REPORT OF COMMITTEE ON DETERMINATIONS OF ATOMIC WEIGHT, PUBLISHED DURING 1893.[1]

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To the Members of the American Chemical Society:

YOUR committee, appointed at the last annual meeting, respectfully submits the following report, showing the advances made in our knowledge of atomic weights during 1893. The year has been one of reasonable activity in this branch of investigation, and it is thought that all the work actually published within its limits is here summarized and recorded. One partial exception possibly may be made to this statement. Morley's work on oxygen, reported orally at the American Association meeting, and at the Chemical Congress in Chicago, is omitted, for only unofficial abstracts of it have yet appeared in print. That work is of such fundamental importance that it seems best to await its completion, rather than to do it possible injustice by fragmentary notices which might be inexact.

In the "Stas Memorial Lecture," by Professor Mallet,[2] will be found a remarkably full discussion of the theory or philosophy of atomic weight determinations, which should be carefully read by all students in this domain. Taking the life and work of Stas as text and example, Mallet considers the conditions necessary to the fruitful continuation of that work, and throws out many suggestions of great practical value. He particularly advocates the multiplication of interdependent data, in order that errors may be eliminated; and he also recommends the establishment of a special, endowed laboratory, in which a group of trained observers may co-operate towards the attainment of the best results.

The individual atomic weight determinations of 1893 are subjoined.

Boron.—W. Ramsay and Emily Aston[3] redetermine the atomic weight of boron by two distinct processes, one of them being entirely new. First, with many precautions, they estimate

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[1] Read at the Baltimore meeting Dec. 28, 1893.

[2] *J. Chem. Soc.*, August, *1893*.

[3] *J. Chem. Soc.*, 63, 207, February, *1893*.

the percentage of water in crystallized borax, $Na_2B_4O_7$, 10 H_2O; all weights being reduced to vacuum standards. The same reduction is also made in their other series, but as they carry out the weights to seven decimal places, the corrections applied go farther than is necessary. In the subjoined tables I give the nearest tenth milligram.

Wt. $Na_2B_4O_7$, $10H_2O$.	Wt. $Na_2B_4O_7$.	Per cent. H_2O.	At. Wt. B.
10.3582	5.4784	47.1099	11.04
5.3440	2.8247	47.1433	10.97
4.9963	2.6379	47.2026	10.85
5.7000	3.0101	47.1912	10.87
5.3143	2.8066	47.1882	10.88
4.9972	2.6392	47.1865	10.885
5.2367	2.7675	47.1524	10.955

Mean atomic weight, B=10.921, ± 0.010.

In the second series of experiments fused borax was distilled with hydrochloric acid and methyl alcohol, and the residual sodium chloride was weighed. Results as follows:

Wt. $Na_2B_4O_7$.	Wt. NaCl.	At. Wt. B.[1]
4.7684	2.7598	11.015
5.2740	3.0578	10.925
3.2344	1.8727	10.992
4.0862	2.3713	10.879
3.4970	2.0266	10.949

Mean atomic weight, B=10.952, ± 0.010.

The distillations were conducted in soft glass flasks of about 100 cc. capacity, in which the sodium chloride was dried at about 350°, and finally weighed. It was found, however, that the flasks were somewhat attacked during the process, with liberation of silica, consequently some oxygen in the alkali of the glass had been replaced by chlorine, and the weight of the vessel increased. Another set of distillations was, therefore, made with flasks of hard combustion tubing, and these were slightly attacked also.

Wt. $Na_2B_4O_7$.	Wt. NaCl.	At. Wt. B.
5.3118	3.0761	10.983
4.7806	2.7700	10.955
4.9907	2.8930	10.936
4.7231	2.7360	10.968
3.3138	1.9187	10.992

Mean atomic weight, B=10.966, ± 0.005.

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[1] Atomic weights used in Ramsay and Aston's calculations: O=16, H=1.008, Ag=107.92, Na=23.05, Cl=35.45, and Br=79.95.

As a check upon these results the sodium chloride was dissolved in water, and after filtration precipitated with silver nitrate. The resulting silver chloride was collected on a Gooch filter, dried at 200°, and weighed.

