VOL. XVIII. MARCH, 1896. No. 3.

THE JOURNAL

OF THE

AMERICAN CHEMICAL SOCIETY.

THIRD ANNUAL REPORT OF COMMITTEE ON ATOMIC WEIGHTS. RESULTS PUBLISHED DURING 1895.[1]

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Received January 3, 1896.

To the Members of the American Chemical Society:

YOUR committee upon atomic weights respectfully submits the following report, summarizing the work done in this branch of chemistry during 1895, a year which may be well called eventful in the history of the science. Two new elements, argon and helium, have been made known to the world, and from the most unexpected sources; the collective works of Stas have been published by the Belgian Academy, as a monument to his memory; Prof. Morley's great research upon oxygen is at last finished; and a goodly number of other important determinations have appeared. Incidentally, but pertinently, I may also call attention to the Marignac memorial lecture by Cleve,[2] in which the atomic weight researches of the former chemist are well outlined; and to the extraordinary number of papers upon the periodic law, which have been called out by the discovery of argon and helium. These papers fall outside the scope of this report, and they are numerous enough to almost warrant a bibliography of their own.

The H: O ratio.—Prof. Morley's work upon this fundamental constant has been published in full by the Smithsonian Insti-

[1] Read at the Cleveland Meeting, December 31, 1895.

[2] *J. Chem. Soc.*, June, 1895.

tute,[1] and divides itself naturally into four parts : .First, the density of oxygen ; second, that of hydrogen ; third, the volumetric composition of water ; and fourth, its gravimetric synthesis.

For the density of oxygen, or rather the weight of one liter at 0°, 760 mm., at sea level and in latitude 45°, three sets of measurements are given, with the following mean values in grams :

Series 1	1.42879 ± 0.000034
" 2	1.42887 ± 0.000048
" 3	1.42917 ± 0.000048

As the third series, on experimental grounds, is regarded by Morley as the best, he assigns it double weight, and on this basis the general mean of all three becomes

$$1.42900 \pm 0.000034.$$

For the weight of a liter of hydrogen, under similar standard conditions, five series of determinations are given, as follows :

Series 1	0.089938
" 2	0.089970
" 3	0.089886 ± 0.0000049
" 4	0.089880 ± 0.0000088
" 5	0.089866 ± 0.0000034

The hydrogen of the first and second series was probably contaminated by traces of mercurial vapor, and these results are therefore rejected by Morley. For the third, fourth and fifth series the electrolytic gas was occluded in palladium and transferred to the measuring globes without the intervention of stop-cocks ; thus avoiding contact with mercury and leakages of external air. Their general mean is

$$0.089873 \pm 0.0000027.$$

Dividing the weight found for oxygen by this value for hydrogen the ratio becomes

$$15.9002.$$

For the volumetric ratio O : 2H, Morley finds the value

[1] "On the Density of Oxygen and Hydrogen, and on the Ratio of their Atomic Weights." By Edward W. Morley. Smithsonian Contributions to Knowledge, 1895. 4to. xi + 117 pp. 40 cuts. Abstract in *Am. Chem. J.*, 17, 267, (gravimetric) ; and *Ztschr. phys. Chem.*, 17, 87, (gaseous densities) ; also note in *Am. Chem. J.*, 17, 396.

1 : 2.00269. Applying this as a correction to the density ratio, we have for the atomic weight of oxygen

$$O = 15.879.$$

In his synthesis of water Morley differs from all of his predecessors in that he weighed both constituents separately, and also the water formed. In other words, his syntheses are complete, and take nothing for granted. The weights in grams, are as follows :

	O used.	H used.	Water found.
1	25.9176	3.2645	29.1788
2	25.8531	3.2559	29.1052
3	30.3210	3.8193	34.1389
4	30.5294	3.8450	Lost.
5	30.4700	3.8382	34.3151
6	30.5818	3.8523	34.4327
7	30.4013	3.8297	34.2284
8	30.3966	3.8286	34.2261
9	30.3497	3.8225	34.1742
10	30.3479	3.8220	34.1743
11	29.8865	3.7637	33.6540
12	30.3429	3.8211	34.1559

From these data, two sets of values for the atomic weight of oxygen are derivable ; one from the ratio H : O, the other from the ratio $H : H_2O$. These sets are subjoined.

