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ANNUAL REPORT OF THE INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS, 1915.

BY F. W. CLARKE, T. E. THORPE, W. OSTWALD AND G. URBAIN.

Received June 23, 1914.

The Council of the International Association of Chemical Societies, with which the Committee on Atomic Weights is now affiliated, recommended, at its meeting in September, 1913, that the annual report of said committee should be published in August. The present report, therefore, is submitted in compliance with that recommendation, although delays due to the difficulties of correspondence may sometimes prevent simultaneous publication in all countries.

Since the report for 1914 was prepared, a number of new atomic weight determinations have been published. These may be briefly summarized as follows:

Silver, Sulfur and Chlorine.—Scheuer[1] dissolved pure silver in sulfuric acid and collected and weighed the sulfur dioxide given off. The weighed sulfate was then converted into chloride by heating in a current of gaseous hydrochloric acid. Three ratios were thus determined, which gave the three desired atomic weights independent of all former determinations. The results obtained are: Ag = 107.884, S = 32.067, Cl = 35.460. The value for silver is rather high; the other values agree with those generally accepted.

[1] *Arch. sci. phys. nat.*, [4] 36, 381.

Calcium.—Oechsner de Coninck[1] has determined the atomic weight of calcium by conversion of the carbonate into the sulphate. This final value is Ca = 40.13.

Barium.—Also redetermined by Oechsner de Coninck.[2] Barium carbonate was dissolved in nitric acid and the carbon dioxide so evolved was weighed. The value found was Ba = 137.36.

Copper.—Atomic weight determined by O. de Coninck and Ducelliez.[3] Copper was oxidized by nitric acid and the oxide was weighed. In five experiments they found Cu = 63.523 to 63.605; in mean, 63.549. These atomic weight determinations by O. de Coninck are published in the briefest possible way, without any of the details that are commonly regarded as essential. How were the substances purified? Were the weights reduced to a vacuum?

Cadmium.—Quinn and Hulett[4] have redetermined the atomic weight of cadmium by electrolysis of the chloride and bromide. In each series the cadmium was collected and weighed in mercury. From the chloride, with Cl = 35.458, Cd = 112.32. From the bromide, with Br = 79.92, Cd = 112.26. These values agree well with those previously found by Perdue and Hulett and by Laird and Hulett, but are much lower than the value (Baxter's) adopted in the table. The cause of the difference is yet to be satisfactorily explained; but it must be due to a constant error in one or the other of the methods employed. A change in the table would be premature.

Mercury.—Taylor and Hulett[5] prepared mercuric oxide by heating pure mercury in oxygen. Weighed amounts of the oxide were then decomposed by heating it with metallic iron, and the mercury was collected and weighed. From the data thus obtained Hg = 200.37. This, as in the case of cadmium, is lower than the recognized value, and its acceptance or rejection must await farther evidence.

Vanadium.—Atomic weight redetermined by Briscoe and Little,[6] from analyses of the oxychloride $VOCl_3$. The mean value found was V = 50.950, but 50.96 is preferred.

Selenium.—Jannek and Meyer[7] determined the atomic weight of selenium by oxidizing Se to SeO_2. The mean of ten experiments gave Se = 79.140.

The same constant was deduced by Bruylants and Bytebier[8] from the

1 *Bull. acad. belg.*, **1913**, 222.

2 *Rev. gén. chim.*, **16**, 245.

3 *Ibid.*, **16**, 122.

4 *J. Physic. Chem.*, **17**, 780.

5 *Ibid.*, **17**, 755.

6 *J. Chem. Soc.*, **105**, 1310.

7 *Z. anorg. Chem.*, **83**, 51.

8 *Bull. acad. belg.*, **1912**, 856. According to Germann (*Compt. rend.*, **157**, 926), the normal liter of oxygen weighs 1.42900 g.

density of selenium hydride, SeH_2. In four series of experiments the weight of a liter of the gas at 0° and 760 mm. was found to be 3.6715 g. For the weight of a liter of oxygen under the same conditions they found 1.4295 g. By the method of limiting densities and with H = 1.008, Se = 79.18, which is near the value given in the table.

