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

THE following report of the Committee covers the twelve-month period, September 30, 1932, to September 30, 1933.*

In view of the fact that a Committee on Atoms of the International Union has been established, developments in the field of isotopes are now and hereafter will be reported only where they may be of influence on the table of atomic weights.

Changes in the table of atomic weights have been made in the following cases :

	1933.	1934.		1933.	1934.
Potassium	39·10	39·096	Tellurium	127·5	127·61
Arsenic	74·93	74·91	Cæsium	132·81	132·91
Selenium	79·2	78·96	Ytterbium	173·5	173·04
Indium	114·8	114·76	Osmium	190·8	191·5

CARBON.—Woodhead and Whytlaw Gray (J., 1933, 846) have compared the densities of oxygen and carbon monoxide with an improved form of micro-displacement balance. Oxygen was prepared from potassium permanganate and potassium chlorate, carbon monoxide from formic acid and potassium ferrocyanide. Both gases were thoroughly dried and fractionally distilled. The corrected ratios of balancing pressures were found as follows :

		Approximate pressures.		
Series.	Temp.	O_2.	CO.	Ratio.
I	0°	382·8	437·2	0·87516
II	19·8	181·9	207·8	0·87523
III	19·8	361·9	413·5	0·87514
IV	19·8	572·3	654·0	0·87500

From the last three ratios the limiting value is found by linear extrapolation against the pressure, while from that of Series I a limiting value is found with the use of the ratio $(PV)_0/(PV)$, for oxygen (1·00094) and carbon monoxide (1·00048).

Series.		Series.	
II and III	0·87533	III and IV	0·87537
II and IV	0·87534	I	0·87534

The average molecular weight of carbon monoxide calculated from the ratios is 28·011 and the atomic weight of carbon 12·011.

This value shows, again, that the atomic weight of carbon is higher than the value 12·00 entered in the table. If one assumes with Tate, Smith, and Vaughan (*Physical Rev.*, 1933, **43**, 1054) and also with Jenkins and Ornstein (*Proc. K. Akad. Wetensch. Amsterdam*, 1933, **35**, 1212) a 1 per cent. participation of C^{13}, there results, considering the packing fraction $+ 3 \times 10^{-4}$, estimated by Aston, likewise the value 12·011. To be sure, the value 12·0054 determined by Cooper and Maass (*II. Internat. Rep.*, p. 4) from the density of CO_2, and the value 12·006 determined by Moles and Salazar (*III. Internat. Rep.*, p. 3) from the density of CO, are somewhat lower, and it would therefore be advisable to refrain from making a correction in the table until new confirmations have been obtained (see Cawood and Patterson, p. 511).

NITROGEN.—Moles and Batuecas (*Anales Soc. Espan. Fis. Quim.*, 1932, **30**, 876) correct

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* 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.

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their results for the density of ammonia previously published (see report for 1931). The corrected densities are :

1 atmosphere	0·77170	1/2 atmosphere	0·76573
2/3 ,,	0·76760	1/3 ,,	0·76380

The authors calculate $1 + \lambda$ to be 1·0157, and the atomic weight of nitrogen to be 14·007, on the assumption that the deviation from Boyle's law is a linear function of the pressure.

Dietrichson, Bircher, and O'Brien (*J. Amer. Chem. Soc.*, **1933**, **55**, 1) and Dietrichson, Orleman, and Rubin (*ibid.*, **1933**, **55**, 14) have determined the density of ammonia at different pressures. Synthetic ammonia was purified by distillation over sodium and fractionation. The density determinations were made by filling globes (5 litre and 1 litre) at 0° and measured pressure and condensing the gas in pyrex capsules which were sealed and weighed. Adsorption was eliminated by thorough baking of the glass in the case of the 1-litre globe. Less satisfactory results were obtained with the 5-litre globe, so that only the results with the 1-litre globe are given in the following table.

The Density of Ammonia.