	H : O.	$H : H_2O$.
1	15.878	15.877
2	15.881	15.878
3	15.878	15.873
4	15.880	.....
5	15.877	15.881
6	15.877	15.876
7	15.877	15.875
8	15.878	15.879
9	15.879	15.881
10	15.881	15.883
11	15.881	15.883
12	15.882	15.878
Mean	15.8792	15.8785

From the density work the value found was 15.879, and the mean of this with the two synthetic results is

$$O = 15.8789.$$

Hence, for all practical purposes the atomic weight of oxygen may be put at 15.88, with an uncertainty of less than one unit in the second decimal.

It is impracticable, in a report of this kind, to go into the details of so elaborate an investigation as this of Morley's, and a bare statement of results must suffice. The research, however, is one of the most perfect of its kind, every source of error having been considered and guarded against, and it will doubtless take its place in chemical literature as a classic. Independently of its main purpose, the book is almost a manual on the art of weighing and measuring gases, and no experimenter who engages upon work of that kind can afford to overlook it.

More recently still, a new determination of the atomic weight of oxygen has been published by Julius Thomsen,[1] whose method is quite novel. First, aluminum, in weighed quantities, was dissolved in caustic potash solution. In one set of experiments the apparatus was so constructed that the hydrogen evolved was dried and then expelled. The loss of weight of the apparatus gave the weight of the hydrogen so liberated. In the second set of experiments the hydrogen passed into a combustion chamber in which it was burned with oxygen, the water being retained. The increase in weight of this apparatus gave the weight of oxygen so taken up. The two series, reduced to the standard of a unit weight of aluminum, gave the ratio between oxygen and hydrogen.

The results of the two series, reduced to a vacuum and stated as ratios, are as follows:

First, $\frac{\text{Weight of H.}}{\text{Weight of Al.}}$ Second, $\frac{\text{Weight of O.}}{\text{Weight of Al.}}$

First.	Second.
0.11180	0.88788
0.11175	0.88799
0.11194	0.88774
0.11205	0.88779
0.11189	0.88785
0.11200	0.88789
0.11194	0.88798
0.11175	0.88787

[1] *Ztschr. anorg. Chem.*, 11, 14.

First.	Second.
0.11190	0.88773
0.11182	0.88798
0.11204	0.88785
0.11202	
0.11204	0.88787 ± 0.000018
0.11179	
0.11178	
0.11202	
0.11188	
0.11186	
0.11185	
0.11190	
0.11187	
0.11190 ± 0.000015.	

Dividing the mean of the second column by the mean of the first, we have for the equivalent of oxygen:

$$\frac{0.88787 \pm 0.000018}{0.11190 \pm 0.000015} = 7.9345 \pm 0.0011.$$

Hence, $O = 15.8690 \pm 0.0022$.

The details of the investigation are somewhat complicated, and involve various corrections which need not be considered here. The result as stated, includes all corrections and is evidently good. The ratios, however, cannot be reversed and used for measuring the atomic weight of aluminum, because the metal employed was not absolutely pure.

The Stas Memorial.—As a monument to the memory of the late Jean Servias Stas, more appropriate than statue or column of stone, the Belgian Academy has published his collected works in three superb quarto volumes.[1] All of his great investigations are here gathered together, and in the third volume, entitled "Oeuvres Posthumes," some hitherto unpublished data are given for the important ratio between potassium chloride and silver. These data are represented by two series: one made with a uniform sample of silver, and chloride from various sources; the other with constant chloride, but with silver of diverse origin; the aim being to establish experimentally the fixed character of each substance. The first series is complete;

[1] Jean Servias Stas. Oeurves Complétes. Edited by W. Spring. Bruxelles, 1894.

of the second series only one experiment was found recorded among Stas' papers.

The quantity of potassium chloride equivalent to 100 parts of silver was found to be as follows:

	69.1227
	69.1236
	69.1234
	69.1244
	69.1235
	69.1228
	69.1222
	69.1211
	69.1219
	69.1249
	69.1238
	69.1225
	69.1211
Mean of first series	69.1229
Second series	69.1240

These results give an effective confirmation to Stas' determinations of 1882.

Cobalt.—The atomic weight of cobalt has been redetermined by Thiele.[1] First, carefully purified oxide of cobalt, CoO, was reduced in hydrogen. The weight and results are as follows:

Residual Co.	Loss of O.		Atomic weight of Co
0.90068	0.24429		58.843
0.79159	0.21445		58.912
1.31558	0.35716		58.788
		Mean	58.848

Reduced to vacuum standards this becomes

$$Co = 58.826,$$

when $O = 15.96$.

