Eighth Report of the Committee on Atomic Weights of the International Union of Chemistry.

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THE following report of the Committee covers the twelve-month period, September 30, 1936, to September 30, 1937.*

The following changes in the table of atomic weights have been made :

Hydrogen	from	1·0078	to	1·0081
Helium	,,	4·002	,,	4·003
Carbon	,,	12·01	,,	12·010
Molybdenum	,,	96·0	,,	95·95
Erbium	,,	167·64	,,	167·2
Tungsten	,,	184·0	,,	183·92
Osmium	,,	191·5	,,	190·2

HYDROGEN AND HELIUM.—Mass spectroscopic values for these elements obtained by Aston (*Nature*, **1936**, **137**, 357, 613) and by Bainbridge and Jordan (*Reviews of Modern Physics*, **1937**, **9**, 370) based on the physical scale are as follows :

	Aston.	Bainbridge and Jordan.
^{1}H	1·00812	1·00813
He	4·00391	4·00389

On the chemical scale these become H_1 = 1·00785 and He = 4·00285 (conversion factor 1·00027). Allowance for ^{2}H, with the abundance ratio 1/5000, gives 1·00805 for chemical hydrogen. The values 1·0081 and 4·003 for hydrogen and helium have been adopted for the table, since they seem more reliable than those obtained by other methods.

CARBON.—Baxter and Hale (*J. Amer. Chem. Soc.*, **1937**, **59**, 506) have continued the quantitative combustion of heavy hydrocarbons, with certain improvements in technique. Chrysene used previously (I) was further purified (II) and a third sample was synthesised from naphthalene (III). Triphenylbenzene used previously (II) was further purified (III) and a new sample was synthesised from benzaldehyde (from amygdalin) (IV). A new sample of anthracene was purified as before (II) and a third sample was synthesised from phthalic acid and benzene (III). As previously reported, the purification of pyrene was not successful. The old as well as the new results are corrected for small increases in weight of the absorption tubes when gases were passed through the combustion train in the absence of any hydrocarbon. The earlier results are further corrected for a small error in weight calibration. Results are calculated with H = 1·0078. The use of the more probable value 1·0081 for hydrogen gives a value for carbon only 0·0003 lower.

Atomic Weight of Carbon.

Sample.	Hydro-carbon, g.	H_2O, g.	H, g.	C, g.	CO_2, g.	O, g.	Ratio C : O_2.	At. wt. of C.
				Chrysene.				
I	2·78052	1·31192	0·14678	2·63374	9·65237	7·01863	0·375250	12·008 (0)
I	2·69266	1·27591	0·14275	2·54991	9·34366	6·79375	0·375332	12·010 (6)
I	2·97790	1·41044	0·15780	2·82010	10·33440	7·51430	0·375298	12·009 (5)
I	2·99659	1·41906	0·15877	2·83782	10·39868	7·56086	0·375330	12·010 (6)
II	3·01102	1·42558	0·15950	2·85152	10·44739	7·59587	0·375404	12·012 (9)
II	2·97646	1·40901	0·15764	2·81882	10·32819	7·50937	0·375374	12·012 (0)
II	2·97260	1·40723	0·15744	2·81516	10·31566	7·50050	0·375330	12·010 (6)
II	1·56689	0·74145	0·08295	1·48394	5·43767	3·95373	0·375327	12·010 (5)
III	3·08222	1·45976	0·16332	2·91890	10·69608	7·77718	0·375316	12·010 (1)
III	2·07420	0·98195	0·10986	1·96434	7·19819	5·23385	0·375315	12·010 (1)
						Average	0·375328	12·010 (5)

* Authors of papers bearing on the subject are requested to send copies to each of the three members of the Committee at the earliest possible moment : Prof. G. P. Baxter, Coolidge Laboratory, Harvard University, Cambridge, Mass., U.S.A.; Prof. O. Hönigschmid, Sofienstrasse 9/2, München, Germany; Prof. P. Lebeau, Faculté de Pharmacie, 4, Avenue de l'Observatoire, Paris (6^e), France.