1 Atmosphere.	2/3 Atmosphere.	1/3 Atmosphere.
0·771262	0·511590	0·254559
0·771273	0·511631	0·254575
0·771239	0·511609	0·254598
0·771262	0·511613	0·254576
	0·511586	
	0·511599	
0·771259	0·511605	0·254576

Calculated by Guye's secondary difference or quadratic method, the limiting density of ammonia is found to be 0·76022 and the atomic weight of nitrogen 14·017. The authors from a quadratic equation of state find 14·007, but feel that extrapolation to limiting dilution is too uncertain with ammonia to afford a reliable method for finding the atomic weight of nitrogen.

SILICON.—Weatherill and Brundage (*J. Amer. Chem. Soc.*, **1932**, **54**, 3932) have determined the ratio of silicon tetrachoride to silicon dioxide. Silicon tetrachloride was purified by prolonged fractional distillation in all-glass exhausted apparatus. Analysis of fractions sealed in silica bulbs during the course of the purification was effected by breaking the bulb under dilute hydrochloric acid in a weighed platinum crucible and gradually heating the product to constant weight at about 1100°. Weights are corrected to vacuum. The number of the fraction indicates the number of fractional distillations to which the material had been subjected.

The Atomic Weight of Silicon.

Fraction.	Wt. of $SiCl_4$.	Wt. of SiO_2.	Ratio $SiO_2 : SiCl_4$.	At. Wt. Si.
13	2·11017	0·74587	0·353464	28·044*
13	2·53146	0·89563	0·353800	28·132*
15	4·59854	1·62648	0·353695	28·104
15	2·86802	1·01447	0·353718	28·110
15	3·01710	1·06731	0·353754	28·120
17	2·90424	1·02706	0·353642	28·090
17	2·55431	0·90357	0·353743	28·117
17	2·80323	0·99175	0·353788	28·129*
17	2·92542	1·03462	0·353665	28·096
18	3·38901	1·19857	0·353664	28·096
18	2·10540	0·74458	0·353653	28·093
		Average	0·353700	28·103

The asterisked analyses were subject to slight experimental uncertainty, but their omission does not change the average. The final result is higher than that found by Baxter, Weatherill, Holmes, and Scripture, 28·063, but agrees well with that found by Hönigschmid and Steinheil, 28·105.

SULPHUR.—Klemenc and Bankowski (*Z. anorg. Chem.*, 1932, **208**, 348) have prepared hydrogen sulphide by synthesis from the elements and fractional distillation. The density was obtained by a combination of the globe and volumeter methods, the gas being measured in a 2-litre globe and weighed after transfer to a somewhat smaller one. Determinations were carried out with carbon dioxide for purposes of comparison.

Density. CO_2.	Density. H_2S.	Density. CO_2.	Density. H_2S.		Density. CO_2.	Density. H_2S.
1·9762	1·5359	1·9771	1·5367		1·9770	1·5362
1·9766	1·5383	1·9765	1·5360		1·9769	1·5360
1·9775	1·5361	1·9764	1·5364	Average	1·9768	1·5362
1·9779	1·5367	1·9765	1·5360			

Using values for $1 + \lambda$ of **1·00706** and **1·01035**, the molecular weights of carbon dioxide and hydrogen sulphide are **43·998** and **34·081** respectively and the atomic weights of carbon and sulphur 11·999 and 32·065. Batuecas (*J. chim. Phys.*, 1933, **30**, 482) discusses this paper critically.

POTASSIUM.—Chlopin and Pasvik-Chlopin (*Bull. Soc. chim.*, 1932, **51**, 1227) have compared potassium extracted from peas with common potassium. Potassium perchlorate was precipitated from an extract of the ashes of peas (seed) and was recrystallised. After conversion to chloride this compound was crystallised. For analysis the salt was dried at 400°. The common potassium consisted of a very pure commercial sample. Analysis was effected by precipitating and weighing silver chloride. No corrections to vacuum are made.

The Atomic Weight of Potassium.

