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SECOND REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS OF THE INTERNATIONAL UNION OF CHEMISTRY

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The following report of the Committee covers all atomic weight investigations published in the period February–October, 1931, which have come to its attention. Future reports will cover a twelve-month period.

On the basis of this report, the following changes in the table of atomic weights are recommended: Kr 83.7 instead of 82.9, and Xe 131.3 instead of 130.2.

The determinations are divided according to methods used into the following three classes: (1) physico-chemical methods, (2) chemical methods and (3) physical methods (mass-spectroscopy). Within each class the arrangement of the elements follows the grouping of the periodic system.

Authors of papers bearing on the subject are requested to send copies to each of the five members of the committee at the earliest possible moment.¹

I. Physico-Chemical Methods

Nitrogen.—T. Batuecas² has carried out a new determination of the normal density of nitrous oxide. The gas was prepared by two methods, (1) by the reaction of hydroxylamine hydrochloride and sodium nitrite and (2) by thermal decomposition of ammonium nitrate. It was washed with concentrated sodium hydroxide, pure sulfuric acid and ferrous sulfate solution, dried with solid potassium hydroxide and phosphorus pentoxide, finally condensed with liquid air and subjected to repeated fractionation. Two globes of 1007.55 ml. (G) and 772.58 ml. (3) were employed.

In the following table P_0 represents the difference between the pressures

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² Batuecas, *Z. physik. Chem.*, Bodenstern-Festband. 18 (1931).

when filled and exhausted, S the weight of gas, L_b the density calculated according to the formula for a perfect gas and L_0 the normal density.

Series	Globe	P_0	S	L_b	L_0	Mean
1	G	758.13	1.98971	1.9797	1.9809	1.9808
	No. 3		1.52559	1.9795	1.9807	
2	G	773.92	2.02945	1.9795	1.9807	1.9807
	No. 3		1.55636	1.9796	1.9807	
3	G	745.16	1.95396	1.9779	1.9794	1.9800
	No. 3		1.49890	1.9792	1.9806	
4	G	761.95	1.99977	1.9797	1.9808	1.9807
	No. 3		1.53328	1.9795	1.9806	
5	G	745.52	1.95562	1.9787	1.9801	1.9800
	No. 3		1.49952	1.9786	1.9800	
6	G	732.34	1.92070	1.9783	1.9800	1.9802
	No. 3		1.47311	1.9788	1.9804	
7	G	752.04	1.97243	1.9784	1.9797	1.9799
	No. 3		1.51288	1.9788	1.9801	
8	G	762.41	2.00081	1.9795	1.9806	1.9807
	No. 3		1.53433	1.9797	1.9808	
9	G	768.33	2.01653	1.9797	1.9807	1.9809
	No. 3		1.54653	1.9801	1.9810	
10	G	752.73	1.97498	1.9791	1.9804	1.9803
	No. 3		1.51433	1.9790	1.9803	

The mean³ of these twenty determinations is found to be 1.98042 \pm 0.00005.

Density determinations at $2/3$, $1/2$ and $1/4$ atmospheres are under way from which the value of $1 + \lambda$ will be found.

Carbon and Sulfur.—D. LeB. Cooper and O. Maass⁴ have determined the density of carbon dioxide at five different temperatures between -30 and 77° over a pressure range of 760 to 250 mm. by filling a globe (5-liter) of known volume at a known temperature and pressure, and, after condensation of the gas in a Pyrex capsule which was sealed by fusion, weighing the condensed gas. The isotherms obtained by plotting molecular weights calculated according to the gas law against the pressure were straight lines whose equations were found by weighing the individual points. Extrapolation to zero pressure yielded the following values for the molecular weight of carbon dioxide and the atomic weight of carbon.

Degrees	Mol. wt. CO ₂	At. wt. C
25	44.0083	12.0083
0	44.0001	12.0001
-30	44.0079	12.0079
	Mean 44.0054	12.0054

³ Incorrect in the original: 1.98038.

⁴ Cooper and Maass, *Can. J. Res.*, 4, 283, 495 (1931).

By similar measurements with sulfur dioxide the same authors determined the molecular weight of sulfur dioxide and the atomic weight of sulfur.