Sample.	Hydro-carbon, g.	H_2O, g.	H, g.	C, g.	CO_2, g.	O, g.	Ratio C : O_2.	At. wt. of C.
				Triphenylbenzene.				
I	3·00022	1·58994	0·17788	2·82234	10·34128	7·51894	0·375364	12·011 (6)
II	2·99781	1·58711	0·17757	2·82024	10·33453	7·51429	0·375317	12·010 (1)
II	2·99647	1·58580	0·17742	2·81905	10·33018	7·51113	0·375316	12·010 (1)
III	3·00284	1·58874	0·17775	2·82509	10·35196	7·52687	0·375334	12·010 (7)
III	6·00641	3·17865	0·35563	5·65078	20·70670	15·05592	0·375320	12·010 (2)
IV	2·99682	1·58563	0·17740	2·81942	10·33123	7·51181	0·375332	12·010 (6)
IV	3·00217	1·58866	0·17774	2·82443	10·35028	7·52585	0·375297	12·009 (5)
IV	2·99844	1·58649	0·17750	2·82094	10·33739	7·51645	0·375302	12·009 (7)
						Average	0·375323	12·010 (3)
				Anthracene.				
I	2·99495	1·51439	0·16943	2·82552	10·35385	7·52833	0·375318	12·010 (2)
I	2·04939	1·03659	0·11597	1·93342	7·08535	5·15193	0·375281	12·009 (0)
III	2·87189	1·45078	0·16231	2·70958	9·92877	7·21919	0·375330	12·010 (6)
III	2·95847	1·49521	0·16729	2·79118	10·22821	7·43703	0·375308	12·009 (9)
III	2·88436	1·45742	0·16306	2·72130	9·97193	7·25063	0·375319	12·010 (2)
II	6·06324	3·06430	0·34284	5·72040	20·96070	15·24030	0·375347	12·011 (1)
II	5·44882	2·75414	0·30814	5·14068	18·83572	13·69504	0·375368	12·011 (8)
II	2·81287	1·42365	0·15928	2·65359	9·72451	7·07092	0·375282	12·009 (0)
II	5·54044	2·80123	0·31340	5·22704	19·15276	13·92572	0·375352	12·011 (3)
						Average	0·375323	12·010 (3)
					Average of all results		0·375325	12·010 (4)

The average atomic weight of carbon is 0·0013 higher than the preliminary value (see Seventh Report of this Committee).

CARBON.—Scott and Hurley (*J. Amer. Chem. Soc.*, **1937**, **59**, 1905) have determined the atomic weight of carbon by comparison of benzoyl chloride with silver. Thiophen-free toluene was oxidised to benzoic acid by means of potassium permanganate. The product was twice precipitated with hydrochloric acid, recrystallised from water, and sublimed. To prepare benzoyl chloride the benzoic acid was warmed with redistilled phosphorus trichloride. Then the benzoyl chloride was purified by fractional distillation in exhausted all-glass systems. During the later stages of the fractionation samples for analysis were sealed off in glass bulbs. Analysis was effected by first breaking the weighed bulbs under aqueous pyridine and collecting the glass on filters for weighing. The solutions were then compared with weighed, nearly equivalent quantities of pure silver by the equal-opalescence method. In the following table the fractions are listed in the order of decreasing volatility. The weights of the bulbs and glass as well as of the silver were corrected for the buoyancy of the air during weighing.

The Atomic Weight of Carbon.

Fraction of benzoyl chloride.	Wt. of benzoyl chloride.	Wt. of Ag.	Ratio C_7H_5OCl : Ag.	At. wt. C.
4	13·08649	10·04596	1·302662	12·0050
5	13·12011	10·06925	1·302988	12·0100
8	13·09014	10·04617	1·302998	12·0102
11	12·43004	9·53960	1·302994	12·0101
12	13·48239	10·34736	1·302979	12·0099
15	14·70047	11·28211	1·302989	12·0101
16	13·80987	10·59833	1·303023	12·0106
14	10·71976	8·22688	1·303016	12·0105
9	14·61669	11·21768	1·303004	12·0103
6	12·53791	9·62157	1·303104	12·0118
	Average, excluding the first and last		1·302999	12·0102

The authors reject the result obtained with Fraction 4, which was the most volatile fraction analysed, since it was suspected to contain hydrogen chloride, and that obtained from Fraction 6 on the score of disagreement. This, however, was the least volatile fraction examined.

If the atomic weight of hydrogen is taken as 1·0081 instead of the current value, that of carbon is lowered only 0·0002.

The final result is in excellent agreement with that of Baxter and Hale (see above) and with that obtained from mass spectroscopic evidence.