Sample.	Wt. of KCl.	Wt. of AgCl.	At. Wt. K.
Ash	0·5211	1·0017	39·11
	0·4632	0·8907	39·08
	0·2949	0·5676	39·01
	0·4894	0·9410	39·09
	0·4871	0·9364	39·10
		Average	39·08
Common	1·0781	2·0724	39·11
	0·6531*	1·2566	39·04
	0·6331	1·2178	39·06
		Average	39·07

The two samples are identical within the experimental error.
* The original paper gives 0·1531.

Baxter and MacNevin (*J. Amer. Chem. Soc.*, 1933, **55**, 3185) have analysed potassium chloride by comparison with silver. Nine samples of salt were prepared by crystallisation as the compounds given in the following table.

Sample Source.	
A. Commercial $KClO_3$(I)	$KClO_3$, $KClO_4$, KCl
B. Commercial KNO_3	KNO_3, KCl
C. Commercial $KClO_3$(II)	$KClO_3$, $KClO_4$, KCl
D_1 and D_2. Commercial $KClO_3$(I)	$KClO_3$, $KClO_4$, KCl
E. Commercial $K_2C_2O_4$	$K_2C_2O_4$, KCl
F. Australian alaunite	$KAl(SO_4)_2 \cdot 12H_2O$, $KClO_4$, KCl
G. Stassfurt K_2CO_3	$KClO_3$, $KClO_4$, KCl
H. Hard wood ash	KNO_3, $KClO_4$, KCl

The chloride was prepared for weighing by fusion in dry nitrogen with the following exceptions. The first three specimens were fused in air. In the eighth and the eleventh analysis a mixture of nitrogen and hydrogen chloride was used, although this resulted in the attacking of the platinum boat. In the twenty-fifth analysis pure hydrogen was used, and in the twenty-sixth a mixture of hydrogen and hydrogen chloride. The weighed salt was compared with silver in the usual way. Weights are corrected for the buoyancy of the air.

The Atomic Weight of Potassium.

Sample.	Wt. of KCl.	Wt. of Ag.	Ratio KCl : Ag.	At. Wt. of K.
A	7·25734	10·50215	0·691034	39·092
A	5·92306	8·57121	0·691041	39·093
A	6·86340	9·93154	0·691071	39·096
A	4·47498	6·47567	0·691045	39·093
A	1·93359	2·79802	0·691057	39·094
A	2·37502	3·43697	0·691021	39·090
		Average	0·691045	39·093
B	5·52011	7·98806	0·691045	39·093
B	5·37543	7·77865	0·691049	39·093
B	5·33013	7·71318	0·691042	39·093
		Average	0·691045	39·093
C	4·83277	6·99408	0·690980	39·086
C	5·04591	7·30265	0·690970	39·085
C	5·54960	8·03105	0·691018	39·090
C	4·39910	6·35490	0·690979	39·086
C	4·53273	6·56001	0·690964	39·084
C	4·45347	6·44457	0·691042	39·093
C	7·23597	10·47029	0·691095	39·098
D_1	6·17283	8·93220	0·691076	39·096
D_1	7·27021	10·52040	0·691058	39·094
D_1	4·87145	7·04946	0·691039	39·092
D_1	5·34406	7·73305	0·691068	39·095
		Average	0·691060	39·094
D_2	6·44377	9·32401	0·691094	39·098
D_2	5·88056	8·50935	0·691070	39·096
D_2	5·89358	8·52839	0·691054	39·094
		Average	0·691073	39·096
E	5·76754	8·34642	0·691020	39·090
E	4·68776	6·78382	0·691021	39·090
E	5·76684	8·34487	0·691064	39·095
E	4·95265	7·16651	0·691082	39·097
		Average	0·691047	39·093
F	4·78080	6·91807	0·691060	39·095
F	5·39065	7·80054	0·691061	39·095
		Average	0·691061	39·095
G	5·04247	7·29628	0·691101	39·099
G	4·54922	6·58299	0·691057	39·094
		Average	0·691079	39·097
H	6·77998	9·81100	0·691059	39·094
H	6·78310	9·81525	0·691078	39·096
		Average	0·691069	39·095
Average of all analyses except those of Sample C			0·691057	39·094

The final value confirms the lower value obtained by Richards and Staehler and Richards and Mueller some years ago, **39·096**, rather than the later one of Hönigschmid and Goubeau, 39·104.