Wt. AgCl.	Per cent. Cl in NaCl.	At. Wt. B. from Cl.
7.5259	60.493	11.071
6.7794	60.515	11.024
7.0801	60.516	11.003
6.6960	60.514	11.039
4.6931	60.479	11.091

Mean atomic weight, B=11.052, ± 0.010.

From all these results, and after discussing the supposable sources of error in them, the authors conclude that the atomic weight of boron is very nearly eleven.

Still another determination of the atomic weight of boron, by an entirely independent method, is due to Rimbach.[1] Taking advantage of the fact that methyl orange, as an indicator, is unaffected by free boric acid, he titrated solutions of borax with standardized hydrochloric acid, thus measuring the amount of sodium in the salt and thence calculating the value to be ascertained. The borax was prepared in platinum vessels from carefully purified boric acid and sodium carbonate; and the hydrochloric acid used contained 1.84983 per cent. of absolute HCl, determined gravimetrically as silver chloride. In the following table of results the titrated hydrochloric acid is given by weight in grams:

Wt. borax.	Wt. HCl. sol.	Per cent. Na.[2]	At. Wt. B.[2]
10.00214	103.1951	12.07081	10.9646
15.32772	158.1503	12.07138	10.9598
15.08870	155.7271	12.07530	10.9273
10.12930	104.5448	12.07517	10.9298
5.25732	54.2571	12.07435	10.9361
15.04324	155.2307	12.07283	10.9486
15.04761	155.2959	12.07448	10.9356
10.43409	107.6602	12.07176	10.9571
5.04713	52.0897	12.07480	10.9330

Calculating from the sum of all the weights the atomic weight of boron becomes 10.945, ± 0.003.

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[1] *Ber. d chem. Ges.*, 26, 164, February, 13, *1893*.

[2] Calculations made with O=16, H=1.0032 (Keiser), Na=23.0575, Cl=35.4529, and Ag=107.9376.

Carbon.—Leduc[1] has determined the density of carbon monoxide, deducing thence the atomic weight of carbon. The globe used held 2.9440 of air. Filled with carbon monoxide the latter weighed

2.8470
2.8468
2.8469

Mean, 2.8469

Hence the density of CO is 0.96702, when air =1, and with

$O=15.88$,
$C=11.913$.
If $O=16$, then $C=12.003$.

In a very brief note[2] Wanklyn announces that he has studied a series of hydrocarbons in which the successive steps rise—not by $CH_2=14$—but by $\frac{1}{2}$ $(CH_2)=7$. If these observations are sustained, then the atomic weight of carbon becomes=6.

Cobalt and Nickel.—Atomic weights determined by Winkler,[3] who starts with weighed quantities of metal, electrolytically deposited. This is then dissolved in a platinum dish in pure hydrochloric acid, and the chlorides produced are finally dried for several hours at 150°. In one set of experiments the chlorine in the chlorides is weighed gravimetrically, as silver chloride; in another set it is titrated with a standard solution of silver. In the first case we have the ratio R:2AgCl, in the other, $R:Ag_2$. Results as follows, for nickel:

Wt. Ni.	Wt. AgCl. (grav.)	At. Wt. Ni.
0.3011	1.4621	58.9102
0.2242	1.0881	58.9418
0.5166	2.5108	58.8571
0.4879	2.3679	58.9419
0.3827	1.8577	58.9304
0.3603	1.7517	58.8334

Mean result, Ni=58.9033.

Wt. Ni.	Wt. Ag (vol.)	At. Wt. Ni.
0.1812	0.6621260	58.9253
0.1662	0.6079206	58.8665
0.2129	0.7775252	58.9584
0.2232	0.8162108	58.8811
0.5082	1.8556645	58.9684
0.1453	0.5315040	58.8631

Mean result, Ni=58.9104.

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[1] *Compt. rend.*, **115**, 1072.

[2] *Phil. Mag.*, (5) **36**, 552, December, *1893*.

[3] *Ztschr. anorg. Chem.*, **4**, 10, *1893*.

The following data were obtained for cobalt:

Wt. Co.	Wt. AgCl. (grav.)	At. Wt. Co.
0.3458	1.6596	59.6044
0.3776	1.8105	59.6609
0.4493	2.1521	59.7215
0.4488	2.1520	59.6577
0.2856	1.3683	59.7081
0.2648	1.2678	59.7480

Mean result, Co=59.6834.