INTERNATIONAL ATOMIC WEIGHTS, 1915.

	Symbol.	Atomic weight.		Symbol.	Atomic weight.
Aluminum	Al	27.1	Molybdenum	Mo	96.0
Antimony	Sb	120.2	Neodymium	Nd	144.3
Argon	A	39.88	Neon	Ne	20.2
Arsenic	As	74.96	Nickel	Ni	58.68
Barium	Ba	137.37	Niton (radium emanation)	Nt	222.4
Bismuth	Bi	208.0	Nitrogen	N	14.01
Boron	B	11.0	Osmium	Os	190.9
Bromine	Br	79.92	Oxygen	O	16.00
Cadmium	Cd	112.40	Palladium	Pd	106.7
Caesium	Cs	132.81	Phosphorus	P	31.04
Calcium	Ca	40.07	Platinum	Pt	195.2
Carbon	C	12.00	Potassium	K	39.10
Cerium	Ce	140.25	Praseodymium	Pr	140.6
Chlorine	Cl	35.46	Radium	Ra	226.4
Chromium	Cr	52.0	Rhodium	Rh	102.9
Cobalt	Co	58.97	Rubidium	Rb	85.45
Columbium	Cb	93.5	Ruthenium	Ru	101.7
Copper	Cu	63.57	Samarium	Sa	150.4
Dysprosium	Dy	162.5	Scandium	Sc	44.1
Erbium	Er	167.7	Selenium	Se	79.2
Europium	Eu	152.0	Silicon	Si	28.3
Fluorine	F	19.0	Silver	Ag	107.88
Gadolinium	Gd	157.3	Sodium	Na	23.00
Gallium	Ga	69.9	Strontium	Sr	87.63
Germanium	Ge	72.5	Sulfur	S	32.07
Glucinum	Gl	9.1	Tantalum	Ta	181.5
Gold	Au	197.2	Tellurium	Te	127.5
Helium	He	3.99	Terbium	Tb	159.2
Holmium	Ho	163.5	Thallium	Tl	204.0
Hydrogen	H	1.008	Thorium	Th	232.4
Indium	In	114.8	Thulium	Tm	168.5
Iodine	I	126.92	Tin	Sn	119.0
Iridium	Ir	193.1	Titanium	Ti	48.1
Iron	Fe	55.84	Tungsten	W	184.0
Krypton	Kr	82.92	Uranium	U	238.5
Lanthanum	La	139.0	Vanadium	V	51.0
Lead	Pb	207.10	Xenon	Xe	130.2
Lithium	Li	6.94	Ytterbium (Neoytterbium)	Yb	172.0
Lutecium	Lu	174.0	Yttrium	Yt	89.0
Magnesium	Mg	24.32	Zinc	Zn	65.37
Manganese	Mn	54.93	Zirconium	Zr	90.6
Mercury	Hg	200.6			

Tellurium.—Dennis and Anderson[1] purified tellurium by preparing the hydride TeH_2 from aluminum telluride, and condensing the gas to a solid at the temperature of liquid air. From the hydride the metal was obtained by heating to 500°. Thirty-one conversions of Te thus prepared into TeO_2 gave in mean Te = 127.6. Other determinations by a volumetric method gave a lower value, near 127.50. The authors conclude that the higher, hypothetical "dvitellurium" does not exist.

Scandium.—Lukens[2] prepared scandium oxide from Colorado wolfram. By calcination of the sulfate to oxide they found Sc = 44.59 and 44.77. The material was probably not quite pure.

Yttrium.—Meyer and Weinheber,[3] by conversion of yttrium oxide into sulfate, found Yt = 88.75. By the reverse process they found Yt = 88.74. Corrected to a vacuum, this becomes 88.70.

Ytterbium and Lutecium.—Atomic weights reinvestigated by Auer von Welsbach.[4] For ytterbium (aldebaranium) he found Yb = 173.00. For lutecium (cassiopeium), Lu = 175.00. (See note.)

