks by Sakurai[5] in his essay upon "Some Points in Chemical Education." There is also, on the hydrogen side of the discussion, an elaborate article by Glücksmann.[6]

Still another standard of values has been proposed by Hinrichs,[7] who takes as the experimental basis of his system the atomic weight of "carbon-diamond" as 12 exactly. He seeks to show that all true atomic weights are multiples of the half-unit of hydrogen, but his method of discussion is more polemical than scientific. He reiterates his well-known objections to the work of

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[1] *Ber. d. chem. Ges.*, **34**, 4358.

[2] *Ztschr. angew. Chem.*, February 19, 1901.

[3] *Ibid.*, August 20, 1901.

[4] *Ztschr. anorg. Chem.*, **28**, 355.

[5] Read before the Chemical Section of the British Association, 1901. Separately printed.

[6] *Ztschr. des. allgem. österr. Apotheker-Vereins*, Nos. 23, 24, 25, 26, 1901.

[7] "The Absolute Atomic Weights of the Chemical Elements, etc." Published at St. Louis, Mo., 1901.

Stas and the "Stasians," and denounces the conclusions of these men as "false and fraudulent."

MISCELLANEOUS NOTES.

Benoist,[1] studying the "specific opacity" of substances with regard to the X-rays, finds that for the elements this property is a definite function of the atomic weight. Applying this principle to certain compounds of indium he shows that the atomic weight of that element must be 113.4 rather than 75.6. That is, the classification of indium as trivalent and not as a dyad is confirmed.

Chabrié and Rengade[2] reach the same conclusion from an ebullioscopic determination of the molecular weight of indium acetylacetonate.

In the report of this committee for 1900, Demarçay's work on the atomic weight of samarium was cited. He then found the oxide hitherto studied to have been contaminated with another earth of higher atomic weight. Continuing the investigation he has isolated this earth,[3]" which corresponds to a new metal of atomic weight 151. To this metal he gives the name *Europium*.

G. and E. Urbain,[4] by a prolonged fractionation of the yttria groups, have obtained yttria and ytterbia in a high degree of purity. The atomic weights of the two metals are given, without details, as

Yt = 88.6.
Yb = 172.6.

These values are presumably based upon O = 16.

A new earth, resembling and associated with zirconia, has been separated by Hofmann and Prandtl[5] from euxenite. They assume that the metal is a tetrad, and determine its atomic weight from two analyses of separate fractions of the sulphate.

Weight of sulphate.	Weight of oxide.	Atomic weight.
0.2176	0.1234	177.6
0.1170	0.0664	177.9

These data are only preliminary, and further investigation is promised.

Strutt[6] has applied the calculus of probabilities to the tendency

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[1] *Compt. rend.*, **132**, 772. See also pages 324, 545.
[2] *Ibid.*, **132**, 472.
[3] *Ibid.*, **132**, 1484.
[4] *Ibid.*, **132**, 136.
[5] *Ber. d. chem. Ges.*, **34**, 1064.
[6] *Phil. Mag.*, (6), **1**, 311.

exhibited by atomic weights to approximate whole numbers. No atomic weight can vary from a whole number by more than 0.5. Taking the eight elements Br, C, Cl, H, N, K, Na, and S, and assuming O = 16, the sum of the eight deviations from whole numbers is only 0.809. The probability that this sum should not be larger, is represented by about one chance in one thousand. Hence the atomic weights tend to approximate the whole numbers to a greater extent than can be accounted for by accident. As Strutt puts the case—"We have stronger reasons for believing in the truth of some modification of Prout's law than in that of many historical events which are universally accepted as unquestionable." A similar discussion, applied to eighteen elements, was once put forth by Mallet, but the mathematical treatment was not the same. There is also a short paper on the same subject by Rudolphi.[1]

TABLE OF ATOMIC WEIGHTS.

The following table of atomic weights is somewhat differently arranged from that of a year ago. First your committee gives its own list, followed by that of the German Chemical Society on the basis of H = 1. Then come the three columns, Clarke, Richards,[2] and the German,[3] on the standard of O = 16.

In the light of the foregoing report, some of the values given in the table must be regarded as doubtful. Demarçay's work on samarium, Baskerville's and Brauner's on thorium, and Brauner's upon the other rare earth metals should be taken into account. All of this work, however, needs to be carried further and published more fully before the table should be correspondingly changed. The magnitude of the necessary changes is as yet too uncertain. In the case of thorium, the atomic weight given relates to that mixture of earths which has hitherto been called thoria, and which we actually meet in analytical operations.

	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Aluminum	26.9	26.9	27.1	27.1	27.1
Antimony	119.5	119.1	120.4	120.0	120.
Argon	39.6	39.6	39.96	39.92	39.9
Arsenic	74.45	74.4	75.0	75.0	75.
Barium	136.4	136.4	137.40	137.43	137.4

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[1] *Chem. Zeitung*, **25**, 1133.

[2] *Proceedings American Academy*, April, 1901.

[3] Accompanying No. 1 of the *Berichte* for 1901, as an extra insertion.