Wt. Co.	Wt. Ag. (vol.)	At. Wt. Co.
0.177804	0.6418284	59.6495
0.263538	0.9514642	59.6396
0.245124	0.8855780	59.5996
0.190476	0.6866321	59.7311
0.266706	0.9629146	59.6388
0.263538	0.9503558	59.7092

Mean result, Co=59.6613.[1]

In the case of the cobalt determinations it is of course conceivable that the chloride formed might be contaminated with traces of basic compounds. This question is considered by Winkler in a supplementary communication.[2] The weighed, electrolytic cobalt, deposited upon the surface of a platinum dish, was treated with a solution of neutral silver sulphate. Silver was thrown down, and was washed, dried, ignited, and weighed. Thus a direct ratio was measured between silver and cobalt, involving no intervention of cobalt chloride, and consequently no error due to basic salts. Results as follows:

Wt. Co.	Wt. As.	At. Wt. Co.
0.2549	0.9187	59.7421
0.4069	1.4691	59.6377

The precipitated silver, as a check upon its purity, was dissolved in nitric acid, reprecipitated with hydrochloric acid as chloride, and filtered off. The filtrate, upon evaporation to dryness, gave traces of residue, containing cobalt. The amount of the latter in the first experiment was at most 0.5 milligram, and in the second not over 0.2 milligram. Correcting for these amounts the values found for the atomic weight of cobalt become 59.6356 and 59.6164, respectively. These figures fall within the limits of variation of those found in the first paper,

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[1] All calculations with Ag=107.66 and Cl=35.37

[2] *Ztschr. anorg. Chem.*, 4, 462, *1893*.

and show that the supposed error, if it existed, could not be large. The author admits, however, that the degree of concordance among his experiments is not so great as could be desired. The main purpose of his work was to show the essential constancy of the values, as opposed to the views of Krüss concerning the supposed composite nature of nickel and cobalt.

Molybdenum.—Atomic weight redetermined by Smith and Maas.[1] Sodium molybdate was converted into chloride by heating in a current of pure, dry, gaseous hydrochloric acid. Results as follows with weights reduced to vacuum standards:

Wt. Na_2MoO_4.	Wt. NaCl.	At. Wt. Mo.
1.14726	0.65087	96.130
0.89920	0.51023	96.094
0.70534	0.40020	96.108
0.70793	0.40182	96.031
1.26347	0.71695	96.087
1.15217	0.65367	96.126
0.90199	0.51188	96.067
0.81692	0.46358	96.077
0.65098	0.36942	96.073
0.80563	0.45717	96.078

In mean, Mo=96.087.

Palladium.—Atomic weight determined by Joly and Leidié[2] by means of potassium palladio-chloride, K_2PdCl_4. In the first series of experiments the salt was dried in vacuo at ordinary temperature. It was then electrolyzed in a solution acidulated with hydrochloric acid, both the palladium and the potassium chloride being weighed. The palladium was dried, ignited in a stream of hydrogen, and cooled in an atmosphere of carbon dioxide. Results as follows:

			At. Wt. Pd.	
Wt. salt.	Wt. Pd.	Wt. KCl.	From salt : Pd.	Pd : 2KCl.
1.0255	0.3919	0.5520	105.749	105.643
1.2178	0.3937	0.5551	104.881	105.535
1.2518	0.4048	0.5687	104.923	105.916

This series was rejected by the authors upon finding that the salt retained water. In one experiment 0.23 per cent. of water was found. Accordingly a second set of determinations was

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[1] This JOURNAL, 15, 397, July, *1893*. Results calculated with O=16, Na=23.05, and Cl=35.45.

[2] *Compt. rend.*, 116, 147, *1893*. Results calculated with O=15.96, Cl=35.37, KCl=74.40, and H=1.

made in which the palladio-chloride was dried in vacuo at 100°

			At. Wt. Pd.	
Wt. salt.	Wt. Pd.	Wt. KCl.	Salt : Pd.	Pd : 2KCl.
1.3635	0.4422	0.6186	105.374	106.368
3.0628	0.9944	1.3929	105.545	106.229
1.4845	0.4816	0.6782	105.405	105.694
1.7995	0.5838	0.8206	105.427	105.861

The mean of the values found from the ratio K_2PdCl_4: Pd is 105.438. If O = 16, this becomes Pd = 105.702. With O = 15.88 we get 104.910. The KCl values were rejected.