The values for ^{12}C found by Aston (*Nature*, **1936**, **139**, 922) and by Bainbridge and Jordan (*Reviews of Modern Physics*, **1937**, **9**, 370) are 12·00355 and 12·00398 on the physical scale. Corrected to the chemical scale (conversion factor 1·00027), these become 12·0003 and 12·0007. Even with the abundance ratio for ^{13}C as low as 1/100 the atomic weight of carbon becomes 12·0103 and 12·0107.

On the basis of the chemical evidence the value 12·010 has been adopted for the atomic weight of carbon in the International Table, but from the physical evidence it seems possible that the correct value is nearer 12·011.

CARBON and NITROGEN.—Moles and Toral (*Sitzungsber. Akad. Wiss. Wien*, **1936**, **11*b***, **145**, 948; *Monatsh.*, **1936**, **69**, 342; *Anal. Soc. Fís. Quím.*, **1937**, **35**, 42) have redetermined the densities of oxygen, carbon dioxide and nitrous oxide with improved apparatus. Oxygen was prepared from potassium permanganate and from a mixture of potassium and sodium chlorates with manganese dioxide. Carbon dioxide was obtained by heating sodium hydrogen carbonate, and after purification was several times resublimed. Nitrous oxide was prepared from ammonium nitrate and was fractionated by sublimation.

The Density of Oxygen.

Globe A.	Globe B.	Average.
	760 mm.	
580·995	454·735	
	1·42892	1·42892
1·42892	1·42890	1·42891
1·42897	1·42899	1·42898
1·42893	1·42896	1·42895
Av. 1·42894	1·42894	1·42894
	506·67 mm.	
1·42849	1·42844	1·42847
1·42854	1·42853	1·42854
Av. 1·42852	1·42848	1·42850
	380 mm.	
1·42819	1·42812	1·42816
1·42836	1·42829	1·42833
1·42856	1·42831	1·42844
1·42823	1·42832	1·42828
1·42824	1·42833	1·42829
Av. 1·42832	1·42827	1·42830

The Density of Carbon Dioxide.

Globe A.	Globe B.	Average.
	760 mm.	
1·97695	1·97696	1·97695
1·97693	1·97691	1·97692
1·97696	1·97695	1·97695
Av. 1·97695	1·97694	1·97694
	570 mm.	
1·97355	1·97349	1·97352
1·97352	1·97358	1·97355
1·97353	1·97351	1·97352
Av. 1·97353	1·97353	1·97353
	475 mm.	
1·97187	1·97174	1·97180
1·97190	1·97189	1·97189
	1·97186	1·97186
	1·97188	1·97188
Av. 1·97189	1·97184	1·97185
	380 mm.	
1·97016	1·97012	1·97014
1·97008	1·97017	1·97012
1·97011	1·97016	1·97013
Av. 1·97012	1·97015	1·97013

The Density of Nitrous Oxide.

Globe A.	Globe B.	Average.
	760 mm.	
1·97826	1·97819	1·97822
1·97822	1·97823	1·97822
1·97820	1·97822	1·97821
Av. 1·97823	1·97821	1·97822
	380 mm.	
1·97103	1·97105	1·97104
1·97096	1·97092	1·97094
Av. 1·97100	1·97099	1·97099

From these values the following limiting densities and molecular weights are calculated:

	L. D.	M. W.
O_2	1·42764	32·0000
CO_2	1·96333	44·0072
N_2O	1·96377	44·0167

The atomic weights of carbon and nitrogen are then 12·007 and 14·008.

Moles (*J. Chim. Phys.*, **1937**, **34**, 49) discusses the calculation of molecular weights by the method of limiting densities.

NITROGEN.—Moles and Sancho (*Anal. Soc. Fís. Quím.*, **1936**, **34**, 865) recalculate the earlier results of Moles and Sancho (see Fifth Report of this Committee) on the density of ammonia after applying a correction for the coefficient of expansion of the barometer scale. The new values are 0·77140 and 0·76560 at one and at one-half atmosphere respectively. A similar correction for the scale used by Moles and Batuecas (see First Report of this Committee) gives 0·77140 for the density at one atmosphere.

New determinations were made by the volumeter method with ammonia prepared by heating nickel ammonia bromide.

The Density of Ammonia (760 *mm*.).