Baxter and Alter (*J. Amer. Chem. Soc.*, **1933**, **55**, **3270**) have analysed the sample of "heavy" potassium obtained by v. Hevesy and Lögstrup (*Z. anorg. Chem.*, **1928**, **171**, **1**).

The Atomic Weight of Potassium.

	Wt. of KCl.	Wt. of Ag.	Ratio KCl : Ag.	At. Wt. of K.
Common	4·92432	7·12559	0·691075	39·096
,, ...	8·76118	12·67767	0·691072	39·096
		Average	0·691073	39·096
v. Hevesy	5·73312	8·29460	0·691187	39·108
,, ...	5·77933	8·36128	0·691201	39·110
		Average	0·691194	39·109

This result is identical with that previously found by Hönigschmid and Goubeau for the same sample of heavy potassium. Hönigschmid and Sachtleben (*Z. anorg. Chem.*, **1933**, **213**, **365**) have confirmed the lower value for potassium by comparison of potassium chloride and bromide with silver. Several samples of material were purified by crystallisation as the compounds given in the following table :

I—III.	Commercial KNO_3	KNO_3, KCl
IV.	Hopflower ash	$KH_5C_4O_6$, KNO_3, KCl
V.	Commercial KNO_3	KNO_3, $KH_5C_4O_6$, KCl
VI.	Commercial $K_2C_2O_4$	$K_2C_2O_4$, KCl
VII—X.	Commercial KNO_3	KNO_3, KCl

In preparing samples VII—X the conditions of precipitating the chloride from a solution of the nitrate were varied.

After fusion in nitrogen, weighed portions of the chloride were compared with silver, and the silver chloride was collected. Vacuum weights are given.

Analyses with Samples I—III gave the higher value **39·104**, owing, in the opinion of the investigators, to the presence of nitrate or some other anion in the fused salt. Lower values were obtained with all the other samples.

The Atomic Weight of Potassium.

Sample.	Wt. of KCl.	Wt. of Ag.	Ratio KCl : Ag.	At. Wt. of K.	Wt. of AgCl.	Ratio KCl : AgCl.	At. Wt. of K.
IV	4·40001	6·36687	0·691094	39·097			
IV	2·76954	4·00768	0·691058	39·094			
		Average	0·691076	39·096			
V	2·76123	3·99573	0·691045	39·093			
V	5·14999	7·45198	0·691090	39·098	9·90113	0·520142	39·099
V	4·06210	5·87777	0·691095	39·098	7·80966	0·520138	39·098
		Average	0·691080	39·096	Average	0·520140	39·098
VI	4·62128	6·68711	0·691073	39·096	8·88476	0·520136	39·098
VI	3·45462	4·99898	0·691065	39·095			
VI	4·40576	6·37550	0·691046	39·093			
VI	2·52655	3·65615	0·691041	39·093			
		Average	0·691056	39·094			
VII	4·12595	5·97030	0·691079	39·097	7·93256	0·520128	39·097
VII	2·99588	4·33516	0·691066	39·095	5·75979	0·520137	39·098
VII	3·23019	4·67421	0·691067	39·095	6·21015	0·520147	39·099
VII	5·06404	7·32794	0·691059	39·094	9·73612	0·520129	39·097
		Average	0·691068	39·095	Average	0·520135	39·098
IX	3·69668	5·34918	0·691074	39·096			
IX	3·70379	5·35946	0·691075	39·096			
		Average	0·691075	39·096			
X	3·99417	5·77972	0·691066	39·095			
X	3·86909	5·59866	0·691074	39·096	7·43880	0·520123	39·096
X	2·52513	3·65400	0·691059	39·094	4·85515	0·520093	39·092
		Average	0·691066	39·095	Average	0·520108	39·094
		Average of all	0·691069	39·096	Average of all	0·520132	39·097

A portion of pure oxalate from Sample VI was converted into bromide by means of pure bromine and the bromide was crystallised. After fusion in nitrogen, the salt was analysed as above.