Still another set of determinations was based upon the reduction of the double chloride in a stream of hydrogen, the data being in other respects like the foregoing. Results as follows:

			At. Wt. Pd.	
Wt. salt.	Wt. Pd.	Wt. KCl.	Salt : Pd.	Pd : KCl
2.4481	0.7949	1.1168	105.560	105.911
1.8250	0.5930	0.8360	105.671	105.656

It is noticeable that these values, in the set K_2PdCl_4 : Pd, run higher than in the electrolytic series. Inasmuch as the latter experiments were made in presence of free hydrochloric acid, it would seem possible that chlorine may have been liberated, preventing complete precipitation of the palladium, and so slightly lowering the apparent atomic weight of the latter. At all events the results obtained are not sharply concordant, and are, therefore, inconclusive.

Barium.—An elaborate memoir upon the atomic weight of barium, by Richards,[1] makes a notable change in the value of that constant. Barium bromide was the compound investigated, and the procedure consisted in titrating its solution with solutions containing known quantities of silver. In many of the experiments the silver bromide thrown down during titration was collected and weighed. From the weights of Ag and of AgBr found, the ratio Ag : Br may be computed as a check on the accuracy of the work.

Full details are given concerning purity of materials, processes, weighings, etc., for which the original memoir must be consulted. The final results are stated in the following columns: First, $BaBr_2$ corresponding to 100 parts Ag. Second,

[1] *Proc. Amer. Acad.*, 28, 1. Presented Jan. 11, *1893*.

$BaBr_2$ corresponding to 174.080 parts AgBr. Third, percentage of Ag in AgBr.

Exp.	I.	II.	III.
1	137.746	137.783	57.460
2	137.736	137.760	57.455
3	......	137.723	.....
4	137.732	......	.....
5	137.735	137.739	57.447
6	137.748	137.748	57.445
7	137.747	......	.....
8	137.740	137.747	57.448
9	137.755	137.748	57.442
10	137.738	137.752	57.451
11	137.747	137.772	57.455
12	......	137.726	.....
14	137.750	137.745	57.443
15	137.756	137.754	57.445
16	137.731	......	.....
17	137.748	......	.....
18	......	137.745	.....
19	137.759	137.758	57.445
Mean, omitting 1 and 2	137.745	137.747	57.448
		Stas found	57.445

The last column, by its agreement with Stas' measurements, serves to confirm the other two, from which the atomic weight of barium is easily computed. From the ratio $Ag_2:BaBr_2$, when $Ag=107.93$ and $Br=79.955$,

$Ba=137.426$.

From the ratio $2AgBr:BaBr_2$,

$Ba=137.431$.

The value 137.43 then must replace the lower value commonly held hitherto. The new results appear to be thoroughly established and unimpeachable.

Thallium.—Lepierre[1] has redetermined the atomic weight of this metal by several distinct methods. First, by the electrolysis of thallous sulphate in presence of an excess of ammonium oxalate, weighing first the sulphate and then the metal obtained. The latter was dried and weighed in an atmosphere of hydrogen. The corrected weights and results are as follows:

Wt. Tl_2SO_4.	Wt. Tl_2.	At. Wt. Tl. ($O=15.96$).
1.8935	1.5327	203.52
2.7243	2.2055	203.67
2.8112	2.2759	203.69

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[1] *Bull. Soc. Chim.*, (3) 9, 166, March 20, *1893*.

Secondly, a weighed quantity of crystallized thallic oxide was converted by means of sulphurous acid into thallous sulphate, which was then subjected to electrolysis as in the preceding series. The results are subjoined.

Wt. Tl_2O_3.	Wt. Tl_2.	At. Wt. Tl.
3.2216	2.8829	203.76
2.5417	2.2742	203.53

In the third series of experiments a definite quantity of thallous salt was fused in a polished silver crucible with ten times its weight of absolutely pure caustic potash. Thallic oxide was thus formed, which was washed with water and alcohol under various precautions, dried at 100°, and finally weighed in the original crucible.