In a second method metallic cobalt was dissolved in hydrochloric acid, and the solution evaporated to dryness with special precautions against dust. The chloride thus obtained was then dried at 150° in a stream of pure gaseous hydrochloric acid, so that basic salts could not be formed. From the weight of cobalt

[1] "Die Atomgewichts bestimmung des Kobalts." A doctoral dissertation. Basel, 1895.

and of cobalt chloride the ratio $Co:Cl_2$ is determined. The chlorine was afterwards re-estimated as silver chloride, giving the ratio Co : 2AgCl. The weights are subjoined:

Co taken.	Cl taken up.	AgCl.
0.7010	0.8453	.....
0.3138	0.3793	.....
0.2949	0.3562	1.4340
0.4691	0.5657	2.2812
0.5818	0.7026	2.8303
0.5763	0.6947	.....
0.5096	0.6142	2.4813

Hence, with Cl = 35.37, and Ag = 107.66, Co =

$Co:Cl_2$.	Co : 2AgCl.
58.66	.....
58.52	.....
58.57	58.828
58.66	58.825
58.58	58.803
58.68	.....
58.69	58.750
Mean 58.64	Mean, 58.801

The second column is subject to a small correction for dissolved silver chloride, which reduces the mean to Co = 58.770. Reduced to a vacuum this becomes 58.765, and the value from the Co : Cl_2 ratio becomes 58.61. Thiele regards Co = 58.765 as the most probable value to be derived from his experiments. This becomes

With O = 16, Co = 58.912
" O = 15.88, Co = 58.470.

In my report for 1894 I gave Winkler's work on cobalt and nickel, which involved their ratios to iodine. In a supplementary paper Winkler[1] gives some similar experiments with iron, intended to show that errors due to metallic occlusion of hydrogen are absent from his determinations. He succeeds in proving that such errors, if they exist, must be very small. Thiele also considered their possibility, and guarded against them in the preparation of his cobalt.

Zinc.—Atomic weights redetermined by Richards and Rogers,[2]

1 *Ztschr. anorg. Chem.*, 8, 291.

2 *Ztshhr. anorg. Chem.*, 10, 1. Calculations made with O = 16, Ag = 107.93, and Br = 79.955.

who used the bromide method. Zinc bromide, carefully purified, was treated gravimetrically with standard silver solution. The weights and results are subjoined :

First, $ZnBr_2 : 2AgBr$.

$ZnBr_2$.	AgBr.	Atomic weight of Zn.
1.69616	2.82805	65.469
1.98198	3.30450	65.470
1.70920	2.84549	65.487
2.35079	3.91941	65.470
2.66078	4.43751	65.400
	Mean,	65.459

Second, same ratio.

$ZnBr_2$.	AgBr.	Atomic weight of Zn.
2.33882	3.90067	65.400
1.97142	3.28742	65.434
2.14985	3.58539	65.402
2.00966	3.35074	65.463
	Mean,	65.425

Third, $ZnBr_2 : Ag_2$.

$ZnBr_2$.	Ag.	Atomic weight of Zn.
2.33882	2.24063	65.409
1.97142	1.88837	65.444
2.14985	2.05971	65.396
2.00966	1.92476	65.472
	Mean,	65.430

Two additional series of data are given by Richards alone, as follows :

First, $ZnBr_2 : Ag_2$.

$ZnBr_2$	Ag.	Atomic weight of Zn.
6.23833	5.9766	65.403
5.26449	5.0436	65.404
9.36283	8.9702	65.392
	Mean,	65.402

Second, $ZnBr_2 : 2AgBr$.

$ZnBr_2$.	AgBr.	Atomic weight of Zn.
2.65847	4.43358	65.410
2.30939	3.85149	65.404
5.26449	8.77992	65.404
	Mean,	65.406

The final mean adopted by Richards is 65.404. With O = 15.88 this becomes

$$Zn = 64.913.$$

Cadmium.—Mr. Bucher's paper,[1] as its title indicates, is a study of methods rather than a final determination of atomic weight; but the results recorded in it compare well with those reached by others. His starting point is metallic cadmium, purified by nine distillations *in vacuo*, and from this material, with pure reagents, his various preparations were made. Vacuum weights are given, and the antecedent values used in calculation are O, 16; S, 32.059; C, 12.003; Cl, 35.45; Br, 79.95; and Ag, 107.93.

