VOL. XXXII. JANUARY, 1909. No. 1.

THE JOURNAL

OF THE

American Chemical Society

# REPORT OF THE INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS, 1910.

Received October 25, 1909.

Since the preparation of our last report there has been much activity in the determination of atomic weights. A brief summary of the results obtained is as follows:

*Chlorine*.—A novel comparison of chlorine with oxygen is due to Guye and Fluss.[1] Nitrosyl chloride, NOCl, was first weighed, and then distilled over silver, to absorb chlorine, then over heated copper, to absorb oxygen, and finally over metallic calcium, which retained the nitrogen. The complete analysis of the chloride was thus effected. From the direct weights of the oxygen and chlorine, Cl = 35.468.

*Nitrogen*.—In the investigation just cited, Guye and Fluss give data which correspond to N = 14.006. Guye and Pintza[2] determined the density of the mixed gases produced by the decomposition of ammonia, and so measured its composition by volume. If H = 1.0076, then N = 14.014. The authors regard the determination as having only a significance corroborative of the lower value for nitrogen.

The ratio AgCl : $NH_4Cl$ : : 100 : 37.3217 has been measured by Richards, Koethner and Tiede.[3] Reduced with Ag = 107.881, Cl = 35.4574, and H = 1.0076, N = 14.0085. If H = 1.0078, N = 14.008. The values assigned to silver and chlorine are derived from former researches by Richards and his colleagues in the Harvard laboratory.

*Carbon*.—From the ratio between silver and tetraethylammonium bromide, as measured by Scott,[4] C = 12.017 when Ag = 107.88. A

[1] *J. chim. phys.*, 6, 732.
[2] *Compt. rend.*, 147, 925.
[3] THIS JOURNAL, 31, 6.
[4] *J. Chem. Soc.*, 95, 1200.

single experiment with the corresponding methyl compound gave C = 12.019. These values are too high to be accepted until they have been confirmed by other methods.

From the density of methane, Baumé and Perrot[1] find C = 12.004. From the density of toluene, as determined by Ramsay and Steele, Leduc[2] computes C = 12.003.

*Iodine and Silver.*—Baxter and Tilley[3] have determined the ratio between iodine pentoxide and silver. The pentoxide was reduced by means of hydrazine, and the hydriodic acid so produced was balanced in the usual way against silver. From the ratio thus found, $I_2O_5$ : 2Ag :: 100 : 64.6225, and 64.6230 (two series), combined with the ratio I : Ag :: 100 : 84.8843, the authors find that the atomic weight of Ag lies between 107.847 and 107.850. The corresponding value for iodine is I = 126.891.

*Phosphorus.*—From the density of phosphine, $PH_3$, Ter Gazarian[4] finds P = 30.906.

*Arsenic.*—Atomic weight redetermined by Baxter and Coffin.[5] The ratios $Ag_3AsO_4$ : 3AgCl and $Ag_3AsO_4$ : 3AgBr were determined by two methods: one by solution and precipitation in the usual way, the other by heating the arsenate in a stream of hydrochloric or hydrobromic acid. The final, mean result is As = 74.957, when Ag = 107.880.

*Chromium.*—From analyses of silver chromate, by two methods, Baxter, Mueller and Hines[6] find Cr = 52.008 when Ag = 107.88. With similar analyses of silver dichromate, Baxter and Jesse[7] find Cr = 52.013. The mean value is 52.01.

*Tellurium.*—Lenher[8] converted the double bromide $K_2TeBr_6$ into 2KCl by heating, first in a stream of chlorine, and afterwards in hydrochloric acid. Sixteen very concordant experiments were made, giving the molecular ratio between the two compounds. The final mean value is Te = 127.55.

*Mercury.*—Analyses of mercuric chloride have been made by Easley,[9] who determined the proportion of mercury in the compound, and also the ratio $HgCl_2$ : 2AgCl. By the first method, Hg = 200.48; by the second method Hg = 200.62. These values are surprisingly high, but as Easley is to continue his investigation it would be unwise to accept

[1] *Compt. rend.*, **148**, 39.
[2] *Ibid.*, **148**, 832.
[3] THIS JOURNAL, **31**, 201.
[4] *Compt. rend.*, **148**, 1397.
[5] THIS JOURNAL, **31**, 297.
[6] *Ibid.*, **31**, 529.
[7] *Ibid.*, **31**, 541.
[8] *Ibid.*, **31**, 20.
[9] *Ibid.*, **31**, 1207.

them until his work is all done. It is quite possible that the increase may be ultimately verified.

*Palladium.*—Atomic weight determined by Gutbier, Haas and Gebhardt,[1] by analyses of palladosamine bromide. The final, most probable mean value, when $N_2H_6Br_2$ = 193.908, is Pd = 106.689.

