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TWELFTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED IN 1904.

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The year 1904 has been notably prolific in determinations of atomic weight, and the new data with regard to rubidium, glucinum, indium and tungsten are of more than ordinary value. Most significant, however, is the work upon nitrogen and iodine, which tends to strengthen the growing impression that the more fundamental atomic weights need to be carefully revised.

Richards and Wells, in an oral communication before the American Chemical Society and the American Association for the Advancement of Science, have shown that the accepted values for sodium and chlorine are inexact, but the details of their research are as yet unpublished. Iodine has been corrected to the extent of a tenth of a unit, and the value 14.04 for nitrogen is seriously questioned. If we regard the hydrogen-oxygen ratios as fixed, the atomic weights which need immediate attention are those of silver, sodium, potassium, chlorine, bromine, iodine, nitrogen, carbon and sulphur. These in great measure, but not absolutely, hinge upon the value assigned to silver, and that, in turn, depends upon analyses of chlorates, bromates and iodates. The atomic weight of silver, therefore, should be carefully scrutinized. Some of the desired revision is already under way, in the hands of well-known investigators, but a large amount of exact work still remains to be done. A summary of the determinations published in 1904 is presented in the following pages.

HYDROGEN, OXYGEN, CARBON AND SULPHUR.

The new data relative to the atomic weights of these elements consist of determinations of gaseous densities, or of calculations based upon former measurements. Lord Rayleigh,[1] for example, has studied the compressibility of oxygen, hydrogen, nitrogen and carbonic oxide, and compared their densities at atmospheric pressure and under conditions of great rarefaction. In the latter case the best agreement with Avogadro's law is to be expected. Leaving nitrogen to be considered separately, the following values are given for the densities of H and CO, as compared with O = 16.

	Atmospheric pressure.	Very small pressure.
H	1.0075	1.0088
CO	14.000	14.003

From the last figure given, the atomic weight of carbon becomes 12.006. At low pressures, if H = 1, O = 15.860.

Guye and Mallet[2] have recalculated Morley's data for the densities of hydrogen and oxygen, and find the ratio to be 1 : 15.8787. In a later paper Guye[3] computes the atomic weights of H and O from Morley's figures, and those of N and C from Rayleigh's work on N and CO. When O = 16, H = 1.00765 and C = 12.003. Jaquerod and Pintza[4] find the weight of 1 liter of oxygen at 0°, 760 mm., and at sea-level in latitude 45° to be 1.4292 grams. This figure is the mean of five determinations. From the density of sulphur dioxide at different pressures they compute S = 32.01, when O = 16.

NITROGEN.

Lord Rayleigh, in the paper previously cited, finds the density of N at atmospheric pressure to be 14.003, and at very low pressures 14.009. Guye's calculations lead to the figure 14.004.

Guye and Bogdan[5] have redetermined the atomic weight of nitrogen by an entirely new method. A fine spiral of iron wire was burned in an atmosphere of nitrous oxide, the gas and iron both having been weighed. The iron oxide thus produced was also weighed, and from these data the atomic weight in question was calculated. The results were as follows when O = 16.

[1] *Proc. Roy. Soc.*, **73**, 153; *Chem. News*, 89, 86.

[2] *Compt. Rend.*. **138**, 1034.

[3] *Ibid.*, **138**, 1213.

[4] *Ibid.*, **139**, 129.

[5] *Ibid.*, **138**, 1494.

Weight, N_2O.	Weight O.	Atomic weight N.
1.1670	0.4242	14.009
0.9498	0.3453	14.005
0.8652	0.3145	14.008
1.2247	0.4455	13.992
1.4202	0.5159	14.023
	Mean,	14.007

In what was evidently a continuation of the foregoing research, Jaquerod and Bogdan[1] studied nitrous oxide volumetrically. Iron wire was burned in the gas, and from the change in volume, by a method which is not explained in detail, they found N = 14.019. Still more recently Guye and Pintza[2] have redetermined the density of nitrous oxide. The weight of 1 liter, under normal conditions, was found to be as follows:

1.97789
1.97774
1.97803

Mean, 1.97788

On the supposition that carbon dioxide is comparable with nitrous oxide, that is, that the two gases are in corresponding states, the authors arrive at the atomic weight of nitrogen. The weight of CO_2, as the mean of Leduc's and Rayleigh's measurements, is 1.97693. Hence, $1.97693 : 1.97788 :: 44.005 : x, = 44.026$, and N = 14.013.