First, cadmium oxalate, dried for fifty hours at 150°, was decomposed by heat, and so reduced to oxide. The variations are mainly attributed to imperfect dehydration of the oxalate. Weights and results are as follows:

Oxalate.	Oxide.	Atomic weight of Cd.
1.97674	1.26474	111.74
1.94912	1.24682	111.83
1.97686	1.25886	111.85
1.87099	1.19675	111.81
1.37550	0.87994	111.86
1.33313	0.85308	111.96
1.94450	1.24452	112.02
2.01846	1.29210	112.09
	Mean,	111.89

Second, cadmium oxalate was transformed to sulphide by heating in a stream of hydrogen sulphide. The data are:

Oxalate.	Sulphide.	Atomic weight of Cd.
2.56319	1.84716	112.25
2,18364	1.57341	112.19
2.11643	1.52462	112.03
3.13105	2.25582	112.12
	Mean,	112.15

Third, cadmium chloride, dried at 300° in a stream of dry, gaseous hydrochloric acid, was precipitated by silver nitrate, and the silver chloride was collected with all necessary precautions. The weights and results are subjoined:

1 "An examination of some methods employed in determining the atomic weight of cadmium." By John E. Bucher. Johns Hopkins University doctoral dissertation. Baltimore (Friedenwald), 1895.

$CdCl_2$.	AgCl.	Atomic weight of Cd.
3.09183	4.83856	112.34
2.26100	3.53854	112.33
1.35729	2.12431	112.32
2.05582	3.21727	112.34
1.89774	2.97041	112.31
3.50367	5.48473	112.28
2.70292	4.23087	112.30
4.24276	6.63598	112.44
3.40200	5.32314	112.37
4.60659	7.20386	112.47
2.40832	3.76715	112.42
2.19144	3.42724	112.46
2.84628	4.45477	112.32
2.56748	4.01651	112.41
2.31003	3.61370	112.41
1.25008	1.95652	112.32
1.96015	3.06541	112.47
2.29787	3.59391	112.45
1.94227	3.03811	112.42
1.10976	1.73547	112.47
1.63080	2.55016	112.48
	Mean,	112.39

Fourth, cadmium bromide was analyzed in much the same way as the chloride. The weights and results are as follows :

$CdBr_2$.	AgBr.	Atomic weight of Cd.
4.39941	6.07204	112.35
3.18030	4.38831	112.42
3.60336	4.97150	112.45
4.04240	5.58062	112.29
3.60505	4.97519	112.38
	Mean,	112.38

Fifth, cadmium sulphate was formed by synthesis from metallic cadmium. 1.15781 grams cadmium gave 2.14776 cadmium sulphate. Hence Cd = 112.35. As any impurity in the sulphate would tend to lower the atomic weight found, this is probably a minimum value.

Sixth, metallic cadmium was converted into oxide by solution in nitric acid and ignition of the nitrate. The ignition was performed in double crucibles, both porcelain in experiments 1 and 2, the inner one of platinum in the rest of the series. Weights and results as follows :

Cd.	CdO.		Atomic weight of Cd.
1.26142	1.44144		112.12
0.99785	1.40135		112.04
		Mean,	112.08
1.11321	1.27247		111.84
1.02412	1.17054		111.91
2.80966	3.21152		111.87
		Mean,	111.87

In this case additional experiments were made to discover the sources of error, leading to corrections which bring the results near to those found in the chloride and bromide series. Each of the methods is quite fully discussed, and the sources of error are noted. With O = 16, 112.39 seems to be a close approximation to the true atomic weight of cadmium.

Molybdenum.—Seubert and Pollard,[1] by two distinct methods, have redetermined the atomic weight of this element. First, molybdenum trioxide was dissolved, in weighed quantities, in a standard solution of caustic soda. The excess of soda was then measured by titration with standard sulphuric acid and lime water. In another set of experiments the volumetric value of the caustic soda had been estimated with standard hydrochloric acid, while the last compound had also been determined gravimetrically in terms of silver chloride. Hence the data, all considered together, give from their true end terms, the ratio MoO_3 : 2AgCl, although in a very indirect manner; and for this indirection the authors give good reasons. The weights and results, considering only the end terms, are as follows:

MoO_3.	AgCl.		Atomic weight of Mo.
3.6002	7.1709		95.734
3.5925	7.1569		95.708
3.7311	7.4304		95.757
3.8668	7.7011		95.749
3.9361	7.8407		95.720
3.8986	7.7649		95.740
3.9630	7.8941		95.723
3.9554	7.8806		95.694
3.9147	7.7999		95.686
3.8543	7.6767		95.740
3.9367	7.8437		95.688
		Mean,	95.722

[1] *Ztschr. anorg. Chem.*, **8**, 434. Calculations on the basis of O = 15.96.