The Atomic Weight of Potassium.

Wt. of KBr.	Wt. of Ag.	Ratio KBr : Ag.	At. Wt. of K.	Wt. of AgBr.	Ratio KBr : AgBr.	At. Wt. of K.
5·21776	4·72975	1·103179	39·095	8·23366	0·633711	39·092
6·45421	5·85042	1·103205	39·098	10·18456	0·633725	39·095
3·87157	3·50941	1·103197	39·097	6·10922	0·633726	39·095
6·29952	5·71012	1·103220	39·099	9·94051	0·633722	39·095
3·81822	3·46109	1·103184	39·096	6·02523	0·633705	39·091
4·04357	3·66536	1·103185	39·096	6·38062	0·633727	39·095
	Average	1·103197	39·097	Average	0·633720	39·094

The average of all the results, **39·096**, supports the lower value for potassium found by Richards, Staehler, and Mueller, and by Baxter and MacNevin. For the table of atomic weights the value **39·096** has been adopted.

CALCIUM.—Kendall, Smith, and Tait (*Nature*, **1933**, **131**, 688) have extracted calcium from felspar (Rhiconich, Sutherlandshire, 1000 million years) and pegmatite (Portsoy, Banffshire, 600 million years). Both minerals were rich in potassium and low in calcium.

After fractionation as oxalate, the nitrate was recrystallised and converted into chloride. Two samples of common calcium chloride also were prepared. Comparison with silver followed. Only the final results are given.

	At. Wt. of Ca.		At. Wt. of Ca.
Rhiconich	40·092	Sea shells	40·076
Portsoy	40·089	Bermuda limestone	40·077

From these differences the authors calculate the half-life period of K^{41}.

ARSENIC.—Baxter, Sheafer, Dorcas, and Scripture (*J. Amer. Chem. Soc.*, **1933**, **55**, 1054) have analysed arsenic trichloride and arsenic tribromide by comparison with silver. The compounds were prepared by synthesis from arsenic and the pure halogens, and were subjected to prolonged fractionation in exhausted glass apparatus. Towards the end of each fractionation head and tail fractions were sealed off in glass bulbs for analysis. In the tables the fractions are numbered in the order of decreasing volatility. Samples I and II of tribromide were prepared in identical manner. Sample II of trichloride was subjected to prolonged refluxing over metallic arsenic. Sample III was repeatedly passed over red hot arsenic. Weights are in vacuum.

The Atomic Weight of Arsenic.

Fraction of $AsBr_3$.	Wt. of $AsBr_3$.	Wt. of Ag.	Ratio $AsBr_3 : 3Ag$.	At. Wt. of As.
		Sample I.		
8	10·00486	10·29087	0·972207	74·897
9	9·64625	9·92076	0·972330	74·937
7	13·92585	14·32280	0·972285	74·922
		Average	0·972272	74·919
		Sample II.		
10	5·73208	5·88287	(0·974368)	(75·596)
48	6·63538	6·82490	0·972231	74·905
11	8·10704	8·33856	0·972235	74·906
46	8·02860	8·25775	0·972250	74·911
23	5·04824	5·19255	0·972208	74·897
37	7·27190	7·48011	0·972165	74·883
38	7·70301	7·92309	0·972223	74·902
24	7·55491	7·77056	0·972248	74·910
29	6·49903	6·68459	0·972241	74·908
30	6·14542	6·32150	0·972146	74·877
31	6·74221	6·93490	0·972214	74·899
32	6·80346	6·99845	0·972138	74·875
33	5·84643	6·01362	0·972195	74·893
27	8·16037	8·39376	0·972195	74·893
28	7·54923	7·76488	0·972228	74·904
		Average	0·972208	74·897

