VOL. XXXIII. MARCH, 1911. NO. 3.

THE JOURNAL

OF THE

American Chemical Society

EIGHTEENTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED IN 1910.

BY F. W. CLARKE.

Received January 20, 1911.

During 1910 a number of important papers on atomic weights have appeared, and their results are summarized in the following pages. A third edition of Clarke's "Recalculation of the Atomic Weights," revised and much enlarged, was published by the Smithsonian Institution early in the year. The new data are as follows:

Hydrogen.—Atomic weight recalculated by Grinnell Jones[1] from all the trustworthy determinations. The value finally deduced is H = 1.00775. That found in Clarke's recalculation is 1.00779. The two agree to within one part in 25000.

Nitrogen.—Guye and Drouginine[2] have determined the atomic weight of nitrogen from analyses of weighed quantities of N_2O_4. A spiral of iron wire was heated electrically in the gas, and its increase in weight gave the amount of oxygen contained in the latter. The figures are as follows:

Weight N_2O_4.	Weight $2O_2$.	Weight N_2.	At. wt. N.
0.8856	0.6160	0.2696	14.005
1.8494	1.2860	0.5634	14.019
2.1281	1.4801	0.6480	14.010
1.7191	1.1957	0.5234	14.008
0.9951	0.6921	0.3030	14.010
1.5324	1.0658	0.4666	14.009
1.2425	0.8642	0.3783	14.008
		Mean,	14.010

---

[1] THIS JOURNAL, 32, 513.

[2] *J. chim. phys.*, 8, 473.

Clarke's combination of all previous determinations gives N = 14.0101. Richards' value is distinctly lower.

Silver and Iodine.—The ratio between silver and iodine has been remeasured, with extreme care, by Baxter.[1] The corrected weights and ratio are subjoined.

Weight I.	Weight Ag.	Ratio Ag : I.
9.00628	7.65468	0.849927
13.45067	11.43179	0.849905
11.86648	10.08571	0.849933
8.52461	7.24498	0.849890
6.42840	5.46351	0.849902
8.30266	7.05641	0.849897
9.95288	8.45904	0.849909
6.97131	5.92591	0.849899
9.38852	7.97927	0.849897
6.56811	5.58231	0.849911
18.87136	16.03902	0.849913
17.84091	15.16249	0.849872
14.95666	12.71170	0.849902
		Mean, 0.849906

This mean, combined with that found by Baxter and Tilley[2] for the ratio $2Ag : I_2O_5$, 0.64230, gives Ag = 107.864 and I = 126.913. These values are remarkably low.

Lithium.—The peculiar merit of the work done by Richards and Willard[3] on the atomic weight of lithium, apart from its accuracy, is found in the fact that the ratios measured give values for Ag, Cl and Li which are independent of all previous investigations. Three ratios were measured: $LiClO_4$ to LiCl (or 4O : LiCl), Ag to LiCl, and AgCl to LiCl. To economize space I omit the "preliminary" series of determinations, and give below only those marked "final." Vacuum weights are given throughout.

RATIO 4O : LiCl.

Weight $LiClO_4$.	Weight LiCl.	Ratio.
12.79265	5.09744	1.50962
10.55416	4.20534	1.50970
11.39912	4.54205	1.50969
11.17008	4.45070	1.50974
17.84842	7.11167	1.50974
22.58273	8.99846	1.50962
	Mean,	1.50968

---

[1] THIS JOURNAL, 32, 1603.

[2] See 17th Report, *Ibid.*, 31, 257, 258.

[3] *Ibid.*, 32, 4.

RATIO LiCl : Ag.

Weight LiCl.	Weight Ag.	Ratio.
5.82422	14.82035	0.392988
6.28664	15.99687	0.392991
5.82076	14.81122	0.392997
6.70863	17.07038	0.392998
6.24717	15.89620	0.392998
7.75349	19.72977	0.392984
7.99108	20.33415	0.392988
	Mean,	0.392992

RATIO LiCl : AgCl.