Reduced to vacuum standards this becomes Mo = 95.729. With O = 16, Mo = 95.969; and with O = 15.88, Mo = 95.249,

Another series of determinations, in confirmation of the first, was made by the old method of reducing molybdenum trioxide in hydrogen. The weights and results are subjoined:

MoO_3.	Mo.		Atomic weight of Mo.
1.8033	1.2021		95.736
1.7345	1.1564		95.777
3.9413	2.6275		95.756
1.5241	1.0160		95.741
4.0533	2.7027		95.813
		Mean,	95.765

Reduced to vacuum, Mo = 95.735, a value very close to the other. When O = 16, the atomic weight of molybdenum is very near the even number 96.

Tellurium.—The determinations of atomic weight by Staudenmeier[1] all start out from telluric acid, $H_2TeO_4.2H_2O$, which had been purified by repeated crystallization. Two essentially different methods were adopted. First, telluric acid was dehydrated, and reduced to TeO_2 by heating. Secondly, telluric acid was reduced by heating in hydrogen to metallic tellurium, finely divided silver being mixed with the acid to retain the tellurium by preventing volatilization. In four experiments, TeO_2 was reduced to Te in the same manner. The weights and results may be classified as follows, for convenience of comparison:

TeO_2 : Te.

TeO_2.	Loss on reduction.	Atomic weight of Te.
0.9171	0.1839	127.6
1.9721	0.3951	127.7
2.4115	0.4835	127.6
1.0172	0.2041	127.5

TELLURIC ACID : TeO_2.

Telluric acid.	Loss.	Atomic weight of Te.
1.7218	0.5260	127.2
2.8402	0.8676	127.1
4.0998	1.2528	127.1
3.0916	0.9450	127.05
1.1138	0.3405	127.0
4.9843	1.5236	127.05
4.6716	1.4278	127.1

1 *Ztschr. anorg. Chem.*, 10, 189. Calculations based upon O = 16 and H = 1.0032.

TELLURIC ACID : Te.

Telluric acid.	Loss.	Atomic weight of Te.
1.2299	0.5471	127.3
1.0175	0.4526	127.3
2.5946	1.1549	127.2

There is a good discussion in the paper as to the possible causes of error in these determinations, and also concerning the place of tellurium in the periodic system. Staudenmeier upholds the homogeneity of tellurium as an element, as against the supposition that it is a mixture.

Some years ago Brauner, in an elaborate paper upon tellurium, sought to show that the ordinary element was a mixture of true tellurium with a higher homologue of atomic weight 214. He now[1] concludes that this is very improbable, and suggests that tellurium may contain a homologue of argon, of atomic weight 130. For this supposition no evidence is given apart from the abnormality of the atomic weight, which should fall below that of iodine.

Yttrium.—The atomic weight of this metal has been redetermined by Jones,[2] who starts out with material purified by Rowland's process, that is, by precipitation with potassium ferrocyanide. First, oxide was converted into sulphate ; and secondly, sulphate was transformed to oxide by calcination. The weights and results were as follows:

FIRST METHOD.

Y_2O_3.	$Y_2(SO_4)_3$.	Atomic weight of Y.
0.2415	0.4984	88.89
0.4112	0.8485	88.92
0.2238	0.4617	88.97
0.3334	0.6879	88.94
0.3408	0.7033	88.90
0.3418	0.7049	89.05
0.2810	0.5798	88.94
0.3718	0.7803	88.89
0.4379	0.9032	89.02
0.4798	0.9901	88.91
	Mean,	88.94

1 *J. Chem. Soc.*, 67, 549.

2 *Am. Chem. J.*, 17, 154. Calculations made with O = 16, and S = 32.06.

SECOND METHOD.