Although the new determinations of the atomic weight of nitrogen are by no means final and unimpeachable, they are remarkably concordant, and lead to the suspicion that the commonly accepted value, 14.04, is too high. Richards,[3] from a careful criticism of all former determinations, concluded that the true figure was not lower than 14.02, nor above 14.04, but this new work was not included in his discussion. Still lower values were obtained by Miss Aston from analyses of lithium, sodium, potassium, strontium, barium and silver trinitrides, and ranged from 13.86 to 13.96, or 13.903 as the mean of eighteen determinations. This work, cited by Ramsay,[4] at whose suggestion it was done, has not been published in detail, and cannot, therefore, be intelligently discussed. Ramsay, however, does

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[1] *Compt. Rend.*, **139**, 49.
[2] *Ibid.*, **139**, 677.
[3] *Proc. Am. Phil. Soc.*, **43**, 116.
[4] Gesellschaft deutscher Naturforscher und Aerzte, meeting of 1903.

not regard the results as conclusive. Evidently, the atomic weight of nitrogen needs to be thoroughly reinvestigated.

IODINE.

Two important researches upon the atomic weight of iodine have appeared during the year. That of Baxter[1] was the first one to be published in complete form, although it was preceded by a preliminary notice of the other investigation.

Baxter employed several methods of determination in which all the material used was scrupulously purified and all weights were reduced to a vacuum. Calculations were based upon O = 16, Ag = 107.93, and Cl = 35.467. The last value was recently announced by Richards and Wells, but the details which establish it are as yet unpublished. First, silver was converted into silver iodide. The metal was dissolved in nitric acid, and precipitated by ammonium iodide in presence of an excess of ammonia. Two series of determinations were made, with the results given below:

PRELIMINARY SERIES.

Weight Ag.	Weight AgI.	Atomic weight I.
5.23123	11.38531	126.970
3.57039	7.77033	126.961
4.60798	10.02804	126.951
4.52467	9.84822	126.986
4.66256	10.14591	126.930
		Mean, 126.960

FINAL SERIES.

Weight Ag.	Weight AgI.	Atomic weight I.
4.77244	10.38698	126.975
4.82882	10.50981	126.977
4.04262	8.79755	126.947
1.64711	3.58515	126.994
4.86054	10.57318	126.972
4.83482	10.52241	126.967
4.97120	10.81800	126.940
3.53858	7.70136	126.969
3.89693	8.48187	126.985
5.33031	11.60111	126.973
5.08748	11.07259	126.973
		Mean, 126.970

The seventh determination in the final series is rejected by Baxter, the mean value then becoming 126.973.

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[1] *Proc. Am. Acad.*, **40**, 419; also this Journal, **26**, 1577.

In the next series of experiments the ratio of silver to iodine was determined directly. Weighed quantities of iodine were converted into hydriodic acid by solution in sulphurous acid, then neutralized with ammonia, and titrated with a known amount of silver.

Weight Ag.	Weight I.	Atomic weight I.
5.54444	6.52288	126.977
6.27838	7.38647	126.979
4.57992	5.38814	126.976
		Mean, 126.977

Finally, the ratio of silver chloride to silver iodide was determined, by heating the latter, in quartz crucibles, in a current of chlorine. In two experiments the iodide was first transformed into bromide and then heated in chlorine. The data are as follows:

Weight AgI.	Weight AgCl.	Atomic weight I.
9.26860	5.65787	126.980
6.72061	4.10258	126.975
11.31825	6.90910	126.978
10.07029	6.74753	126.970
13.65457	8.33535	126.975
17.35528	10.59454	126.974
		Mean, 126.975

The mean of all three ratios is I = 126.975, a confirmation of the conclusions previously reached by Ladenburg. A continuation of the research is promised.