Iridium.—Holzmann[5] made four reductions of the salt $(NH_4)_2IrCl_6$ in hydrogen, and found Ir = 193.42. This is higher than the accepted value and not conclusive enough to justify a change.

Helium.—Heuse,[6] in seven determinations of the density of helium, finds the weight of a normal liter to be 0.17856 g. Hence, by the method of limiting densities, He = 4.002.

Neon.—From two determinations of the density of neon, Leduc[7] finds Ne = 20, when H = 1.

No changes of serious importance seem to be needed in the atomic weight table. Possibly the values for yttrium, ytterbium, helium and neon should be changed, but such action may well be deferred until next year. Some experiments by Richards and Cox[8] on the purity of lithium perchlorate also suggest a possible lowering of the atomic weight of silver, namely, from 107.88 to 107.871.

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NOTE.—Since this report was finished and approved, Professor Urbain has informed me that, jointly with M. Blumenfeld, he has redetermined

[1] THIS JOURNAL, 36, 882.
[2] *Ibid.*, 35, 1470.
[3] *Ber.*, 46, 2672.
[4] *Monatsh. Chem.*, 34, 1713.
[5] *Sitzungsb. phys.-med. Svz. Erlangen*, 44, 84.
[6] *Verh. Deutsch. physik. Ges.*, 15, 518.
[7] *Compt. rend.*, 158, 864.
[8] THIS JOURNAL, 36, 819.

the atomic weight of neo-ytterbium with great care. The earth was subjected to many fractionations, and each fraction was studied magnetically and spectroscopically. The value found for the atomic weight, the mean of 13 determinations, was 173.50. He suspects that the "aldebaranium" studied by Auer von Welsbach contained an element of lower atomic weight, probably thulium. Urbain's paper will be published in the near future, perhaps before this report appears. F. W. C.

[CONTRIBUTION FROM THE KENT CHEMICAL LABORATORY, THE UNIVERSITY OF CHICAGO.]

STUDIES IN CONDUCTIVITY. II. THE CONDUCTIVITY OF SOME FORMATES AND OF HYDROGEN CHLORIDE IN (ANHYDROUS) FORMIC ACID. CASES OF APPARENT AGREEMENT OF STRONG ELECTROLYTES WITH THE MASS LAW.[1]

BY H. I. SCHLESINGER AND A. W. MARTIN.[2]

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In the first paper of this series, Schlesinger and Calvert[3] showed that the solutions formed when ammonia is passed into formic acid are excellent conductors and that the electrolyte, ammonium formate, obeys the law of mass action, although it is highly ionized. It is well known that strong electrolytes do not, in general, obey this law and these solutions, therefore, are exceptionally interesting. Consequently, we have undertaken to extend this work, with the intention of determining the limiting concentrations within which the law is applicable and of obtaining results of greater accuracy by improving the methods employed. In addition to a study of the conductivity of these solutions, their viscosity was also determined. Since it was possible that the agreement with the mass law in the one case, ammonium formate, might be due to a cancellation of deviations from the law in opposite directions, the validity of the conclusion that the agreement is not accidental in character was tested by studying the behavior of other formates in this solvent. Finally, preliminary determinations of the conductivities and freezing points of solutions of hydrogen chloride in the same solvent were carried out, as there was reason to believe that previous work on this subject by Zanninovich-Tessarin[4] was incorrect.

The formic acid used in this work was purified by a method which is a considerable improvement over that employed by Schlesinger and Cal-

[1] Presented, in part, at the Cincinnati meeting of the American Chemical Society, April 9, 1914.

[2] The work reported in this article constitutes the basis of a dissertation submitted by A. W. Martin to the faculty of the University of Chicago in part fulfilment of the requirements for the degree of Doctor of Philosophy.

[3] THIS JOURNAL, 33, 1924 (1911).

[4] *Z. phys. Chem.*, 19, 251 (1896).