Fraction of $AsCl_3$.	Wt. of $AsCl_3$.	Wt. of Ag.	Ratio $AsCl_3 : 3Ag$.	At. Wt. of As.
		Sample I.		
36	5·58768	9·97651	0·560084	74·895
37	7·75110	13·83860	0·560107	74·902
56	9·14735	16·33229	0·560078	74·893
39	6·79634	12·13395	0·560109	74·903
40	6·07547	10·84673	0·560120	74·906
41	5·07411	9·05925	0·560103	74·901
53	6·33798	11·31630	0·560075	74·892
52	6·90994	12·33683	0·560107	74·902
51	3·93552	7·02561	0·560168	74·922
49	5·41621	9·66859	0·560186	74·928
45	4·81464	8·59483	0·560179	74·925
43	4·66762	8·33241	0·560176	74·924
46	3·13878	5·60332	0·560164	74·920
		Average	0·560128	74·909
		Sample II.		
80	4·19732	7·49357	0·560123	74·907
81	4·98056	8·89154	0·560146	74·915
14	4·73909	8·46146	0·560079	74·893
15	4·15568	7·42009	0·560058	74·886
79	5·15747	9·20770	0·560126	74·908
16	5·29708	9·45801	0·560063	74·888
		Average	0·560099	74·900

Fract. of $AsCl_3$.	Wt. of $AsCl_3$.	Wt. of Ag.	Ratio $AsCl_3 : 3Ag$.	At. Wt. of As.
		Sample III.		
35	4·94345	8·82593	0·560105	74·901
36	4·82524	8·61491	0·560103	74·901
64	3·84375	6·86240	0·560117	74·905
65	4·28593	7·65175	0·560124	74·908
38	4·62010	8·24806	0·560144	74·914
67	4·01638	7·17073	0·560108	74·902
		Average	0·560117	74·905
		Samples II and III.		
50	5·10281	9·10967	0·560153	74·917
52	5·06855	9·04864	0·560145	74·914
55	5·29138	9·44656	0·560138	74·912
56*a*	5·67514	10·13182	0·560130	74·909
56*b*	5·14259	9·18110	0·560128	74·909
56*c*	5·82250	10·39473	0·560140	74·913
		Average	0·560139	74·912
		Average of all	0·560122	74·907

Fract. of $AsCl_3$.	Wt. of $AsCl_3$.	Wt. of AgCl.	Ratio $AsCl_3 : 3AgCl$.	At. Wt. of As.
		Samples II and III.		
50	5·10281	12·10339	0·421602	74·922
52	5·06855	12·02213	0·421602	74·922
55	5·29138	12·55061	0·421603	74·923
56*a*	5·67514	13·46140	0·421586	74·916
56*b*	5·14259	12·19848	0·421576	74·911
56*c*	5·82250	13·81144	0·421571	74·909
		Average	0·421590	74·917

The average result of all analyses, 74·91, is lower than Krepelka's 74·938 and slightly lower than Aston's 74·919.

Baxter and Shaefer (*J. Amer. Chem. Soc.*, 1933, **55**, 1957) have compared arsenic trichloride with iodine pentoxide by hydrolysing weighed quantities of the trichloride with sodium hydroxide in a vacuum. After neutralisation, a solution of a weighed, nearly equivalent quantity of iodine pentoxide was added. The end-point was found in the presence of starch by neutralising with phosphate and adding standard dilute iodine or arsenite solutions. The weight of iodine pentoxide, besides being corrected to vacuum, was subjected to a negative correction for retained moisture of 0·0023 per cent. and to one of 0·001 per cent. for adsorbed air.

The Atomic Weight of Arsenic.