The work done by Koethner and Aeuer[1] upon the atomic weight of iodine is rather complex, and not easy to summarize. They first attempted to measure the ratio AgI : AgCl, and were surprised at obtaining values even lower than those found by Stas. This result was finally explained by the discovery that silver iodide, precipitated from a nitrate solution, carried with it inclusions of silver nitrate, which, however, together with silver chloride, was removable by long digestion with ammonia. The silver chloride produced from the iodide was found to volatilize to a small extent, and it was necessary to collect and estimate these traces. Finally, with iodide of silver from several sources, the following determinations were made, the weights

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[1] *Ann. Chem.*(Liebig), **337**, 124; Supplementary paper, p. 362; Preliminary notice, *Ber. d. chem. Ges.*. **37**, 2536.

being reduced to a vacuum. The calculations, for H = 1, were based upon Ag = 107.12 (107.93) and Cl = 35.18 (35.45).

Weight AgI.	Weight AgCl.	Atomic weight I.
24.88066	15.18917	125.982
10.24699	6.25565	125.980
12.57020	7.67391	125.981
9.62006	5.87286	125.982
12.26770	7.48902	125.988
22.60660	13.80058	125.988
20.98601	12.81162	125.981
22.47667	13.72122	125.988
	Mean,	125.984
	For O = 16,	126.936

In their supplementary paper, which was called forth by Baxter's research, the authors apply the new Richards and Wells value for chlorine to this mean value, which then becomes I = 126.964, in closer agreement with Baxter's determinations.

Koethner and Aeuer also made two syntheses of silver iodide by different methods. First, hydriodic acid was prepared from ethyl iodide, and used as the source of iodine. 34.51789 grams Ag gave 75.12752 AgI. Hence I = 126.026, for H = 1, or 126.978 when O = 16. In the second experiment iodine was purified by Stas' method, and the silver was burned in a stream of iodine vapor. 11.37544 grams Ag gave 24.75691 AgI. Hence I = 126.011, for H = 1, or 126.963 when O = 16. The last value they regard as the most probable. In their latest paper they also give one more measurement of the ratio AgI : AgCl. 25.18868 grams AgI gave 15.37678 AgCl. Hence I = 126.008 (H = 1), or 126.968 (O = 16).

Finally, Koethner and Aeuer recalculate their determinations of the AgI : AgCl ratios and also Ladenburg's, with the data used by Baxter for his vacuum corrections.

	H = 1.	O = 16.
Koethner and Aeuer	126.004	126.964
Baxter	126.015	126.975
Ladenburg	126.028	126.988

From the mean of all the forty-one determinations made by Ladenburg, Scott, Baxter, and themselves they find I = 126.010 (H = 1), and 126.970 (O = 16).

RUBIDIUM.

The determinations by Archibald[1] of the atomic weight of

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[1] *J. Chem. Soc.*, 85, 776.

rubidium follow the lines of the investigation upon caesium, which was published a year ago by Richards and Archibald. The chloride and bromide were the compounds analyzed. From the chloride the following data were obtained, with all weights reduced to a vacuum and O = 16.

Weights.			Atomic weight Rb.	
RbCl.	AgCl.	Ag.	RbCl : AgCl.	RbCl : Ag.
1.99966	2.37070	1.78454	85.489	85.485
2.06480	2.44778	1.84241	85.496	85.503
2.29368	2.71960	2.04710	85.475	85.478
1.09495	1.29796	0.97702	85.502	85.503
2.14381	2.54118	1.91316	85.507	85.488
2.89700	2.43475	2.58550	85.482	85.479
2.19692	2.60452	1.96076	85.491	85.475
2.14543	2.54386	1.91462	85.473	85.486
2.12164	2.51557	1.89346	85.477	85.483
2.25777	2.67685	2.01515	85.482	85.471
2.18057	2.58528	1.94594	85.484	85.489
2.32699	2.75878	2.07668	85.488	85.484
4.00035	4.74233	3.56998	85.495	85.486
2.43440	2.88613	2.17233	85.488	85.496
		Mean,	85.488	85.486

Archibald divides the foregoing determinations into four series, representing different samples of material, a procedure which need not be followed in an abstract like this. From all of the experiments the ratio between silver and silver chloride becomes 100 : 75.274. Stas found 75.276.