$Y_2(SO_4)_3$.	Y_2O_3.	Atomic weight of Y.
0.5906	0.2862	88.91
0.4918	0.2383	88.89
0.5579	0.2705	89.03
0.6430	0.3117	88.99
0.6953	0.3369	88.89
1.4192	0.6880	88.99
0.8307	0.4027	88.99
0.7980	0.3869	89.02
0.8538	0.4139	88.99
1.1890	0.5763	88.96
	Mean,	88.97

These determinations are probably the best hitherto made, although they have been briefly criticized by Delafontaine,[1] who prefers the lower value obtained by himself, $Y = 87.3$. Delafontaine reaffirms the existence of phillipium, and regards gadolinium as identical with decipium. Jones,[2] in a brief rejoinder defends his own work, and urges that Delafontaine has failed to show wherein it is defective.

The Cerite Earths.—Papers upon this subject have been published during the year by Schutzenberger and by Brauner. In his first communication, Schuntzeberger[3] deals with cerium, which had been freed from lanthanum and "didymium" by fusion of the mixed nitrates with saltpeter. The yellowish-white cerium oxide was converted into cerium sulphate, which was dried at 440°. In this salt, with special precautions, the sulphuric acid was estimated by precipitation with barium chloride. One hundred parts of cerium sulphate gave 123.30 of barium sulphate. Hence, Ce = 139.45, according to Schutzenberger's calculations. Recomputing, with

$$O = 16,\ S = 32.07,\ \text{and}\ Ba = 137.43.$$
$$Ce = 139.96.$$

In a second paper,[4] Schutzenberger describes the results obtained by the fractionation of cerium sulphate. Preparations were thus secured giving oxides of various colors, such as canary yellow, yellowish rose, reddish, and brownish red. These,

1 *Chem. News*, 71, 243.
2 *Chem. News.*, 71, 305.
3 *Compt. rend.*, 120, 663.
4 *Compt. rend.*, 120, 962.

by the synthesis of the sulphates, the barium sulphate method, etc., gave varying values for cerium ranging from 135.7 up to 143.3. Schutzenberger concludes that the cerium sesquioxide from cerite contains small quantities of another earth of lower atomic weight. In a third paper[1] he continues the investigation with the other cerite earths. For the didymiums he finds a range in atomic weight from 137.5 to 143.5, approximately.

Brauner's paper[2] is partly a reclamation of priority over Schutzenberger, and partly a preliminary statement of new results. In his earlier work he found that cerium oxide was a mixture of two earths; one white, the other flesh color with a tinge of orange, and atomic weights for the contained metal of 140.2 and 145.72, respectively. In his later researches Brauner fractionates his material by several methods. One constituent obtained from cerium oxide is a dark salmon-colored earth, the oxide of a metal which he calls "meta-cerium." The other constituent he calls cerium. Pure cerium oxalate by Gibbs' permanganate method gave 29.506 and 29.503 per cent. of cerium sesquioxide with 46.934 per cent. of cerium dioxide. Hence, Ce = 139.91, or, with a slight correction, Ce = 140.01. This is not far from Schutzenberger's value.

Helium and Argon.—The true atomic weights of these remarkable gases are still in doubt, and so far can only be inferred from their specific gravities. For argon, the dicoverers, Rayleigh and Ramsay,[3] give various determinations of density, ranging (H = 1) from 19.48 to 20.6. The value 19.9 they regard as approximately correct.

For helium, Ramsay[4] gives the density 2.18, while Langlet[5] finds the somewhat lower value 2.00.

From one set of physical data, both gases appear to be monatomic, but from other considerations they are supposably diatomic. Upon this question, controversy has been most active, and no final settlement has yet been reached. If diatomic, argon and helium have approximately the atomic weights, two

1 *Compt. rend.*, 120, 1143.
2 *Chem. News.*, 71, 283.
3 *Phil. Trans.*, 186, 220–223.
4 *J. Chem. Soc.*, 3, 684.
5 *Ztschr. anorg. Chem.*, 10, 289.

and twenty, respectively ; if monatomic, these values must be doubled. In either case, helium is an element lying between hydrogen and lithium ; but argon is most difficult to classify. With the atomic weight 20, argon fills in the eighth column of the periodic system, between fluorine and sodium ; but if it is 40, the position of the gas is anomalous. A slightly lower value would place it between chlorine and potassium, and again in the eighth column of Mendelejeff's table, but for the number 40 no opening can be found.