Weight LiCl.	Weight AgCl.	Ratio.
6.28662	21.25442	0.295779
5.82076	19.67873	0.295790
6.70863	22.68030	0.295791
6.24717	21.12073	0.295784
5.50051	18.59600	0.295790
8.34521	28.21438	0.295779
6.65987	22.51564	0.295789
	Mean,	0.295786

From these ratios, combined, Ag = 107.871, Cl = 35.454, and Li = 6.939. The authors regard the value for silver as representing the lower limit for that constant.[1]

Calcium.—Atomic weight redetermined by Richards and Hönigschmid,[2] from analyses of calcium bromide. Two ratios were measured, with the following results. Vacuum weights are implied. Values calculated with Ag = 107.88, Br = 79.916.

RATIO $CaBr_2$: 2Ag.

Weight $CaBr_2$.	Weight 2Ag.	At. wt. Ca.
4.20860	4.54252	40.068
4.58644	4.95025	40.071
5.34866	5.77301	40.068
7.23724	7.81126	40.073
4.67673	5.04779	40.068
7.41636	8.00455	40.074
	Mean,	40.0703

---

[1] Scheuer, *J. chim. phys.*, 8, 289, discusses the atomic weight of chlorine as deduced from the density of HCl. The paper is practically a reproduction of one cited last year. Hinrichs, *Compt. rend.*, 151, 513, argues that Ag = 108 exactly.

[2] THIS JOURNAL, 32, 1577. A second paper by the same authors is in THIS JOURNAL for January, 1911.

RATIO $CaBr_2 : 2AgBr$.

Weight $CaBr_2$.	Weight $2AgBr$.	At. wt. Ca.
10.18591	19.13778	40.073
7.92400	14.88810	40.072
6.78048	12.73961	40.072
6.45970	12.13702	40.070
5.95390	11.18684	40.067
5.15998	9.69513	40.067
	Mean,	40.0702

Why this determination, which confirms the earlier work of Richards, should be so much lower than that of Hinrichsen is unexplained. The new work is probably to be preferred.

Strontium.—Thorpe and Francis[1] have redetermined the atomic weight of strontium by several distinct methods. The corrected weights are given in the following summary of results:

RATIO $SrBr_2 : 2Ag$.

Weight $SrBr_2$.	Weight $2Ag$.	Ratio.
1.77884	1.55073	1.1471
1.86109	1.62260	1.1470
1.85254	1.61511	1.1470
1.73801	1.51534	1.1470
1.85787	1.61994	1.1469
1.70563	1.48707	1.1470
	Mean,	1.1470

Hence Sr = 87.645.

RATIO $SrBr_2 : 2AgBr$.

Weight $SrBr_2$.	Weight $2AgBr$.	Ratio.
1.86112	2.82438	0.65895
1.85261	2.81155	0.65893
1.73807	2.63762	0.65895
1.85798	2.81999	0.65886
1.70571	2.58866	0.65892
	Mean,	0.65892

Hence Sr = 87.653.

RATIO $SrCl_2 : 2Ag$.

Weight $SrCl_2$.	Weight $2Ag$.	Ratio.
1.64759	2.24203	0.73486
1.66352	2.26356	0.73491
1.53462	2.08817	0.73491
1.64619	2.24011	0.73487
1.76006	2.39486	0.73493
1.56224	2.12572	0.73492
	Mean,	0.73490

Hence Sr = 87.642.

---

[1] *Proc. Roy. Soc.*, 83 (A), 277.

RATIO $SrCl_2$: $2AgCl$.

Weight $SrCl_2$.	Weight $2AgCl$.	Ratio.
1.64764	2.97899	0.55309
1.66357	3.00762	0.55312
1.53467	2.77416	0.55314
1.64624	2.97653	0.55307
1.76010	3.18202	0.55314
	Mean,	0.55311

Hence Sr = 87.645.

Supplementary determinations were made by determining the ratios $SrBr_2$: $SrSO_4$, and $SrCl_2$: $SrSO_4$, as follows:

RATIO $SrBr_2$: $SrSO_4$.