The bromide analyses were as follows:

Weights.			Atomic weight Rb.	
RbBr.	AgBr.	Ag.	RbBr : AgBr.	RbBr : Ag.
2.68170	3.04578	1.74930	85.471	85.502
2.07280	2.35401	1.35230	85.486	85.479
2.10086	2.38589	1.37061	85.485	85.478
2.61044	2.96462	1.70300	85.484	85.486
3.84082	4.36215	2.50590	85.475	85.471
3.77852	4.29084	2.46502	85.499	85.488
4.34299	4.93210	2.83340	85.488	85.477
		Mean,	85.484	85.483

The final mean adopted by Archibald for all of the determinations is Rb = 85.485. From the weights of silver and silver bromide the percentage of metal in the latter substance is 57.445, a value identical with that found by Stas.

GLUCINUM.

The redetermination by Parsons[1] of the atomic weight of glucinum is notable both for its thoroughness and for its novelty. After a careful investigation of the halide salts of glucinum and of the sulphate, which were found to be unsuitable for exact work, two new methods of determination were adopted. In one series the acetylacetonate, $Gl(C_5H_7O_2)_2$, purified by repeated sublimations, was reduced by ignition to oxide. In the other series the volatile basic acetate, $Gl_4O(C_2H_3O_2)_6$, was similarly treated. All weights were reduced to a vacuum, and the oxide obtained was also examined and corrected for occluded gases. The final figures for the two series are given below, with reduction based upon O = 16.

Weight acetylacetonate.	Weight oxide.	Atomic weight Gl.
2.62245	0.31798	9.142
3.28037	0.39757	9.129
2.08993	0.25286	9.081
2.41401	0.29233	9.105
1.61353	0.19554	9.127
1.39714	0.16905	9.083
1.85023	0.22419	9.122
		Mean, 9.113

Weight basic acetate.	Weight oxide.	Atomic weight Gl.
1.89291	0.46788	9.139
1.47931	0.36534	9.111
1.09012	0.26911	9.097
1.35642	0.33493	9.105
1.56787	0.38715	9.106
1.34465	0.33204	9.106
2.61484	0.64630	9.137
2.67721	0.66109	9.107
3.11534	0.76930	9.107
		Mean, 9.113

Tanatar[2] has endeavored to show that glucinum is a tetrad element, with an atomic weight double that which it is commonly assigned. The specific heat of the metal at low temperatures accords best with this view. The suggestion, however, does not seem to be entitled to much weight. Very recently Pollok[3] has brought forward evidence indicating that ordinary glucinum con-

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[1] This Journal. **26**, 721.

[2] *J. Chem. Soc.*, **86**, ii, abst., 335; From *Jour. Russ. Chem. Soc.*, **36**, 82.

[3] *J. Chem. Soc.*, **85**, 1630.

tains an admixture of an oxide of higher molecular weight. Fractional distillation of the chloride gave portions much more volatile and of higher molecular weight than the ordinary compound, and spectroscopic differences were also noted. If this research should be confirmed, the atomic weight of the true glucinum would be lowered.

ALUMINUM.

The work of Kohn-Abrest,[1] at least so far as it has been published, adds little or nothing to our knowledge of the atomic weight of aluminum. A metal containing 98.68 per cent. of aluminum, with known impurities, was dissolved in hydrochloric acid, and the hydrogen evolved was burned over copper oxide. From the weight of water formed the atomic weight was calculated, with $O = 15.88$. The mean of seven experiments gave $Al = 27.05$. In a single experiment 0.3429 gram Al gave 0.6444 gram Al_2O_3. Hence $Al = 27.09$. Until more details of the work have been published, the value of these experiments must remain problematical.

INDIUM.

In Thiel's research upon the atomic weight of indium,[2] several methods of determination were investigated. The conversion of the metal, through its nitrate, into the oxide gave values ranging from 113.42 to 115.6, a variation due to unavoidable errors in the process. On the one hand, indium oxide is somewhat volatile, and on the other, it tends to occlude impurities, which are probably, for the most part, gaseous. It is also hygroscopic. Indium oxide, therefore, is at present an unsatisfactory compound to employ for measurements of this kind.

With indium trichloride, better results were obtained. The following data represent vacuum weights, with all corrections applied. The calculations are based upon $O = 16$.