Degrees	Mol. wt. SO ₂	At. wt. S
0	64.064	32.064
25.28	64.054	32.054
	Mean 64.059	32.059

No correction for adsorption is applied in either investigation.

Fluorine.—H. S. Patterson, R. Whytlaw-Gray and W. Cawood⁵ have repeated the work of Moles and Batuecas⁶ on the determination of the limiting density of methyl fluoride. The former are of the opinion that methyl fluoride is very difficult to prepare in a state of high purity by the method employed by Moles, and that the density determinations of Moles and Batuecas show variations far larger than the permissible experimental error.

They prepared methyl fluoride according to the method of Collie by thermal decomposition of tetramethylammonium fluoride and purified the gas by liquefaction and repeated fractional distillation. With the aid of the same microbalance which had been employed for the determination of the density of xenon (see below), the equilibrium pressures of oxygen and methyl fluoride corresponding to two different densities were compared. For oxygen pressures of 335.61 and 156.86 mm. at 21° the relative values were 1.06726 and 1.06550, respectively.

By extrapolation to zero pressure the limiting value 1.06395 was found and from this the molecular weight of methyl fluoride, 34.046. Upon the assumption that the atomic weight of carbon is 12.010, a value which they derive from limiting density measurements with highly purified ethylene, they calculate the atomic weight of fluorine to be 19.013. From these results they also calculate the compressibility coefficient at 21° to be 1.00823 and the corresponding value at 0° to be 1.0109 if the thermal expansion coefficient of methyl fluoride is assumed to be a little higher than that of carbon dioxide, an assumption which appears justifiable to the authors. This value is far lower than that calculated by Moles, 1.0180. They believe that his methyl fluoride was contaminated with several per cent. of ether, that therefore his values for the density and the compressibility coefficient are too high, and that only by compensation of errors was the atomic weight 19.000 obtained, corresponding to the finding of the mass spectrocope. They believe it probable that the true atomic weight of fluorine lies nearer 19.010 than 19.000. This points to a slight admixture of a higher isotope although Aston believes fluorine to be a simple element.

⁵ Patterson, Whytlaw-Gray and Cawood, *Nature*, **128**, 375 (1931).

⁶ Moles and Batuecas, *J. chim. phys.*, **18**, 353 (1920).

Krypton.—H. E. Watson⁷ has compared the densities of especially pure krypton and oxygen with the aid of a microbalance and finds that the two gases have the same densities at 25° and pressures of 301.15 and 787.8 mm., respectively. On the assumption that proportionality obtains between the compressibility corrections of the two gases, he calculates the atomic weight of krypton to be 83.71, while the most probable value for the compressibility of krypton calculated by him in 1910 yields the value 83.63.

This value while preliminary makes it probable that Aston's value for krypton, 83.77, is nearer the truth than the international value in use up to now, 82.9. Therefore the value 83.7 has been adopted for the table.

Xenon.—R. Whytlaw-Gray, H. S. Patterson and W. Cawood⁸ with the aid of a highly sensitive microbalance have compared the pressures at which pure xenon provided by F. W. Aston and pure oxygen possess the same densities. The already pure gas was further fractionated until no further increase in density could be detected. For pressures of xenon of 80 and 153 mm. at 18° the relation P_{O_2}/P_{Xe} after applying all corrections was found to be 4.1035 and 4.1049, respectively, as averages of two concordant series. The limiting value of this relation at zero pressure was found by extrapolation to be 4.1020. The atomic weight of xenon is then $4.1020 \times 32 = 131.26$ with an apparent error of ± 0.005 . This value corroborates Aston's value, 131.27.

The Committee adopts Xe 131.3 for the table in place of the value heretofore in use.

II. Chemical Methods

Nitrogen and Silver.—G. P. Baxter and C. H. Greene⁹ have determined gravimetrically the ratio Ag:NH₃. This ratio combined with the ratio NO₃:Ag, which has already been determined with a high degree of accuracy, yields the ratio NO₃:NH₃, from which the atomic weight of nitrogen referred to oxygen and hydrogen may be calculated.

The method, which has previously been employed by Stas, was as follows. A weighed amount of the purest ammonia, adsorbed on dehydrated and degassed chabazite, was allowed to evaporate into dilute hydrochloric or hydrobromic acid and until the acid was exactly neutralized, with the use of methyl red or litmus as indicator. The ammonium halide was then compared with the purest silver in the usual way with the help of a nephelometer.