Weight $SrBr_2$.	Weight $SrSO_4$.	Ratio.
7.14570	5.30466	1.3471
7.64281	5.67326	1.3472
9.86072	7.32047	1.3470
	Mean,	1.3471

Hence Sr = 87.629.

RATIO $SrCl_2$: $SrSO_4$.

Weight $SrCl_2$.	Weight $SrSO_4$.	Ratio.
7.30246	8.46071	0.86310
8.71628	10.09868	0.86311
8.46493	9.80743	0.86311
8.79502	10.18959	0.86314
	Mean,	0.863115

Hence Sr = 87.661.

The authors adopt 87.65 as their final value, after discussing the relative merits of the several ratios. The calculations are based upon Ag = 107.88, Cl = 35.46, Br = 79.916, and S = 32.07.

Mercury.—Easley[1] has continued his research upon the atomic weight of mercury, the first part of which was noticed last year. Mercuric chloride was analyzed by electrolysis, giving the subjoined results. The weights are reduced to a vacuum, and the calculations are based upon Cl = 35.46.

PRELIMINARY SERIES.

Weight $HgCl_2$.	Weight Hg.	At. wt. Hg.
10.05743	7.43123	200.68
8.41289	6.21687	200.71
10.99056	8.11897	200.52
10.28282	7.59681	200.58
19.57120	14.46032	200.65
	Mean,	200.63

---

[1] THIS JOURNAL, 32, 1117.

FINAL SERIES.

Weight $HgCl_2$.	Weight Hg.	At. wt. Hg.
8.14695	6.01909	200.61
11.03881	8.15592	200.64
13.48192	9.96129	200.66
11.08026	8.18610	200.60
11.31231	8.35819	200.66
21.44026	15.84060	200.62
	Mean,	200.63

This confirms the previous work, and seems to prove that the heretofore accepted value for mercury is too low.

Phosphorus.—Atomic weight redetermined by Baxter and Jones[1] from analyses of silver phosphate.

Weight Ag_3PO_4.	Weight 3AgBr.	Ratio.
6.02166	8.34490	1.34558
6.35722	8.55419	1.34559
5.80244	7.80819	1.34567
5.05845	6.80685	1.34564
3.34498	3.43544 (AgCl)	1.34560
7.15386	9.62694	1.34570
7.20085	9.68947	1.34560
6.20182	8.34522	1.34561
5.20683	7.00605	1.34555
	Mean,	1.34562

In experiment 5 the silver was weighed as chloride, but recalculated to bromide in the ratio. With Ag = 107.88, P = 31.043.

Vanadium.—Prandtl and Bleyer, whose work on the atomic weight of vanadium was noticed in my report for 1909, have published a second memoir[2] on the subject. Eight new analyses of vanadyl trichloride are given, of which four are rejected as defective. The four satisfactory determinations follow, with vacuum weights, and the ratio 3AgCl : $VOCl_3$: : 100 : x.

Weight $VOCl_3$.	Weight 3AgCl.	Ratio.
7.77585	19.26836	40.301
8.41904	20.86554	40.311
10.66137	26.42699	40.321
5.53998	13.73492	40.333
	Mean,	40.3165

From these figures, combined with the earlier series, the authors deduce V = 51.061, ±0.024, when Ag = 107.880 and Cl = 35.460.

Prandtl and Bleyer also investigated the ratio $V_2O_5 : V_2O_3$, by re-

---

[1] THIS JOURNAL, **32**, 298.

[2] *Z. anorg. Chem.*, 67, 257.

duction of the pentoxide in hydrogen. Their determinations, with vacuum weights, appear in the next table.

Weight V_2O_5.	Weight V_2O_3.	At. wt. V.
9.11431	7.51639	51.261
9.85727	8.13127	51.376
8.70923	7.18456	51.395
12.26426	10.11721	51.394
	Mean,	51.3565 [1]

Although these determinations agree with Roscoe's, the authors regard them as doubtful. Their $VOCl_3$ determinations are preferred.