It must be noted that neither gas, so far, has been proved to be absolutely homogeneous ; and it is quite possible that both may contain admixtures of other things. This consideration has been repeatedly urged by various writers. If argon is monatomic, a small impurity of greater density, say of an unknown element falling between bromine and rubidium, would account for the abnormality of its atomic weight, and tend towards the reduction of the latter. If the element is diatomic, its classification is easy enough on the basis of existing data. Its resemblances to nitrogen, as regards density, boiling point, difficulty of liquefaction, etc., lead me personally to favor the lower figure for its atomic weight, and the same considerations may apply to helium also. Until further evidence is furnished, therefore, I shall assume the values two and twenty as approximately true for the atomic weight of helium and argon.

Carbon.—Wanklyn,[1] on the basis of his investigations into the composition of hydrocarbons, reiterates his belief that the atomic weight of carbon is not 12, but 6. This question is one which falls rather outside the scope of this report and needs no further discussion here. If Wanklyn's contention is sustained, the value assigned to carbon in the table at the close of this paper, should be divided by two.

In the following table of atomic weights, the values are given according to both standards, $H = 1$ and $O = 16$. Many of the figures are the results of new and complete recalculation from all available data, made in the preparation of a new edition of my "Recalculation of the Atomic Weights." This work is now well under way, and it will probably be completed during 1896 :

[1] *Chem. News*, 72, 164. See also *Phil. Mag.*, August, *1895*. Also the reports of this committee for 1893 and 1894.

	H = 1.	O = 16.
Aluminum	26.91	27.11
Antimony	119.52	120.43
Argon	?	?
Arsenic	74.52	75.09
Barium	136.40	137.43
Bismuth	206.54	208.11
Boron	10.86	10.95
Bromine	79.34	79.95
Cadmium	111.08	111.93
Cesium	131.89	132.89
Calcium	39.78	40.08
Carbon	11.92	12.01
Cerium	139.1	140.2
Chlorine	35.18	35.45
Chromium	51.74	52.14
Cobalt	58.49	58.93
Columbium	93.3	94.0
Copper	63.12	63.60
Erbium	165.0	166.3
Fluorine	18.89	19.03
Gadolinium	154.9	156.1
Gallium	68.5	69.0
Germanium	71.75	72.3
Glucinum	9.01	9.08
Gold	195.74	197.24
Helium	?	?
Hydrogen	1.00	1.008
Indium	112.8	113.7
Iodine	125.89	126.85
Iridium	191.66	193.12
Iron	55.60	56.02
Lanthanum	137.6	138.6
Lead	205.36	206.92
Lithium	6.97	7.03
Magnesium	24.11	24.29
Manganese	54.57	54.99
Mercury	198.5	200.0
Molybdenum	95.26	95.98
Neodymium	139.4	140.5
Nickel	58.24	58.69
Nitrogen	13.94	14.04
Osmium	189.55	190.99
Oxygen	15.879	16.00
Palladium	105.56	106.36
Phosphorus	30.79	31.02

Platinum	193.41	194.89
Potassium	38.82	39.11
Praseodymium	142.4	143.5
Rhodium	102.23	103.01
Rubidium	84.78	85.43
Ruthenium	100.91	101.68
Samarium	148.9	150.0
Scandium	43.7	44.0
Selenium	78.4	79.0
Silicon	28.18	28.40
Silver	107.11	107.92
Sodium	22.88	23.05
Strontium	86.95	87.61
Sulphur	31.83	32.07
Tantalum	181.2	182.6
Tellurium	126.1 ?	127.0 ?
Terbium	158.8	160.0
Thallium	202.60	204.15
Thorium	230.87	232.63
Thulium	169.4	170.7
Tin	118.15	119.05
Titanium	47.79	48.15
Tungsten	183.44	184.84
Uranium	237.77	239.59
Vanadium	50.99	51 38
Ytterbium	171.7	173.0
Yttrium	88.28	88.95
Zinc	64.91	65.41
Zirconium	89.9	90.6

COMPOSITION OF WOOD GUM.

By S. W. Johnson.

Received January 20, 1896.

SINCE 1879, when Thomsen published his investigation of "Wood Gum," the writer has, from time to time, as opportunity offered, employed several of the chemists of the Connecticut Agricultural Experiment Station in work upon the alkali-soluble carbohydrates of maize cobs, birch wood and vegetable ivory. This work has necessarily been subject to frequent and prolonged interruptions, and for that reason the publication of conclusive results has been greatly delayed.

Wood gum, which is abundantly extracted from the wood of deciduous trees by cold, weak (two to ten per cent.) solutions of