Pressure of filling.	Density.	Pressure of filling.	Density.	Pressure of filling.	Density.
762	0·77135	583	0·76856	264	0·76376
760	0·77147	509	0·76758	263	0·76372
Average	0·77141	397	0·76562	Average	0·76374
		396	0·76560		
		Average	0·76561		

The equation $D_p = 0{\cdot}759877 + 0{\cdot}001153p$ expresses these results within the limit of accuracy of the experiments. With the limiting densities 0·75988 and 1·42761 for ammonia and oxygen the molecular weight of ammonia is 17·0327. With the atomic weight of hydrogen 1·0078, nitrogen is 14·009. The value 1·0081 for hydrogen gives 14·008 for nitrogen.

CARBON, NITROGEN, AND FLUORINE.—Cawood and Paterson (*Trans. Roy. Soc.*, **1936**, *A*, **236**, 77), using an improved micro-displacement balance, have compared the density of oxygen with those of carbon dioxide, ethylene, carbon tetrafluoride, nitrous oxide and methyl fluoride under two different pressure conditions. By extrapolation the ratios at zero pressure were found.

The gases were subjected to chemical purification and fractional distillation or sublimation. Each ratio in the following tables is the mean of a long series of measurements at 21°.

Carbon dioxide.

P_{O_2}.	P_{O_2}/P_{CO_2}.
418·3	1·37764
234·5	1·37662
0	1·37532

$M_{CO_2} = 44{\cdot}0101$. C = 12·010.

Ethylene.

P_{O_2}.	$P_{O_2}/P_{C_2H_4}$.
428·1	0·879963
234·9	0·878507
0	0·876735

$M_{C_2H_4} = 28{\cdot}0556$.
C = 12·012 (H = 1·0078).

Carbon tetrafluoride.

P_{O_2}.	P_{O_2}/P_{CF_4}.
484·2	2·75106
252·8	2·75040
0	2·74967

$M_{CF_4} = 87{\cdot}989$.
F = 18·995 (C = 12·011).

Methyl fluoride.

P_{O_2}.	P_{O_2}/P_{CH_3F}.
454·8	1·06839
229·0	1·06596
0	1·06350

$M_{CH_3F} = 34{\cdot}0318$. F = 18·997 $\begin{cases} H = 1{\cdot}0078 \\ C = 12{\cdot}011. \end{cases}$

Nitrous oxide.

P_{O_2}.	P_{O_2}/P_{N_2O}.
418·6	1·37794
229·1	1·37680
0	1·37542

$M_{N_2O} = 44{\cdot}0135$. N = 14·007.

SODIUM.—Scott and Hurley (*J. Amer. Chem. Soc.*, **1937**, **59**, 2078) point out that with the atomic weight of carbon 12·010 and the current values of International atomic weights various recent experimental values for ratios involving sodium carbonate indicate a value for the atomic weight of sodium lower than the International value and in agreement with that recently found by Johnson, 22·994 (see Fifth Report of this Committee).

Ratio	
$Na_2CO_3 : 2Ag$	22·993
$Na_2CO_3 : 2AgBr$	22·993
$Na_2CO_3 : I_2O_5$	22·994

ALUMINIUM.—Hoffman and Lundell (*Bureau of Standards J. Research*, **1937**, **18**, 1) have determined the ratio of aluminium to aluminium oxide. Weighed quantities of aluminium were dissolved in hydrochloric acid and in one set of experiments aluminium hydroxide was precipitated, collected, and ignited (Series I). In another the aluminium chloride was converted into sulphate, and this compound in turn into oxide by ignition (Series II). Analysis of the two samples of aluminium employed revealed only traces of a few impurities, including oxygen. The oxide obtained in the main experiments was ignited at 1200—1300° in platinum crucibles. Tests for residual gases, sulphate and water were negative, provided the oxide was cooled and weighed in a closed receptacle. In every case blank experiments carried on simultaneously with very small weighed quantities of aluminium were used for comparison, the weights of metal and oxide being subtracted from those of the experiments proper.

The weights given in the following tables are corrected for the small amounts of impurities found in the original metal, and for the buoyancy of the air.

The Atomic Weight of Aluminium.