		At. Wt. Tl.
3.1012 Tl_2SO_4 gave	2.8056 Tl_2O_3	203.57
2.3478 " "	2.1239 "	203.44
2.7591 $TlNO_3$ "	2.3649 "	203.73

Finally, crystallized thallic oxide was reduced in a stream of hydrogen, and the water so formed was collected and weighed.

Wt. Tl_2O_3.	Wt. H_2O.	At. Wt. Tl.
2.7873	0.3301	203.54
3.9871	0.4716	203.82
4.0213	0.4761	203.00

The mean of the eleven figures given for thallium is 203.57, but stated by the author as 203.62. If O=16 this becomes Tl=204.08; and with O=15.88, Tl=202.55. It will be observed that the values found in the individual experiments vary among themselves through a range of over eight-tenths of a unit, and that, therefore, the final mean result is entitled to little consideration. M. Lepierre is evidently unfamiliar with the determinations of his predecessors; for, quite ignoring the admirable work of Crookes, he speaks of the currently accepted value for Tl as resting without proof upon the calculations of Meyer and Seubert. He also neglects to state whether his weighings were reduced to vacuum standards, and he gives no evidence bearing upon the absolute purity and definiteness of the several compounds weighed. The metallic thallium which served as a starting point for the investigations, seems to have been carefully purified.

The Composition of water by Volume.—The volume ratio between H and O in water, which controls the atomic weight of oxygen as deduced from its density, has been redetermined by Scott.[1] The report published is only in abstract, but the subjoined values for the ratio, $H_2:O$, are given.

2.0020
2.0024
2.0026
2.0030
2.0022
2.0025
2.0029
2.0023
2.0028
2.0017
2.0022
2.0028

Mean, 2.00245, ± 0.00007.

Combining this mean with the density ratio, O:H::15.882:1,[2] gives for the atomic weight of oxygen the value 15.862.

Scott gives mean results of several other series of experiments, but only this one in detail. The hydrogen was obtained from palladium hydride, and the oxygen from silver oxide. With only an abstract available, the work done cannot be critically compared with Morley's.

The Density of the Principal Gases.—These data, as determined by Lord Rayleigh,[3] having important bearing upon atomic weights, fall properly within the scope of this report. Full details are given as to the apparatus used, and all corrections are applied; such, for instance, as for the difference in volume of the glass globes when filled or exhausted, for the value of gravity at the laboratory in latitude 51°47″, etc., etc. The final results are as follows, with air as unity.

H	0.06960
N	0.97209
O	1.10535

The weights in grams per liter are:

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[1] *Proc. Roy. Soc.*, 53, 130. Read March 23, *1893*.

[2] Rayleigh.

[3] *Proc. Roy. Soc.*, 53, 134. Received March 4, *1893*.

H	0.09001
N	1.25718
O	1.42952
Air	1.29327

Two of these constants have also been remeasured by Leduc;[1] who gives the following weights for one liter each:

Air	1.29315
N	1.2570

Miscellaneous Notes.—Richards and Rogers, in a paper upon the occlusion of gases by metallic oxides,[2] show that when the oxides of copper, nickel, zinc, and magnesium are prepared by the ignition of the nitrates, they retain appreciable quantities of gaseous impurities, such as nitrogen and oxygen, especially the former. The oxides of cadmium, mercury, lead, and bismuth, similarly prepared, contained no gaseous occlusion, excepting a mere trace in the case of cadmium. This observation reveals a possible serious source of error in several determinations of atomic weight, particularly in the cases of zinc and magnesium. In consequence of this fact, the atomic weight of zinc is now under reinvestigation in the Harvard laboratory, the compounds selected for study being the chloride and bromide.

In the study of the rare earths, rough determinations of atomic weight are of great importance in the identification of material. Commonly they are made by the sulphate method, which is familiar to all chemists. Gibbs,[3] however, in a study of these substances, makes use of the oxalates. By ignition, the oxide is left and can be weighed, while the proportion of oxalic acid is easily determinable by titration with permanganate solution. In some cases the oxalates were ignited with weighed quantities of pure sodium tungstate, the increase in weight representing R_2O_3. From the ratio between R_2O_3 and C_2O_3 the molecular weight of the oxide is easily calculated, and agrees well with determinations made by the sulphate process.