All reagents were purified by standard methods. Commercial synthetic liquid ammonia was freed from the more probable impurities such as moisture and uncondensable gases by repeated fractional distillation and

⁷ Watson, *Nature*, 127, 631 (1931).

⁸ Whytlaw-Gray, Patterson and Cawood, *ibid.*, 127, 970 (1931).

⁹ Baxter and Greene, *THIS JOURNAL*, 53, 604 (1931).

finally was adsorbed in a special weighing tube on chabazite. Actually it is not possible to free ammonia from last traces of moisture in this way, so that in a special series of experiments the percentage of moisture was determined by absorption in fused potassium hydroxide, and a corresponding correction was applied in each experiment.

In the following table the ratio $\text{NO}_3:\text{NH}_3$ is calculated on the assumption that $\text{NO}_3:\text{Ag} = 0.57479$. The bromide analyses gave in general higher results for the atomic weight of nitrogen than the chloride analyses, apparently owing to occlusion of soluble bromide, and this difference was greater, the higher the concentration of the bromide solution used.

THE ATOMIC WEIGHT OF NITROGEN							
No.	Concn./n	Acid	NH_3 in vac.	Ag in vac.	$\text{Ag}:\text{NH}_3$	$\text{NO}_3:\text{NH}_3$	At. wt. N
1	0.09	HCl	1.43953	9.11867	6.33448	3.64100	14.0067
2	.07	HBr	4.67035	29.58295	6.33420	3.64083	14.0078
3	.06	HCl	4.11520	26.06744	6.33443	3.64097	14.0069
4	.08	HBr	1.62620	10.30014	6.33387	3.64065	14.0090
5	.15	HBr	1.85833	11.77004	6.33367	3.64053	14.0098
6	.09	HBr	1.81372	11.48804	6.33397	3.64070	14.0087
7	.08	HCl	1.61251	10.21397	6.33421	3.64084	14.0078
8	.03	HBr	1.92927	12.22037	6.33419	3.64083	14.0078
9	.02	HCl	1.20999	7.66426	6.33415	3.64081	14.0080
10	.025	HBr	1.67684	10.62158	6.33428	3.64088	14.0075
11	.03	HBr	1.89941	12.03092	6.33403	3.64074	14.0084
12	.03	HBr	1.98867	12.59593	6.33385	3.64063	14.0091
Average of chlorides (1, 3, 7, 9)							14.0074
Average of concentrated bromides (2, 4, 5, 6)							14.0088
Average of dilute bromides (8, 10, 11, 12)							14.0082
Average of analyses 1, 3, 7, 8, 9, 10, 11, 12							14.0078

If the experiments in which the more concentrated bromide solutions were used are omitted, the remaining bromide and chloride analyses yield an atomic weight of nitrogen in excellent agreement with the present international value.

If $N = 14.0078$, then $\text{Ag} = 107.879$, while if $N = 14.008$, silver becomes 107.880 from the ratio $\text{Ag}:\text{NH}_3$ and 107.879 from the ratio $\text{Ag}:\text{NO}_3$.

Chlorine.—Since Scott and Johnson¹⁰ have called attention to an erroneous assumption by O. Höning Schmid and Bedr Chan as to the solubility of silver chloride in water at 0° , Höning Schmid¹¹ has redetermined this value and finds one in close agreement with that obtained by T. W. Richards and H. H. Willard,¹² *i. e.*, 0.5 mg./liter. Using this value O. Höning Schmid corrects the gravimetric results of the complete silver chloride syntheses of O. Höning Schmid and Bedr Chan.¹³

¹⁰ Scott and Johnson, *THIS JOURNAL*, **52**, 3586 (1930).

¹¹ Höning Schmid, *ibid.*, **53**, 3012 (1931).

¹² T. W. Richards and Willard, *ibid.*, **32**, 4 (1910).

¹³ Höning Schmid and Chan, *Z. anorg. allgem. Chem.*, **163**, 315 (1927).