Sample of Al.	Al, g.	Al_2O_3.	Ratio 2Al : 3O.	At. wt. Al.	Al, g.	Al_2O_3.	Ratio 2Al : 3O.	At. wt. Al.
		Series I.				Series II.		
	2·00100	3·78105	1·124126	26·979	1·88650	3·56504	1·123893	26·973
	1·89511	3·58079	1·124241	26·982	2·00812	3·79482	1·123927	26·974
	1·83837	3·47351	1·124289	26·983	1·63804	3·09555	1·123862	26·973
	1·88787	3·56752	1·123966	26·975	2·65087	5·00956	1·123874	26·973
	1·90155	3·59348	1·123894	26·973*	2·64428	4·99696	1·123944	26·975
	2·33772	4·41805	1·123726	26·969*	2·04031	3·85588	1·123785	26·971
	1·99419	3·76859	1·123867	26·973	1·72393	3·25736	(1·124231)	(26·982)
		Average	1·124015	26·976	Average, omitting the last analysis		1·123881	26·973
					Average of Series I and II			26·975

* Recalculated.

The average agrees extraordinarily well with the earlier results of Krepelka and of Krepelka and Nikolic by analysis of the chloride, **26·975** and **26·974**. Richards and Krepelka found **26·963** by analysis of the bromide, and Aston's latest figure (*Nature*, **1936**, **137**, 163), corrected to the chemical scale with the conversion factor **1·00027**, is **26·984**.

Arsenic.—Krepelka and Kocnar (*Coll. Chem. Comm.*, **1936**, **8**, 485) have determined the ratio of arsenic tribromide to silver and silver bromide. Pure arsenic and pure bromine were caused to react at 180—200° in an all-glass apparatus and the product was three times fractionally distilled, once over arsenic, in a current of nitrogen, and was once fractionated in exhausted apparatus into small bulbs for analysis.

The bulbs, after being weighed in air and under water, were broken under ammonia and the glass was collected and weighed. Comparison of the solutions with solutions of weighed, very nearly equivalent quantities of pure silver were carried out by the equal-opalescence method. In one analysis the silver bromide was collected, dried, and weighed. Weights are corrected to vacuum.

The Atomic Weight of Arsenic.

$AsBr_3$, g.	Ag, g.	$AsBr_3$: 3Ag.	At. wt. As.
2·46237	2·53249	0·972312	74·931
3·10332	3·19176	0·972291	74·924
5·24485	5·39448	0·972262	74·915
1·83326	1·88549	0·972299	74·927
1·18537	1·21921	0·972244	74·909
2·67066	2·74673	0·972305	74·929
	Average	0·972286	74·923
	AgBr.		
4·09965	7·33996	0·558539	74·926

Molybdenum.—Hönigschmid and Wittmann (*Z. anorg. Chem.*, **1936**, **229**, 65) have analysed molybdenum pentachloride by comparison with silver. Molybdenum trioxide first was fractionally sublimed. The middle portions were combined and fractionally volatilised as chlorohydrine in a current of hydrogen chloride. After solution in water ammonia was added, and the ammonium molybdate, after evaporation, was ignited to oxide. Reduction in hydrogen to metal followed (Sample I). Sample II was prepared from the head and tail fractions of molybdenum pentachloride rejected in the preparation of this substance.

The pentachloride was prepared by heating the pure metal in a current of oxygen-free chlorine and fractionally subliming the pentachloride four times in chlorine in an all-glass apparatus. The samples of pentachloride for analysis were sealed in glass tubes after evacuation without exposure to the air.

The tubes were weighed in air and in water and then were broken under ammonia containing hydrogen peroxide in a stoppered flask. The glass fragments were collected and weighed. After several days' standing to allow peroxymolybdic acid to decompose, a large excess of nitric acid was added and the solution was compared with weighed, nearly equivalent quantities of pure silver by the equal-opalescence method. Weights are corrected to vacuum.

The Atomic Weight of Molybdenum.

Sample.	$MoCl_5$, g.	Ag, g.	$MoCl_5$: 5Ag.	At. wt. Mo.	Sample.	$MoCl_5$, g.	Ag, g.	$MoCl_5$: 5Ag.	At. wt. Mo.
I	3·92664	7·75178	0·506546	95·946	I	1·12271	2·21639	0·506549	95·948
I	1·15477	2·27969	0·506546	95·946	I	1·29219	2·55093	0·506556	95·952
I	1·97299	3·89488	0·506559	95·953	I	1·81107	3·57528	0·506553	95·950
I	1·70337	3·36269	0·506550	95·948	I	1·89693	3·74477	0·506554	95·950
I	0·54405	1·07400	0·506564	95·955	I	1·33890	2·64321	0·506543	95·944
I	1·61924	3·19664	0·506544	95·945	I	3·75537	7·41382	0·506536	95·941
I	0·69492	1·37182	0·506568	95·958	II	0·58655	1·15788	0·506572	95·960
I	3·35249	6·61842	0·506539	95·942	II	1·91751	3·78537	0·506558	95·952
I	1·84113	3·63462	0·506554	95·950	II	1·62848	3·21487	0·506546	95·946
I	2·84577	5·61795	0·506550	95·948			Average	0·506552	95·949

The average result 95·95, which is supported by Aston's isotopic analysis of molybdenum, has been adopted for the table.