Hinrichs, in a series of communications published in the *Comptes Rendus*,[4] attempts to show that Stas' determinations

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[1] *Compt. rend.*, 117, 1072.

[2] *Proc. Amer. Acad.*, 28, 200. Presented May 10, *1893*.

[3] *Am. Chem. J.*, 15, 546, November, *1893*.

[4] On the $KClO_3$ work, in 115, 1074. On the lead determinations, in 116, 431.

of atomic weights are vitiated by systematic errors, depending upon the quantities of material weighed. According to him the larger the weight of the substance employed the larger the error; and he constructs curves to represent his views graphically. His mathematical procedure, however, his "method of limits," is not clear, and it savors somewhat of assuming Proutian values in advance, and then regarding variations from them as errors for which corrections should be applied. At all events he fails to point out, on the basis of experimental evidence, how the supposed errors were produced, and he does not show that they could have been of sufficient magnitude to account for the divergencies to be explained. If Stas' work is to be set aside, it can be by experimental researches only.

In a third[1] paper the same author gives his mathematical process in some detail, and still later he discusses Dumas' experiments relative to the atomic weight of oxygen,[2] seeking to show that it is exactly sixteen. Very recently he has also discussed the determinations of the same constant made by Keiser, Cooke and Richards, Morley, and Dittmar and Henderson, reaching the conclusion that the ratio $H:O=1:16$ rigorously.[3] He objects especially to the use of averages as fallacious, but does not fully establish the legitimacy of his conclusions.

In another journal[4] Hinrichs criticizes Richards' researches upon the atomic weight of copper. After showing that several published determinations of the electrolytic ratio between silver and copper agree quite well with the ratio 108 : 63.5, he takes up in particular Richards' analyses of copper sulphate, and points out that a part of the data correspond with the even values $O=16$, $S=32$, and $Cu=63.5$. The other work of Richards he dismisses as erroneous, but neglects to show wherein the errors lie.

In still another paper[5] Hinrichs proposes to abandon gases like O and H as bases for atomic weight determinations, and to

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[1] *Compt. rend.*, 116, 695.

[2] *Compt. rend.*, 116, 753.

[3] *Compt. rend.*, 117, 663.

[4] *Chem. News*, 68, 171, October, 6. *1893*.

[5] *Compt. rend.*, 117, 1075.

adopt carbon (diamond) = 12 as the fundamental standard, on the ground that it can be exactly weighed. Oxygen and calcium are combined with this as substandards, becoming sixteen and forty respectively.

Replies to Hinrichs' criticism of Stas have been published by Spring[1] and by Van der Plaats.[2] Both writers object to the processes of extrapolation of which Hinrichs makes use, and Van der Plaats shows by tabulation of data that the systematic errors alleged to exist in Stas' experiments are not there. Only fortuitous errors occur, and these are of insignificant magnitude. Furthermore, the ratios determined by Stas are so numerous, so varied, and so concordant in their final results that the presumption in their favor is overwhelming.

In the same paper, indeed, as its main object, Van der Plaats gives the results of a recalculation of Stas' twenty-one ratios by the method of least squares. He does not, however, give his equations nor explain the special form of the method which he used. The results are stated in two tables, one, (A), computed upon the supposition that each ratio is entitled to weight inversely proportional to the square of its mean error; the other, (B), regarding all as of equal weight. O = 16 is the base of the system.

	A	B
Ag	107.9244 ± 0.0136.	107.9202.
Cl	35.4565 ± 0.0049.	35.4516.
Br	79.9548 ± 0.0101.	79.9497.
I	126.8494 ± 0.0166.	126.8445.
S	32.0590 ± 0.0085.	32.0576.
K	39.1403 ± 0.0059.	39.1414.
Na	23.0443 ± 0.0043.	23.0453.
Li	7.0235 ± 0.0051.	7.0273.
Pb	206.9308 ± 0.0404.	206.9089.
N	14.0519 ± 0.0078.	14.0421.
NH_4	18.0740 ± 0.0034.	18.0760.
Hence H =	1.0055 ± 0.0021.	1.0085.