Weight $InCl_3$.	Weight AgCl.	Atomic weight In.
5.0194	9.7526	115.03
4.7049	9.1401	115.07
5.7067	11.0862	115.07
5.4075	10.5055	110.06
	Mean,	115.05

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[1] *Compt. Rend.*, **139**, 669.

[2] *Ztschr. anorg. Chem.*, **40**, 280. Preliminary notice, *Ibid.*, **39**, 119, and *Ber. d. chem. Ges.*, **37**, 175.

Incidentally, and as a check upon these determinations, two analyses were performed with potassium chloride.

Weight KCl.	Weight AgCl.	Atomic weight K.
7.4314	14.2903	39.11
7.4321	14.2939	39.10

With the tribromide a somewhat lower value for indium was found. The final, but uncorrected, data are subjoined.

Weight $InBr_3$.	Weight AgBr.	Atomic weight In.
8.9040	14.1531	114.74
8.2140	13.0512	114.88
9.4016	14.9422	114.79
	Mean,	114.80

The cause of the difference is unexplained, and further investigation is promised. Meanwhile, the value In = 115 is the most probable.

It should also be mentioned that Dennis and Geer have undertaken to determine the atomic weight of indium, and a preliminary notice by them on the purification of the metal has already appeared.[1]

TUNGSTEN.

The determinations, by Smith and Exner,[2] of the atomic weight of tungsten represent the culmination of ten years' work in the laboratory of the University of Pennsylvania. Many methods of determination were examined, with many failures, and unforeseen difficulties in the purification of material had to be overcome. Finally, pure compounds of tungsten were obtained, and with them the new measurements were made.

First, tungsten hexachloride was converted into trioxide by decomposition with water and ignition of the residue at a dull red heat. All weights were reduced to a vacuum, and the antecedent atomic weights were O = 16 and Cl = 35.45. Twenty-seven determinations were made, as follows:

Weight WCl_6.	Weight WO_3.	Atomic weight W.
3.18167	1.86085	184.04
2.66612	1.55903	183.94
3.52632	2.06244	184.05
1.52117	0.88972	184.07
1.22299	0.71523	184.00
2.28445	1.33603	184.01

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[1] This Journal. **26**, 437; *Ber. d. chem. Ges.*, **37**, 961.

[2] *Proc. Am. Phil. Soc.*, **43**, 123. A condensation of the memoir was given in this Journal, **26**, 1082.

Weight WCl_6.	Weight WO_3.	Atomic weight W.
3.25404	1.90337	184.10
3.37078	1.97133	184.01
7.76488	4.54082	183.98
2.08764	1.22114	184.11
2.80141	1.63859	184.09
3.24328	1.89681	184.02
4.97975	2.91262	184.06
3.04036	1.77838	184.10
4.31046	2.52133	184.10
2.21201	1.29381	184.07
2.70368	1.58135	184.06
3.60658	2.10934	184.03
2.63037	1.53835	184.02
3.41668	1.99808	184.07
3.49940	2.04675	184.06
3.86668	2.26145	184.05
3.40202	1.98970	184.03
3.20661	1.87533	184.01
3.26386	1.90909	184.09
6.73833	3.94031	183.94
7.37889	4.31643	184.14

Mean, 184.04

Secondly, twenty-three determinations were based upon the conversion of metallic tungsten into trioxide, with the subjoined results:

Weight W.	Weight WO_3.	Atomic weight W.
2.24552	2.83144	183.96
1.78151	2.24619	184.07
1.63590	2.06270	183.98
1.38534	1.74665	184.04
1.29903	1.63774	184.09
2.01302	2.53781	184.12
2.18607	2.75632	184.01
2.36755	2.98478	184.12
1.94958	2.45781	184.12
4.43502	5.59141	184.09
2.37603	2.99548	184.11
2.58780	3.26260	184.08
2.58503	3.25886	184.14
2.38298	3.00441	184.06
2.05578	2.59169	184.13
3.60828	4.54915	184.08
6.22621	7.84949	184.11
5.28444	6.66239	184.08
3.99095	5.03138	184.12

Weight W.	Weight WO_3.	Atomic weight W.
7.30166	9.20647	184.00
3.44143	4.33870	184.10
2.67709	3.37541	184.01
4.96735	6.26229	184.13
	Mean,	184.07

The mean value 184.05 probably approximates very closely to the atomic weight of tungsten.