## International Atomic Weights, 1910.

| | Symbol. | Atomic weight. | | Symbol. | Atomic weight. |
|---|---|---|---|---|---|
| Aluminium | Al | 27.1 | Molybdenum | Mo | 96.0 |
| Antimony | Sb | 120.2 | Neodymium | Nd | 144.3 |
| Argon | A | 39.9 | Neon | Ne | 20.0 |
| Arsenic | As | 74.96 | Nickel | Ni | 58.68 |
| Barium | Ba | 137.37 | Nitrogen | N | 14.01 |
| Bismuth | Bi | 208.0 | Osmium | Os | 190.9 |
| Boron | B | 11.0 | Oxygen | O | 16.00 |
| Bromine | Br | 79.92 | Palladium | Pd | 106.7 |
| Cadmium | Cd | 112.40 | Phosphorus | P | 31.0 |
| Caesium | Cs | 132.81 | Platinum | Pt | 195.0 |
| Calcium | Ca | 40.09 | Potassium | K | 39.10 |
| Carbon | C | 12.00 | Praseodymium | Pr | 140.6 |
| Cerium | Ce | 140.25 | Radium | Ra | 226.4 |
| Chlorine | Cl | 35.46 | Rhodium | Rh | 102.9 |
| Chromium | Cr | 52.0 | Rubidium | Rb | 85.45 |
| Cobalt | Co | 58.97 | Ruthenium | Ru | 101.7 |
| Columbium | Cb | 93.5 | Samarium | Sa | 150.4 |
| Copper | Cu | 63.57 | Scandium | Sc | 44.1 |
| Dysprosium | Dy | 162.5 | Selenium | Se | 79.2 |
| Erbium | Er | 167.4 | Silicon | Si | 28.3 |
| Europium | Eu | 152.0 | Silver | Ag | 107.88 |
| Fluorine | F | 19.0 | Sodium | Na | 23.00 |
| Gadolinium | Gd | 157.3 | Strontium | Sr | 87.62 |
| Gallium | Ga | 69.9 | Sulphur | S | 32.07 |
| Germanium | Ge | 72.5 | Tantalum | Ta | 181.0 |
| Glucinum | Gl | 9.1 | Tellurium | Te | 127.5 |
| Gold | Au | 197.2 | Terbium | Tb | 159.2 |
| Helium | He | 4.0 | Thallium | Tl | 204.0 |
| Hydrogen | H | 1.008 | Thorium | Th | 232.42 |
| 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 | 55.85 | Tungsten | W | 184.0 |
| Krypton | Kr | 83.0 | Uranium | U | 238.5 |
| Lanthanum | La | 139.0 | Vanadium | V | 51.2 |
| Lead | Pb | 207.10 | Xenon | Xe | 130.7 |
| Lithium | Li | 7.00 | 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 | 200.0 | | | |

[1] *J. prakt. Chem.* [2], **79**, 457. This includes the work of Haas, cited in the report for 1909.

*Krypton and Xenon.*—Moore[1] isolated krypton and xenon in considerable quantities from the residues from 120 tons of liquid air. Calculated from the densities of the two gases the atomic weights are Kr = 83.012, and Xe = 130.70.

It will be seen from the evidence given above that few changes are needed in the table of atomic weights. Chromium, 52.01, may be rounded off to 52, as compared with the 52.1 formerly accepted. Arsenic becomes 74.96, in accordance with the work of Baxter and Coffin. The new values for krypton and xenon should also be adopted. As regards mercury, action may be deferred until more evidence is received.

*Signed,* F. W. CLARKE,
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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF HARVARD COLLEGE.]

# FURTHER INVESTIGATION CONCERNING THE ATOMIC WEIGHTS OF SILVER, LITHIUM AND CHLORINE.

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Received October 28, 1909.

## PART I.—THE RATIO OF LITHIUM CHLORIDE TO SILVER CHLORIDE AND SILVER.

### Introduction.

The present uncertainty in the atomic weight of silver causes confusion and uncertainty throughout the whole table of atomic weights. Long ago Dumas[2] pointed out that Stas, with all his care, had not succeeded in preparing pure silver, and accordingly that the atomic weights referred to silver need revision. Later, in reply to Dumas, Stas[3] sought to determine the oxygen remaining in the metal and succeeded in finding only a trace. Hence for many years Dumas' criticism was unheeded. A careful study of Stas's experiments shows, however, that the metal which he used in these later trials had not been treated in the same way as that which he used in his work upon atomic weights and hence that the presence or absence of oxygen in the later samples proved little with regard to the earlier samples. As a matter of fact it was shown in 1903 in the chemical laboratory of Harvard University[4] that Stas's silver

[1] *J. Chem. Soc.*, 93, 2181.

[2] Dumas, *Ann. chim. phys.*, 14, 289 (1878).

[3] Stas, *Oeuvres Completes*, III, 106–125 (Brussels, 1903).

[4] Richards and Wells, "A Revision of the Atomic Weights of Sodium and Chlorine," Carnegie Institution of Washington, Publication No. 28; THIS JOURNAL, 27, 459 (1905); *Z. anorg. Chem.*, 47, 56 (1905). This paper is reprinted in full in "Experimentelle Untersuchungen über die Atomgewichte," by T. W. Richards, page 689 (Hamburg, 1909), and also in *Chem. News*, 93.