In the following table are given the weights of chlorine and silver used, the corrected weight of silver chloride found, the difference between the sum of the chlorine and silver and the silver chloride, and the calculated atomic weight of chlorine.

No.	ATOMIC WEIGHT OF CHLORINE					
	Cl in vac.	Ag in vac.	AgCl in vac.	Diff.	Cl:AgCl	At. wt. of Cl
1	2.85458	8.68543	11.54010	-0.09	0.2473618	35.4558
2	2.25569	6.86312	9.11889	- .08	.2473645	35.4563
4	2.46049	7.48635	9.94704	- .20	.2473590	35.4553
5	3.35955	10.22139	13.58106	- .12	.2473702	35.4574
6	2.96007	9.00620	11.96637	- .10	.2473657	35.4565
7	2.21357	6.73502	8.94863	- .04	.2473641	35.4562
8	3.04333	9.25949	12.30290	- .08	.2473669	35.4568
9	2.17711	6.62409	8.80133	- .13	.2473615	35.4558
	<u>21.32439</u>	<u>64.88109</u>	<u>86.20632</u>	- .84	<u>.2473646</u>	<u>35.4563</u>

The mean atomic weight of chlorine from these eight gravimetric determinations is 35.4563 while by nephelometric titration 35.4567 was found. The average deviation between the weights of silver chloride calculated and found is 0.1 mg. and the total for eight determinations is 0.84 mg.

Iodine.—G. P. Baxter and A. Q. Butler¹⁴ have again undertaken the investigation of iodine pentoxide, begun more than twenty years ago by Baxter and Tilley¹⁵ in order to explain the discrepancy between the ratio $2\text{Ag}:\text{I}_2\text{O}_5$ as determined experimentally, 0.646225, and that calculated from the atomic weights $\text{Ag} = 107.880$ and $\text{I} = 126.932$, 0.646251. A small part of this difference is explained by the discovery that air is adsorbed by the very porous iodine pentoxide to the extent of 0.001%.

Analysis was carried out by thermal decomposition of weighed amounts of the pentoxide and weighing of the iodine liberated.

Iodic acid was obtained by metathesis from sulfuric acid and barium iodate, which had been prepared from pure materials, and was purified by fractional crystallization. The acid was dehydrated at gradually increasing temperatures (100–240°). The decomposition was conducted in a special quartz weighing tube, which could be closed with ground stoppers, in which the resulting iodine was condensed for weighing. Since the pentoxide cannot be entirely freed from moisture at the highest temperature at which it is stable, in each analysis a water determination was made by passing the oxygen evolved through a weighed U-tube containing phosphorus pentoxide. The water determinations were subject to a blank correction obtained in a special series of experiments. In addition a correction was made of 0.001% for air adsorbed on the pentoxide.

¹⁴ Baxter and Butler, *THIS JOURNAL*, 53, 968 (1931).

¹⁵ Baxter and Tilley, *ibid.*, 31, 201 (1909).

THE RATIO OF IODINE TO IODINE PENTOXIDE					
No.	Corr. wt. of I ₂ O ₅	I in vac.	O in vac.	I ₂ :I ₂ O ₅	I ₂ :5O
1	23.43527	17.81810	5.61717	0.760311	3.17208
2	25.52824	19.40949	6.11875	.760314	3.17213
3	42.45905	32.28337	10.17568	.760341	3.17260
4	46.13308	35.07699	11.05609	.760344	3.17264
5	46.22581	35.14741	11.07840	.760342	3.17261
6	21.05562	16.00913	5.04649	.760326	3.17233
7	22.07654	16.78564	5.29090	.760338	3.17255
8	41.88974	31.85032	10.03942	.760337	3.17253
9	42.71266	32.47602	10.23664	.760337	3.17253
Average				.760332	3.17244
Average 3, 4, 5, 7, 8, 9				.760340	3.17259

Analyses 1, 2 and 6 were rejected since they were subject to known errors. The values for the ratio of iodine to oxygen and to pentoxide are subject to a correction for displacement of air from the weighing tube by iodine vapor at 25°. The effect of this is to raise the value of the ratio I₂:5O by 0.001% to 3.17262 and of the ratio I₂:I₂O₅ by 0.0003% to 0.760342.