The work of McAdam[2] on this constant consisted in reducing $NaVO_3$ to NaCl by heating in dry HCl. With vacuum weights, and NaCl = 58.46, the following results were obtained:

Weight $NaVO_3$.	Weight NaCl.	At. wt. V.
4.8564	2.3277	50.966
5.6404	2.7033	50.976
4.4263	2.1220	50.946
5.7805	2.7710	50.952
9.4902	4.5478	50.997
	Mean,	50.967

Taking into consideration the determinations of Prandtl and Bleyer, the atomic weight of vanadium may be rounded off to 51.

Tantalum.—Balke's[3] determinations of the atomic weight of tantalum are based upon the hydrolysis of the pentachloride. With vacuum weights and Cl = 35.46, the final results are as follows:

Weight $TaCl_5$.	Weight Ta_2O_5.	At. wt. Ta.
12.99680	8.02326	181.49
9.24957	5.71104	181.60
10.17456	6.28133	181.52
17.99542	11.11014	181.55
11.70558	7.22693	181.55
6.24767	3.85658	181.46
7.26375	4.48398	181.48
15.88270	9.80465	181.49
	Mean,	181.52

The rounded-off number 181.5 is to be accepted.

Tellurium.—Marckwald and Foizik,[4] by a complex volumetric process, find for this atomic weight the value 127.61. The data are too bulky and complicated for reproduction here. The purpose of the investigation

---

[1] The authors give 51.374.

[2] THIS JOURNAL, 32, 1603.

[3] *Ibid.*, 32, 1127.

[4] *Ber.*, 43, 1710.

was not so much to determin the atomic weight exactly, as to ascertain the cause of the low value found in several previous researches.

Flint[1] has continued the work reported by Browning and Flint in 1909 on the fractionation of tellurium by hydrolysis of the tetrachloride. The unfractionated material, by the basic nitrate method, gave Te = 127.45. Progressive diminution of the atomic weight was noted in a series of fractions, namely the fourth, eight and tenth. The tenth gave low atomic weights as shown in the following table:

Weight Te_2HNO_7.	Weight TeO	At. wt. Te.
2.06311	1.71688	124.25
2.18903	1.82172	124.27
3.56161	2.96446	124.42
2.99821	2.49537	124.37
2.86977	2.38824	124.27
2.47403	2.05898	124.31
4.85363	4.03943	124.32
	Mean,	124.32

The investigation is still in progress; but the present results are promising, and seems to show that ordinary tellurium is really a mixture. If that should be proved, all former determinations of the atomic weight would go for nothing.

Scandium.—Preliminary determinations of the atomic weight of scandium, by the sulfate method, are given by Meyer and Winter,[2] but without the detailed weighings. The values found for Sc range between 44.86 and 45.37; in mean, 45.12. This is much higher than the accepted value.

Neodymium.—By very careful analyses of neodymium chloride, Baxter and Chapin[3] have determined the atomic weight of the metal. Two ratios were measured, with vacuum weights, and reduced with Ag = 107.880 and Cl = 35.457.

RATIO $NdCl_3$: 3Ag.

Weight $NdCl_3$.	Weight 3Ag.	At. wt. Nd.
4.27402	5.51855	144.283
2.79574	3.61030	144.249
2.77391	3.58196	144.259
3.42064	4.41695	144.267
4.11855	5.31786	144.280
3.95958	5.11289	144.266
4.64435	5.99699	144.271
	Mean,	144.268

---

[1] *Am. J. Sci.*, [4] 30, 209.

[2] *Z. anorg. Chem.*, 67, 398.

[3] *Proc. Am. Acad.*, 46, 215 (1910); reproduced in THIS JOURNAL for January, 1911.

Ratio $NdCl_3 : 3AgCl$.

Weight $NdCl_3$.	Weight $3AgCl$.	At. wt. Nd.
3.16218	5.42546	144.257
2.93305	5.03226	144.262
2.99149	5.13195	144.289
2.62468	4.50338	144.250
2.38439	4.09064	144.278
2.55827	4.38891	144.280
3.59114	6.16095	144.277
4.27402	7.33203	144.293
4.69459	8.05444	144.264
2.79574	4.79630	144.280
2.59810	4.45741	144.270
3.42064	5.86872	144.265
4.11855	7.06518	144.298
3.95958	6.79345	144.262
2.71834	4.66395	144.257
	Mean,	144.272

A slight correction for a little unseparated praseodymium raises the value to 144.275. This is doubtless the best determination of the constant yet made.