EUROPIUM.—Baxter and Tuemmler (*J. Amer. Chem. Soc.*, **1937**, **59**, **1133**), working with material purified by McCoy, have analysed europous chloride. Europium originally containing about 70% of rare-earth impurities was five times precipitated as europous chloride. Spectroscopic examination by King then revealed less than 0·001% of other rare earths. Further purification consisted in several precipitations as europic oxalate from acid solution, fractional crystallisation of europic nitrate from nitric acid, and fractional crystallisation of europic chloride from hydrochloric acid.

Attempts to prepare anhydrous europic chloride failed because of instability of this salt at high temperatures even in a chlorine atmosphere. Anhydrous europous chloride was, however, easily prepared by slow dehydration and eventual fusion in hydrogen chloride and hydrogen. Weighed amounts of the anhydrous dichloride were dissolved in very dilute nitric acid and allowed to oxidise in the air. Comparison of the solution with silver followed conventional lines. Weights are corrected to vacuum. (Density of $EuCl_2$ assumed to be 5·0.)

The Atomic Weight of Europium.

$EuCl_2$, g.	Ag, g.	$EuCl_2$: 2Ag.	At. wt. Eu.
2·37131	2·29571	1·03293	151·95
3·08192	2·98364	1·03294	151·95
2·81855	2·72847	1·03301	151·97
4·88930	4·73350	1·03291	151·95
		Average 1·03295	151·95

The final value, which is preliminary, is not far from the International value, 152·0, and the mass spectrum value, 151·90 (Aston).

ERBIUM.—Hönigschmid and Wittner (*Z. anorg. Chem.*, **1937**, **232**, **113**) have published detailed results of analyses of erbium chloride (see Seventh Report of this Committee). The erbium material, purified by Feit, was several times precipitated as oxalate and after crystallisation the chloride was carefully dehydrated by efflorescence at gradually increasing temperatures up to 450°. Analysis in the usual way by comparison with silver followed. Weights are corrected to vacuum.

Atomic Weight of Erbium.

$ErCl_3$, g.	Ag, g.	$ErCl_3$: 3Ag.	At. wt. Er.	AgCl, g.	$ErCl_3$: 3AgCl.	At. wt. Er.
2·51386	2·97656	0·84455	166·960	3·95499	0·63562	166·952
3·53255	4·18243	0·84462	166·981	5·55730	0·63566	166·970
2·15972	2·55725	0·84455	166·959	3·39780	0·63562	166·954
3·03007	3·58787	0·84453	166·953	4·76709	0·63562	166·954
2·62962	3·11371	0·84453	166·953	4·13701	0·63563	166·958
4·53536	5·37025	0·84453	166·954	7·13535	0·63562	166·952
	Average	0·84455	166·960	Average	0·63563	166·957

X-Ray analysis of this material by Noddack indicated 0·37 atom % of yttrium and 0·42 of thulium. Corrected for these impurities, the atomic weight of erbium becomes 167·24. Aston's mass spectrographic analysis yielded 167·15. On the basis of these results the atomic weight of erbium in the Table has been changed from 167·64 to 167·2.

TUNGSTEN.—Hönigschmid and Menn (*Z. anorg. Chem.*, 1936, **229**, 49) have compared tungsten hexachloride with silver. Tungsten material was purified first by synthesising the hexachloride and distilling it fractionally. Solution in ammonia and precipitation of tungstic acid with nitric acid followed and this process was repeated three times. Ignition and reduction of the oxide in hydrogen was the next step. At this point spectroscopic examination gave doubtful indication of a trace of molybdenum, but *X*-ray spectra showed none of this element. The pure metal was then converted into hexachloride in a current of oxygen-free chlorine in quartz and the hexachloride was fractionally sublimed in a current of chlorine into a glass tube which could be exhausted and sealed.

After being weighed in air and under water, the sealed tube was broken under ammonia and the glass fragments were collected on a platinum sponge crucible. The solution was then compared with weighed, nearly equivalent quantities of pure silver by the equal-opalescence method. In precipitating the silver chloride it was found desirable first to add the silver nitrate to the ammoniacal solution and then to acidify with nitric acid in the presence of tartaric acid. Weights are corrected to vacuum.