The result of these analyses is very surprising since the values for these ratios calculated from the atomic weight of iodine, 126.932, are 3.17330 and 0.760381, respectively. The atomic weight of iodine calculated from the analytical data is 126.905. Since this value is believed to be impossibly low, the conclusion is reached that the most carefully prepared iodine pentoxide contains more oxygen than corresponds to its stoichiometric composition, apparently because of the presence of a higher oxide of iodine, and that it is therefore unsuited as a starting point for experiments of high precision. This conclusion is supported by the result of the earlier investigation by Baxter and Tilley in which the ratio 2Ag:I₂O₅ was found to be smaller than that expected. By combination of the experimentally determined ratios, 2Ag:I₂O₅ and I₂:I₂O₅ the ratio I:Ag may be calculated to be 1.176579 and the atomic weight of iodine 126.929.

O. Hönigschmid and H. Striebel¹⁶ have completed an investigation on the atomic weight of iodine by determining the ratio AgI:AgCl. The silver iodide was obtained by synthesis from the purest atomic weight silver and carefully purified iodine. The purification of the iodine followed the procedure recommended by Guichard, and consisted essentially in decomposing potassium iodide with copper sulfate and purifying the iodine which separated by distillation from solution in potassium iodide and sublimation. The silver iodide, contained in a weighed quartz tube, was fused in an atmosphere containing iodine vapor and after being weighed was converted to chloride by heating in a current of chlorine. All weighings were made by substitution with the use of counterpoises and were corrected to vacuum.

¹⁶ Hönigschmid and Striebel, *Z. physik. Chem.*, Bodenstein-Festband, 282 (1931).

THE RATIO OF SILVER IODIDE TO SILVER CHLORIDE				
No.	AgI in vac.	AgCl in vac.	AgI:AgCl	At. wt. I
1	4.07537	2.48790	1.638076	126.917
2	5.41399	3.30511	1.638067	126.916
3	6.45241	3.93901	1.638079	126.917
4	7.20017	4.39557	1.638051	126.913
5	6.74801	4.11943	1.638093	126.919
6	8.42163	5.14113	1.638078	126.917
7	8.79602	5.36972	1.638078	126.917
	<u>47.10760</u>	<u>28.75787</u>	1.638076	126.917

These seven concordant determinations yield for the atomic weight of iodine the strikingly low value 126.917 if chlorine is assumed to have the value 35.457.

The authors call attention to the fact that on the basis of Aston's value for the atomic weight of iodine based on $O_{16} = 16$, 126.932, the chemical atomic weight must be about 1/10000 lower, not far from 126.918, providing always that the relation $A_{\text{mass.}} = A_{\text{chem.}} \times 1.000125$, which depends on Babcock and Naudé's determination of the isotopic proportion $O_{16}:O_{18}:O_{17}$, is correct. From a similar determination by Mecke and Childs the relation $A_{\text{mass.}} = A_{\text{chem.}} \times 1.00022$ has been obtained, and from Aston's value for iodine the chemical value 126.905, which is identical with that calculated from Baxter and Butler's data already given. However, Aston's value is a mean of the observed limiting values 126.907 and 126.957 so that aside from the uncertainty of the conversion factor, calculations of this kind will have no definite significance until the accuracy of the mass spectrographic measurements is increased.

III. Physical Methods

In continuation of his investigations with the mass spectrograph, F. W. Aston¹⁷ has calculated the chemical atomic weights of several elements from the results of microphotometric measurements of the intensities of isotopic lines. For conversion from the physical basis $O_{16} = 16.000$ to the chemical basis $O = 16.000$, Naudé's equation is used. $O_{\text{chem.}}:O_{16} = 1.000125:1.000000$.

Oxygen.—R. Mecke and W. H. J. Childs¹⁸ have completed a new determination of the relative proportions of the oxygen isotopes by microphotometric evaluation of the band spectrum of oxygen, with the following result: $O_{16}:O_{18}:O_{17} = 630 \pm 20:1:0.2$. On the basis of $O_{16} = 16$ the atomic weight of chemical oxygen is calculated to be 16.0035 ± 0.0003 . The conversion of atomic weights determined with the mass spectroscope to

¹⁷ Aston, *Nature*, **127**, 233, 519, 813; **128**, 149 (1931); *Proc. Roy. Soc.*, **A132**, 487 (1931).