Erbium.—Hofmann,[1] by analyses and syntheses of the sulfate, has made three new determinations of the atomic weight of "neoerbium."

Weight Er_2O_3.	Weight sulfate.	Weight Er_2O_3.	At. wt. Er.
0.3117	0.5070	0.3117	167.67
0.4486	0.7296	0.44863	167.73
0.3718	0.6048	0.3718	167.64
		Mean,	167.68

The oxide in the first column was converted into sulfate, which, on calcination, gave the oxide of the third column. Calculated with S = 32.07.

The Helium-Argon Group.—Watson[2] has determined the weight of a normal liter of helium as 0.17814 and 0.17830 gram. Hence He = 3.994. For neon, eleven determinations of the normal liter ranged from 0.8997 to 0.9006 gram; in mean, 0.9002. This, by the method of limiting densities, gives Ne = 20.200. By the same method Watson[3] has reduced the densities of krypton and xenon, as measured in 1908 by Moore.[4] The final values are Kr = 82.92 and Xe = 130.22.

The density of argon has been redetermined by Fischer and Hähnel.[5]

---

[1] *Ber.*, 43, 2635.

[2] *J. Chem. Soc.*, 97, 810.

[3] *Ibid.*, 97, 833.

[4] *Proc. Chem. Soc.*, 24, 273.

[5] *Ber.*, 43, 1435.

The mean of seven determinations is 19.945, referred to O = 16. Hence A = 39.89.

Ramsay and Gray,[1] by means of the microbalance, have been able to weigh the gaseous emanation of radium, for which they propose the name *niton*. The values thus found for its molecular weight are 222, 216, 227, 218, 217, in mean 220. The same value was also found by Debierne[2] by a different method.

Miscellaneous Notes.—Richards and Baxter[3] have investigated the subject of density corrections, or in other words the reduction of weights to a vacuum. They regard the validity of the corrections, as applied at Harvard, as well established. Relations between the atomic weights have been studied by Howard.[4] Dubreuil[5] has continued his recalculation of the determinations of Stas.

[Contributions from the Chemical Laboratory of Harvard College.]

THE ULTRAVIOLET ABSORPTION SPECTRUM OF AQUEOUS SOLUTIONS OF NEODYMIUM CHLORIDE.

By Gregory Paul Baxter and Truman Stephen Woodward.

Received December 22, 1910.

In a recent paper upon the atomic weight of neodymium[6] the absorption spectrum of aqueous solutions of neodymium salts from λ 7000 to λ 4000 is described. After the earlier measurements were made a large quartz spectrograph became available, and with this instrument the ultraviolet absorption spectrum of aqueous neodymium chloride has been examined.

The spectrograph was constructed by R. Fuess, Berlin. It has lenses 5 cm. in diameter, provided with diaphragms, and of about 80 cm. focal length, while the 60° Cornu prism is of 5 cm. base and 4.5 cm. high. In order to avoid as far as possible difficulty from double refraction the diameter of the lenses was diminished one-half with the diaphragms. By means of a series of trial negatives, with the spark of a cadmium alloy for illumination, the prism was set in the position of minimum deviation for approximately λ 3400, and the positions of the collimating and camera lenses were so adjusted that the region λ2500 to λ7500 was in fair focus throughout. Owing to the curvature of the spectrum image, it was not possible to have a wider range in focus at any one time. However, this range included the whole of the best continuous spectrum which we were able to produce.

---

[1] *Compt. rend.*, 151, 126.

[2] *Ibid.*, 150, 1740.

[3] This Journal, 32, 507.

[4] *Chem. News*, 101, 181, 265.

[5] *Bull. soc. chim.*, [4] 7, 119.

[6] Baxter and Chapin, *Proc. Am. Acad.*, 46, 215 (1910); This Journal, 33, 13.