The Atomic Weight of Tungsten.

WCl_6, g.	Ag, g.	WCl_6 : 6Ag.	At. wt. W.	WCl_6, g.	Ag, g.	WCl_6 : 6Ag.	At. wt. W.
1·75701	2·86712	0·612814	183·920	1·62596	2·65332	0·612802	183·913
1·73590	2·83255	0·612840	183·937	3·26518	5·32827	0·612803	183·913
1·93036	3·15007	0·612799	183·911	0·58492	0·95442	0·612854	183·946
2·60625	4·25263	0·612856	183·948	3·12581	5·10073	0·612816	183·922
1·86801	3·04814	0·612836	183·935	4·55270	7·42866	0·612856	183·948
2·70714	4·41774	0·612788	183·904	2·75996	4·50378	0·612810	183·918
3·39835	5·54586	0·612772	183·893	2·28497	3·72869	0·612808	183·916
2·80394	4·57536	0·612835	183·934	3·39738	5·54385	0·612820	183·924
4·95955	8·09324	0·612802	183·912	3·56066	5·81059	0·612788	183·904
2·77074	4·52115	0·612840	183·937	3·15808	5·15369	0·612780	183·899
1·69490	2·76594	0·612775	183·895		Average	0·612812	183·920
1·72253	2·81100	0·612782	183·900				

The average value agrees well with Aston's mass-spectroscopic value and has been adopted for the table.

OSMIUM.—Nier (*Phys. Rev.*, 1937, **52**, 885) has recently redetermined the isotopic abundance ratios of osmium. These lead to a chemical atomic weight 190·21 (packing fraction -1×10^{-4}; conversion factor 1·00027), and the measurements by Aston (*Proc. Roy. Soc.*, 1931, *A*, **132**, 492) give 190·28. It therefore seems probable that the present International value for this element, 191·5, is too high, and accordingly the value for osmium in the table has been changed to 190·2.

LEAD.—Baxter, Tuemmler and Faull (*J. Amer. Chem. Soc.*, 1937, **59**, 702) have determined the atomic weights of several radiogenic leads. After extraction from the mineral the lead salts were purified by crystallisation as nitrate and chloride, followed by distillation of the chloride in a current of hydrogen chloride. In preparation for weighing, the lead chloride was fused in hydrogen chloride. Comparison of the lead chloride with silver followed in the conventional way. Weights are corrected to vacuum (see upper table on p. 1108).

Since the Beaverlodge Lake and Katanga pitchblendes are free from thorium, it appears that both contain appreciable amounts of common lead. Allowing for the thorium–uranium ratio of this specimen of samarskite, 0·442, this seems also to be the case with the samarskite lead.

Marble (*J. Amer. Chem. Soc.*, 1937, **59**, 654) has determined the atomic weight of lead from a specimen of galena occurring in a vein which cuts one of the pitchblende veins of the Great Bear Lake deposit and from a point not far from the pitchblende. Purification included crystallisation of the nitrate and of the chloride as well as distillation of the

The Atomic Weight of Lead.

$PbCl_2$, g.	Wt. of Ag, g.	$PbCl_2$: 2Ag.	At. wt. Pb.
Common lead.			
4·39335	3·40822	1·28905	207·211
3·49797	2·71356	1·28907	207·216
4·21579	3·37033	1·28910	207·222
4·27224	3·31427	1·28904	207·210
5·99791	4·65298	1·28905	207·211
4·74688	3·68250	1·28904	207·209
3·99080	3·09581	1·28910	207·222
	Average	1·28906	207·214
Beaverlodge Lake pitchblende.			
2·61248	2·03489	1·28384	206·088
2·75235	2·14398	1·28373	206·070
3·17452	2·47283	1·28376	206·070
6·38415	4·97247	1·28392	206·099
4·01745	3·12921	1·28384	206·089
2·72167	2·11990	1·28387	206·093
2·17947	1·69765	1·28382	206·082
	Average	1·28383	206·084
Samarskite.			
1·28803	1·00238	1·28497	206·331
0·75523	0·58769	1·28508	206·355
	Average	1·28503	206·343
Katanga pitchblende, hydrochloric acid extract.			
3·43131	2·67306	1·28366	206·049
3·52881	2·74901	1·28367	206·050
2·54121	1·97960	1·28370	206·057
4·28996	3·34206	1·28363	206·041
4·84228	3·77217	1·28369	206·054
4·50429	3·50889	1·28368	206·053
	Average	1·28367	206·051
Katanga pitchblende, unaltered.			
1·70238	1·32624	1·28361	206·038
1·60461	1·25003	1·28366	206·048
4·61797	3·59755	1·28364	206·045
3·73794	2·91206	1·28361	206·037
	Average	1·28363	206·042

chloride in hydrogen chloride. Analysis was by the conventional method of comparison with silver. Weights are corrected to vacuum.