¹⁸ Mecke and Childs, *Z. Physik*, **68**, 362 (1931).

ATOMIC WEIGHTS

1932

	Symbol	Atomic Number	Atomic Weight		Symbol	Atomic Number	Atomic Weight
Aluminum	Al	13	26.97	Molybdenum	Mo	42	96.0
Antimony	Sb	51	121.76	Neodymium	Nd	60	144.27
Argon	A	18	39.944	Neon	Ne	10	20.183
Arsenic	As	33	74.93	Nickel	Ni	28	58.69
Barium	Ba	56	137.36	Nitrogen	N	7	14.008
Beryllium	Be	4	9.02	Osmium	Os	76	190.8
Bismuth	Bi	83	209.00	Oxygen	O	8	16.0000
Boron	B	5	10.82	Palladium	Pd	46	106.7
Bromine	Br	35	79.916	Phosphorus	P	15	31.02
Cadium	Cd	48	112.41	Platinum	Pt	78	195.23
Calcium	Ca	20	40.08	Potassium	K	19	39.10
Carbon	C	6	12.00	Praseodymium	Pr	59	140.92
Cerium	Ce	58	140.13	Radium	Ra	88	225.97
Cesium	Cs	55	132.81	Radon	Rn	86	222
Chlorine	Cl	17	35.457	Rhenium	Re	75	186.31
Chromium	Cr	24	52.01	Rhodium	Rh	45	102.91
Cobalt	Co	27	58.94	Rubidium	Rb	37	85.44
Columbium	Cb	41	93.3	Ruthenium	Ru	44	101.7
Copper	Cu	29	63.57	Samarium	Sm	62	150.43
Dysprosium	Dy	66	162.46	Scandium	Sc	21	45.10
Erbium	Er	68	167.64	Selenium	Se	34	79.2
Europium	Eu	63	152.0	Silicon	Si	14	28.06
Fluorine	F	9	19.00	Silver	Ag	47	107.880
Gadolinium	Gd	64	157.3	Sodium	Na	11	22.997
Gallium	Ga	31	69.72	Strontium	Sr	38	87.63
Germanium	Ge	32	72.60	Sulfur	S	16	32.06
Gold	Au	79	197.2	Tantalum	Ta	73	181.4
Hafnium	Hf	72	178.6	Tellurium	Te	52	127.5
Helium	He	2	4.002	Terbium	Tb	65	159.2
Holmium	Ho	67	163.5	Thallium	Tl	81	204.39
Hydrogen	H	1	1.0078	Thorium	Th	90	232.12
Indium	In	49	114.8	Thulium	Tm	69	169.4
Iodine	I	53	126.932	Tin	Sn	50	118.70
Iridium	Ir	77	193.1	Titanium	Ti	22	47.90
Iron	Fe	26	55.84	Tungsten	W	74	184.0
Krypton	Kr	36	83.7	Uranium	U	92	238.14
Lanthanum	La	57	138.90	Vanadium	V	23	50.95
Lead	Pb	82	207.22	Xenon	Xe	54	131.3
Lithium	Li	3	6.940	Ytterbium	Yb	70	173.5
Lutecium	Lu	71	175.0	Yttrium	Y	39	88.92
Magnesium	Mg	12	24.32	Zinc	Zn	30	65.38
Manganese	Mn	25	54.93	Zirconium	Zr	40	91.22
Mercury	Hg	80	200.61				