	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Bismuth	206.5	206.9	208.1	208.	208.5
Boron	10.9	10.9	11.0	11.0	11.
Bromine	79.35	79.36	79.95	79.955	79.96
Cadmium	111.55	111.6	112.4	112.3	112.4
Caesium	131.9	132.	132.9	132.9	133.
Calcium	39.8	39.7	40.1	40.1	40.
Carbon	11.9	11.91	12.0	12.001	12.00
Cerium	138.0	139.	139.0	140.	140.
Chlorine	35.18	35.18	35.45	35.455	35.45
Chromium	51.7	51.7	52.1	52.14	52.1
Cobalt	58.55	58.56	59.00	59.00	59.
Columbium	93.0	93.3	93.7	94.	94.
Copper	63.1	63.1	63.60	63.60	63.6
Erbium	164.7	164.8	166.0	166.	166.
Fluorine	18.9	18.9	19.05	19.05	19.
Gadolinium	155.2	155.	156.4	156. ?	156.
Gallium	69.5	69.5	70.0	70.0	70.
Germanium	71.9	71.5	72.5	72.5	72.
Glucinum	9.0	9.03	9.1	9.1	9.1
Gold	195.7	195.7	197.2	197.3	197.2
Helium	3.93	4.0	3.96	3.96	4.
Hydrogen	1.000	1.00	1.008	1.0075	1.01
Indium	113.1	113.1	114.0	114.	114.
Iodine	125.89	125.90	126.85	126.85	126.85
Iridium	191.7	191.5	193.1	193.0	193.
Iron	55.5	55.6	55.9	55.9	56.
Krypton	81.15	81.2	81.76	81.7	81.8
Lanthanum	137.6	137.	138.6	138.5	138.
Lead	205.36	205.35	206.92	206.92	206.9
Lithium	6.97	6.98	7.03	7.03	7.03
Magnesium	24.1	24.18	24.3	24.36	24.36
Manganese	54.6	54.6	55.0	55.02	55.
Mercury	198.50	198.8	200.0	200.0	200.3
Molybdenum	95.3	95.3	96.0	96.0	96.
Neodymium	142.5	142.5	143.6	143.6	143.6
Neon	19.8	19.9	19.94	19.94	20.
Nickel	58.25	58.3	58.70	58.70	58.7
Nitrogen	13.93	13.93	14.04	14.04	14.04
Osmium	189.6	189.6	191.0	190.8	191.
Oxygen	15.88	15.88	16.000	16.000	16.00
Palladium	106.2	105.2	107.0	106.5	106.
Phosphorus	30.75	30.77	31.0	31.0	31.0
Platinum	193.4	193.3	194.9	195.2	194.8
Potassium	38.82	38.86	39.11	39.14	39.15
Praseodymium	139.4	139.4	140.5	140.5	140.5
Rhodium	102.2	102.2	103.0	103.0	103.0

	H = 1.		O = 16.		
	Clarke.	German.	Clarke.	Richards.	German.
Rubidium	84.75	84.76	85.4	85.44	85.4
Ruthenium	100.9	100.9	101.7	101.7	101.7
Samarium	149.2 ?	148.9	150.3 ?	150.	150.
Scandium	43.8	43.8	44.1	44.	44.1
Selenium	78.6	78.5	79.2	79.2	79.1
Silicon	28.2	28.2	28.4	28.4	28.4
Silver	107.11	107.12	107.92	107.93	107.93
Sodium	22.88	22.88	23.05	23.05	23.05
Strontium	86.95	86.94	87.60	87.68	87.6
Sulphur	31.83	31.83	32.07	32.065	32.06
Tantalum	181.5	181.6	182.8	183.	183.
Tellurium	126.1	126.	127.7	127.5 ?	127.
Terbium	158.8	....	160.	160.	....
Thallium	202.61	202.6	204.15	204.15	204.1
Thorium	230.8 ?	230.8	232.6 ?	233.	232.5
Thulium	169.4	170.	170.7	171. ?	171.
Tin	118.1	117.6	119.0	119.0	118.5
Titanium	47.8	47.7	48.15	48.17	48.1
Tungsten	182.6	182.6	184.	184.	184.
Uranium	237.8	237.7	239.6	238.5[1]	239.5
Vanadium	51.0	50.8	51.4	51.4	51.2
Xenon	127.	127.	128.0	128.	128.
Ytterbium	171.9	172.	173.2	173.	173.
Yttrium	88.3	88.3	89.0	89.0	89.
Zinc	64.9	64.9	65.4	65.40	65.4
Zirconium	89.7	90.0	90.4	90.6	90.7

METALLIC SOAPS FROM LINSEED OIL. AN INVESTIGATION OF THEIR SOLUBILITIES IN CERTAIN OF THE HYDROCARBONS.

By Hermann T. Vulté and Harriet Winfield Gibson.

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In the analysis of mixed paints, two of the most important points to be determined are the nature and the amount of the drying agent contained therein, since upon the quality of the drier present the value of the paint is largely conditioned. In modern practice, the driers used are almost invariably either the manganese or the lead soaps of linseed oil (so-called linoleates) or they are the resinates of the same metals, or they may be any mixture of these salts. The investigation of paint driers, therefore, resolves itself into a determination of the four salts mentioned. The method ordinarily pursued has been to separate the

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[1] From unpublished determinations by Richards and Merigold.