The Atomic Weight of Lead.

$PbCl_2$, g.	Ag, g.	$PbCl_2$: 2Ag.	At. wt. Pb.
0·54549	0·42318	1·28903	207·206
2·77993	2·15663	1·28902	207·204
1·17288	0·90990	1·28902	207·205
	Average	1·28902	207·205

The sample appears to be common lead and if so is one of the oldest to be examined.

RADIUM.—Attention is called to the fact that in the recent determination of the atomic weight of radium by Hönigschmid and Sachtleben (Sixth Report of this Committee) no correction is made for the effect of the temperature of radium salts on their weights. Allowance for this will presumably raise the atomic weight of radium by 0·01—0·02 unit.

ATOMIC WEIGHTS, 1938.

	Symbol.	At. No.	At. wt.		Symbol.	At. No.	At. wt.
Aluminium	Al	13	26·97	Neon	Ne	10	20·183
Antimony	Sb	51	121·76	Nickel	Ni	28	58·69
Argon	A	18	39·944	Niobium (Columbium)	Nb (Cb)	41	92·91
Arsenic	As	33	74·91	Nitrogen	N	7	14·008
Barium	Ba	56	137·36	Osmium	Os	76	190·2
Beryllium	Be	4	9·02	Oxygen	O	8	16·0000
Bismuth	Bi	83	209·00	Palladium	Pd	46	106·7
Boron	B	5	10·82	Phosphorus	P	15	31·02
Bromine	Br	35	79·916	Platinum	Pt	78	195·23
Cadmium	Cd	48	112·41	Potassium	K	19	39·096
Cæsium	Cs	55	132·91	Praseodymium	Pr	59	140·92
Calcium	Ca	20	40·08	Protoactinium	Pa	91	231
Carbon	C	6	12·010	Radium	Ra	88	226·05
Cerium	Ce	58	140·13	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	85·48
Copper	Cu	29	63·57	Ruthenium	Ru	44	101·7
Dysprosium	Dy	66	162·46	Samarium	Sm	62	150·43
Erbium	Er	68	167·2	Scandium	Sc	21	45·10
Europium	Eu	63	152·0	Selenium	Se	34	78·96
Fluorine	F	9	19·00	Silicon	Si	14	28·06
Gadolinium	Gd	64	156·9	Silver	Ag	47	107·880
Gallium	Ga	31	69·72	Sodium	Na	11	22·997
Germanium	Ge	32	72·60	Strontium	Sr	38	87·63
Gold	Au	79	197·2	Sulphur	S	16	32·06
Hafnium	Hf	72	178·6	Tantalum	Ta	73	180·88
Helium	He	2	4·003	Tellurium	Te	52	127·61
Holmium	Ho	67	163·5	Terbium	Tb	65	159·2
Hydrogen	H	1	1·0081	Thallium	Tl	81	204·39
Indium	In	49	114·76	Thorium	Th	90	232·12
Iodine	I	53	126·92	Thulium	Tm	69	169·4
Iridium	Ir	77	193·1	Tin	Sn	50	118·70
Iron	Fe	26	55·84	Titanium	Ti	22	47·90
Krypton	Kr	36	83·7	Tungsten	W	74	183·92
Lanthanum	La	57	138·92	Uranium	U	92	238·07
Lead	Pb	82	207·21	Vanadium	V	23	50·95
Lithium	Li	3	6·940	Xenon	Xe	54	131·3
Lutecium	Lu	71	175·0	Ytterbium	Yb	70	173·04
Magnesium	Mg	12	24·32	Yttrium	Y	39	88·92
Manganese	Mn	25	54·93	Zinc	Zn	30	65·38
Mercury	Hg	80	200·61	Zirconium	Zr	40	91·22
Molybdenum	Mo	42	95·95				
Neodymium	Nd	60	144·27				