	Isotopic weights and percentages								Packing fraction	Atomic weight		
										O = 16		
Lithium	6	7							$\left\{ \begin{array}{l} +20 \times 10^{-4} \\ +17 \times 10^{-4} \end{array} \right.$	6.923		
	8.9	91.1										
Cesium	133								-5×10^{-4}	132.91		
	100											
Boron	10	11							$\left\{ \begin{array}{l} +13.5 \times 10^{-4} \\ +10.0 \times 10^{-4} \end{array} \right.$	10.806		
	20.7	79.3										
Germanium	70	71	72	73	74	75	76	77	$\left\{ \begin{array}{l} \text{between} \\ -7 \text{ and } -10 \\ \times 10^{-4} \end{array} \right.$	72.65		
	19.72	1.53	25.41	9.22	35.47	2.26	6.09	0.70				
Selenium	74	76	77	78	80	82				-7.3×10^{-4}	78.96	
	0.9	9.5	8.3	24.0	48.0	9.3						
Tellurium	125	126	128	130						-5×10^{-4}	128.03	
	6.6	20.9	36.1	36.4								
Tungsten	182	183	184	186						0	183.96	
	22.6	17.2	30.1	30.0								
Bromine	79	81							$\left\{ \begin{array}{l} -9.0 \times 10^{-4} \\ -8.6 \times 10^{-4} \end{array} \right.$	79.916		
	50	50										
Rhenium	185	187							-1×10^{-4}	186.22		
	38.2	61.8										
Ruthenium	96	98	99	100	101	102	104				-6×10^{-4}	101.1
	5		12	14	22	30	17					
Osmium	186	187	188	189	190	192					-1×10^{-4}	190.31
	1.0	0.6	13.5	17.3	25.1	42.6						

the chemical basis would then need to follow the equation $A_{\text{mass.}} = A_{\text{chem.}} \times 1.00022$ while at present the Naudé conversion factor 1.000125 is in use.

The Atomic Weight Standard.—The discovery of the oxygen isotopes has created the undesirable situation that chemistry and physics are using two different scales for the determination of atomic weights. Because of this the question of an absolute standard has already been more or less widely discussed and various proposals made, for instance, $H_1 = 1.00000$; $He_4 = 4.00000$; $O_{16} = 16.0000$ as well as the present chemical standard $O = 16.0000$.

F. W. Aston, who discussed the question comprehensively before the British Association in 1931, concludes that it is advisable for chemists to retain the present chemical standard, since it amply satisfies all requirements of International Atomic Weights so far as accuracy is concerned. For the more exacting requirements of physics the oxygen isotope O_{16} seems to him a better standard. The disadvantage that the two scales differ by one or two parts in ten thousand and that this difference will be subject to continual revision does not seem particularly important to him. Confusion may be easily avoided by speaking in one case of the "atomic weight for chlorine" and in the other of the "weight of the chlorine atom 35."

The Committee agrees unanimously with Aston's opinion and sees no reason for proposing a change in the present standard of atomic weights, $O = 16.0000$.

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF MICHIGAN]
**LIQUID JUNCTION POTENTIALS. I. REPRODUCIBLE STATIC
LIQUID JUNCTIONS CONSTANT IN POTENTIAL OVER
LONG PERIODS OF TIME¹**

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Static liquid junctions have caused endless difficulties since measurements of single electrode and concentration cell potentials were first attempted.² To get results at all reproducible, investigators have adopted numerous arbitrary methods for overcoming these difficulties, but none are accepted as satisfactory. Such procedures, of course, have rendered the data empirical.³ An extensive study of the most promising devices was made by Lamb and Larson.⁴ They concluded that results with static junctions, made in various ways, are unsatisfactory, and, therefore, proceeded to develop the flowing junction.

There are many instances, however, where it is not possible or convenient to use flowing junctions and yet it is highly important that constant and reproducible values be obtained; for instance, in the comparison of the standard hydrogen with a calomel or any other electrode, liquid junction potential is included in the measurement and becomes a part of the value given to the calomel or other electrode. All such values are as uncertain as the boundary potential, and whenever the calomel electrode is used as a standard the assumption must be made that the solution potential, which is a part of its value, always remains the same. When a saturated calomel electrode or a bridge of saturated potassium chloride is used, the common assumption is that no boundary potential exists under these conditions. It is well known, however, that neither of these assumptions is justified. The present work is an attempt to construct static boundaries of this nature in such a manner as to give potentials more constant and reproducible than have previously been done. The

¹ The material in this article is from a portion of the thesis submitted to the Graduate School of the University of Michigan by Kenneth Van Lente in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

² The present authors do not include a bibliography because several are now in print; see, for instance, Guggenheim, *THIS JOURNAL*, 52, 1315 (1930).

³ These remarks do not apply to junctions which consist of two different concentrations of the same electrolyte. Such boundaries, according to both theory and practice, give but little trouble.

⁴ Lamb and Larson, *THIS JOURNAL*, 42, 229 (1920).