NEODYMIUM AND PRASEODYMIUM.

Auer von Welsbach's recent atomic weight determinations[1] for these two metals are given without weights or details as to the method employed. His figures, referred to O = 16, are as follows:

	Pr.		Nd.
	140.64		144.55
	140.50		144.52
	140.56		144.57
Mean,	140.57	Mean,	144.54

SAMARIUM.

Urbain and Lacombe[2] have deduced the atomic weight of samarium from analyses of the sulphate $Sm_2(SO_4)_3.8H_2O$. The material studied was derived partly from gadolinite, partly from earths obtained from monazite sand, and the absence of europium and gadolinium was rigorously proved. The data are subjoined:

Weights.			Atomic weight.		
A. $Sm_2(SO_4)_3.8H_2O$.	B. $Sm_2(SO_4)_3$.	C. Sm_2O_3.	From A : B.	From B : C.	From A : C.
1.0499	0.8435	0.4996	150.24	150.33	150.31
1.2898	1.0362	0.6137	150.19	150.30	150.28
1.3650	1.0969	0.6497	150.58	150.34	150.39
1.7992	1.4453	0.8557	150.04	150.16	150.13
1.8636	1.4977	0.8873	150.71	150.44	150.50
0.8407	0.6749	0.4001	149.08	150.72	150.35
2.5107	2.0172	1.1948	150.30	150.34	150.33
3.1171	2.5045	1.4840	150.36	150.50	150.47
2.9425	2.3635	1.4004	149.91	150.49	150.36
		Means,	150.157	150.402	150.347

Two additional analyses gave the following figures:

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[1] *Sitzungsber. Akad. Wiss. Wien.*, **112**, 1037.

[2] *Compt. Rend.*, **138**, 1166.

A. $Sm_2(SO_4)_3.8H_2O$.	B. $Sm_2(SO_4)_3$.	C. Sm_2O_3.	From A : B.	From B : C.	From A : C.
3.2200	2.5874	1.5324	150.37	150.33	150.34
2.8382	2.2804	1.3508	150.35	150.37	150.37

The value finally adopted for the atomic weight of samarium is 150.34, when $O=16$. The value taken for sulphur is not stated, nor is anything said concerning a reduction of the weights to a vacuum.

A single determination of this atomic weight by Käppel is given by Muthmann and Weiss.[1] 4.1267 grams $Sm_2(SO_4)_3$ gave 2.45028 grams Sm_2O_3. Hence $Sm=151.39$. This figure is a unit higher than that found by Urbain and Lacombe.

EUROPIUM.

The atomic weight of europium has been determined by Urbain and Lacombe,[2] who analyzed the octohydrated sulphate. Their calculations are based on $O=16$, although it is not stated what value was assumed for S. Neither are we informed whether the weights were reduced to a vacuum. The data are as follows:

Weights.			Atomic weight		
A. $Eu_2(SO_4)_3.8H_2O$.	B. $Eu_2(SO_4)_3$.	C. Eu_2O_3.	From A : B.	From B : C.	From A : C.
1.7787	1.4303	0.8500	151.58	151.77	151.72
2.4785	1.9935	1.1848	151.94	151.80	151.83
2.4777	1.9449	1.1554	152.17	151.61	151.74
2.4831	1.9968	1.1870	151.639	151.89	151.83
2.2988	1.8488	1.0990	151.80	151.88	151.86
		Means,	151.826	151.790	151.796

The second of these means, representing the ratio $Eu_2(SO_4)_3 : Eu_2O_3$, is assumed to be most nearly correct.

GADOLINIUM.

Two determinations of the atomic weight of gadolinium are given by Marc[3]. The usual method of synthesis of sulphate from oxide was employed. The figures given are:

Weight Gd_2O_3.	Weight $Gd_2(SO_4)_3$.	Atomic weight.
0.2201	0.3666	156.30
0.2444	0.4070	156.35

These results agree closely with those reported by Bettendorf and Benedicks.

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[1] *Ann. Chem.* (Liebig), **331**, 16.

[2] *Compt. Rend.*, **138**, 627.