Another contribution to the Hinrichsian literature is furnished by E. Vogel,[3] who criticizes Stas at considerable length. His

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[1] *Chem. Ztg.*, 17, 242, February, 22, *1893*.

[2] *Compt. rend.*, 116, 1362.

[3] *Bull. Acad. Bruxelles*, (3), 26, 469.

paper is preceded by adverse reports from W. Spring and L. Henry.

In conclusion I submit a table of atomic weights revised to January 1, 1894. Oxygen=16 is taken as the base of the system, but for provisional reasons only. Before long, with improved determinations, it may be practicable to return to the more philosophical H=1, when the entire system can be transformed once for all into something like permanent shape. A premature transformation of this kind, however, would only work confusion, without corresponding benefit.

Name.	Atomic Weight.	Name.	Atomic Weight.
Aluminum	27.	Neodymium	140.5
Antimony	120.	Nickel	58.7
Arsenic	75.	Nitrogen	14.03
Barium	137.43	Osmium	190.8
Bismuth	208.9	Oxygen	16.
Boron	11.	Palladium	106.6
Bromine	79.95	Phosphorus	31.
Cadmium	112.	Platinum	195.
Caesium	132.9	Potassium	39.11
Calcium	40.	Praseodymium	143.5
Carbon	12.	Rhodium	103.
Cerium	140.2	Rubidium	85.5
Chlorine	35.45	Ruthenium	101.6
Chromium	52.1	Samarium	150.
Cobalt	59.	Scandium	44.
Columbium	94.	Selenium	79.
Copper	63.6	Silicon	28.4
Erbium	166.3	Silver	107.92
Fluorine	19.	Sodium	23.05
Gadolinium	156.1	Strontium	87.6
Gallium	69.	Sulphur	32.06
Germanium	72.3	Tantalum	182.6
Glucinum	9.	Tellurium	125.
Gold	197.3	Terbium	160.
Hydrogen	1.008	Thallium	204.18
Indium	113.7	Thorium	232.6
Iodine	126.85	Thulium	170.7
Iridium	193.1	Tin	119.
Iron	56.	Titanium	48.
Lanthanum	138.2	Tungsten	184.
Lead	206.95	Uranium	239.6
Lithium	7.02	Vanadium	51.4
Magnesium	24.3	Ytterbium	173.
Manganese	55.	Yttrium	89.1
Mercury	200.	Zinc	65.3
Molybdenum	96.	Zirconium	90.6

Discussion.—Dr. Wiley. By our organization we are able to present to American chemists the latest and most accurate numbers for atomic weights. It is a matter for congratulation that this has been accomplished by the American Chemical Society.

UPON THE DETERMINATION OF NITRATES IN POTABLE WATER.

BY AUGUSTUS H. GILL.

Received February 19, 1894.

PART II.

(b) THE REDUCTION TO AMMONIA.

AFTER a discussion of the various processes for the determination of nitrates by reduction to ammonia, Tiemann concludes with the following:[1] "On account of the unreliability and chances for error which this principle involves, we strongly advise against its use."[2] Tables are given, pp. 208 *et. seq.*, in which the results obtained by reduction with sodium amalgam, aluminum, and the zinc-copper couple, vary from plus ten to minus thirty-eight per cent. which sufficiently illustrate the unreliability.

The objections to any method for such reduction are in brief:

1. THE NUMEROUS CORRECTIONS TO BE APPLIED:
   I. For free ammonia.
   II. For nitrates.
   III. For materials used.
   IV. For ammonia carried away by the hydrogen.

2. The liability of reducing the organic matter present in the water to ammonia.

3. The time required and chances for error in manipulation.

To the method proposed by Hazen and Clark,[3] they not distilling the reduced liquid before nesslerizing are added two more, *viz.*:

4. The colors produced by the Nessler reagent are in many cases not the same *tone* as the standards, and are usually read higher than the amount of ammonia actually found by distilla-

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[1] "*Die chem. und bacteriologische Untersuchung des Wassers.*" Tiemann und Gaertner Braunschweig *1890*, 212.

[2] "Entschieden davon abzurathen."

[3] *J. Anal. Appl. Chem.*, 5, 3.