[3] *Ztschr. anorg. Chem.*, **38**, 128.

THORIUM, CAROLINIUM, BERZELIUM.

Baskerville[1] has continued his investigations upon the complexity of ordinary thorium, and has separated the fractions by preparing and distilling the chlorides in quartz tubes. The non-volatile residue gave an oxide soluble in concentrated hydrochloric acid, from which the chloride so produced was recrystallized several times. From this chloride the oxide was prepared, and atomic weight determinations were made by the sulphate method. The metal of the oxide was assumed to be a tetrad, and upon that basis the following results were obtained:

Weight oxide.	Weight sulphate.	Atomic weight metal.
1.559290	2.434914	255.5
0.524254	0.819365	255.9
0.549331	0.854810	255.6

To this element the name carolinium is given.

The volatile chloride obtained in the first part of the distillation, converted into oxide, gave the subjoined values:

Weight oxide.	Weight sulphate.	Atomic weight metal.
0.306778	0.505705	213.5
0.320618	0.530890	212.0
0.794692	1.309245	212.7

This series represents the element which Baskerville has named berzelium.

Finally, the thorium, which had been freed in great measure from carolinium and berzelium, was also examined.

Weight oxide.	Weight sulphate.	Atomic weight Th.
0.425456	0.694934	220.6
0.740052	1.210405	220.1

These data are only preliminary, but they strongly support the fundamental conception upon which the research was based.

MISCELLANEOUS NOTES.

Guthe[2] has remeasured the electrochemical equivalent of silver, and finds it to be 1.11683 milligrams per coulomb. A similar determination by Van Dijk and Kunst[3] gave 1.11818. The unavailability of an electrolytic comparison with silver for determining the atomic weight of antimony was mentioned in the report for 1903. The investigation there referred to has been continued by Cohen, Collins and Strengers,[4] and the former results are

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[1] This Journal, **26**, 922.

[2] Bull. Bureau of Standards, **1**, 21.

[3] *K. Acad. Weten*, Amsterdam: *Proc. Section of Sciences*, **6**, 441.

[4] *Ztschr. phys. Chem.*. **50**, 291.

confirmed. The apparent atomic weight of antimony increases with the concentration of the solution from which it is deposited. Methods for determining the atomic weights of the rare earths are discussed by W. Wild[1], who compares the volumetric and gravimetric processes. Rudorf[2] has investigated the atomic weight of radium as deduced from regularities between the spectral lines, and favors the preliminary acceptance of Ra = 225. There are also memoirs on the general subject of the spectral regularities by Runge[3] and by Watts.[4] Wetherell[5] has studied the relations between the atomic weights, and sought to explain their anomalies. On the vexed question of the standards there is another defense of the hydrogen unit by Erdmann,[6] and the same chemist[7] has proposed a table of rounded-off values for ordinary use. The international table for 1905 appeared in the January number of this Journal.

THE ELECTRICAL CONDUCTIVITY OF LIQUID AMMONIA SOLUTIONS, II.

By Edward C. Franklin and Charles A. Kraus.

Received January 5, 1905.

In our earlier investigations on the electrical conductivity of liquid ammonia solutions[8] attention was given especially to the determination of the maximum molecular conductivity of a number of salts in solution in this solvent at its boiling point, —33°. As a consequence of the direction taken by this work measurements were made only on dilute solutions. The cell used was made for this special purpose and was not adapted to measurements on good conducting solutions. We were unable therefore, without reconstructing this essential part of the apparatus, to extend our measurements to concentrated solutions.

In our preliminary qualitative work we had found that many substances which are insoluble in water, or which, although soluble, form solutions which are non-conducting, dissolve in am-

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[1] *Ztschr. anorg. Chem.*, **38**, 191.
[2] *Ztschr. phys. Chem.*. **50**, 100.
[3] *Ztschr. Elektrochem.*, **10**, 119.
[4] *Phil. Mag.*, Ser. 8, p. 279.
[5] *Chem. News*, **90**, 260, 271.
[6] *Chem. Ztg.*, **28**, 679.
[7] *Ztschr. angew. Chem.*, **38**, 1397.
[8] *Am. Chem. J.*, **23**, 277 (1900).