Wt. of $AsCl_3$.	Wt. of I_2O_5.	Ratio $6AsCl_3 : I_2O_5$.	At. Wt. of As.	Wt. of $AsCl_3$.	Wt. of I_2O_5.	Ratio $6AsCl_3 : I_2O_5$.	At. Wt. of As.
7·21705	2·21507	3·25816	74·910	21·15293	6·49218	3·25822	74·913
9·15444	2·80921	3·25872	74·941	17·66650	5·42190	3·25836	74·921
10·21968	3·13631	3·25850	74·929	18·35205	3·63253	3·25822	74·913
9·66130	2·96521	3·25822	74·913	14·63971	4·49298	3·25835	74·920
17·39861	5·33925	(3·25862)	(74·935)	20·48010	6·28471	(3·25872)	(74·941)
17·77941	5·45676	3·25824	74·914	13·53616	4·15364	(3·25887)	(74·949)
20·40160	6·26138	3·25832	74·919	17·51544	5·37602	3·25807	74·905
17·17037	5·27036	3·25791	74·896	17·32860	5·31874	3·25803	74·903
21·97776	6·74506	3·25835	74·920	18·18162	5·58033	3·25816	74·910
21·44152	6·57529	(3·26092)	(75·063)	18·05460	5·54146	3·25809	74·906
22·11839	6·78901	3·25797	74·899	Average excluding parenthetical results		3·25823	74·914

The average value for the atomic weight of arsenic, excluding the first four analyses which were preliminary and the parenthetical analyses which were subject to known error, is 74·911 (I = 126·917). In view of the concordance of the result of this method and that of the work on the comparison of the arsenic halides with silver, the value for arsenic in the table of atomic weights has been changed from 74·93 to 74·91.

SELENIUM.—Hönigschmid and Kapfenberger (*Z. anorg. Chem.*, 1933, **212**, 198) have quantitatively synthesised silver selenide from metallic silver. Selenium dioxide was prepared by oxidation of the metal with nitric acid, and was purified by sublimation in a current of oxygen. By reduction with hydrazine the metal was again obtained, and the above purification was repeated. The elementary selenium was finally dried by sublimation in a current of pure nitrogen.

The synthesis was effected by heating weighed quantities of the purest silver in a current of nitrogen laden with selenium vapour. Excess of selenium was removed by heating first in nitrogen to 300° and then in a high vacuum to 190°. Since a further treatment with selenium vapour followed by removal of excess selenium was found in general to produce no change in the weight of the silver selenide, the authors conclude that the product was normal in composition. Weights are corrected to vacuum.

The Atomic Weight of Selenium.

Wt. of Ag.	Wt. of Ag_2Se.	Ratio $2Ag : Ag_2Se$.	At. Wt. of Se.	Wt. of Ag.	Wt. of Ag_2Se.	Ratio $2Ag : Ag_2Se$.	At. Wt. of Se.
4·70165	6·42241	0·732069	78·966	4·44063	6·06573	0·732085	78·960
4·88889	6·67806	0·732082	78·961	4·42179	6·04004	0·732080	78·962
4·04605	5·52675	0·732085	78·960	7·15979	9·78012	0·732076	78·964
3·57459	4·88282	0·732075	78·964	6·09006	8·31864	0·732098	78·955
4·28539	5·85373	0·732079	78·962	6·05372	8·26925	0·732076	78·963
4·79795	6·55384	0·732082	78·961		Average	0·732081	78·962

In view of the fact that Aston (*Proc. Roy. Soc.*, 1931, **132**, *A*, 487) by quantitative estimation of the proportions of the six isotopes has arrived at the value 78·96 for the chemical atomic weight of selenium, it seems highly probable that the value 79·2 heretofore adopted for the International table is too high. It therefore has been replaced in the table for this year by the value 78·96.

INDIUM.—Baxter and Alter (*J. Amer. Chem. Soc.*, 1933, **55**, 1943) have analysed indium trichloride and indium tribromide by comparison with silver. Commercial very pure indium was twice subjected to electrolytic transport from a dissolving anode. The product of the first electrolysis still contained traces of impurities, but that of the second when subjected to spectroscopic examination showed no evidence of impurity. After fusion in hydrogen the metal was converted into chloride or bromide by heating in a current of nitrogen and chlorine or bromine in a glass (first two experiments) or quartz tube, and the product was twice sublimed in a current of nitrogen and halogen. The section of the tube containing the salt was sealed off while exhausted. From the volume and weight of the tube the weight in vacuum was obtained. After breaking under a slightly acid solution the glass or quartz was washed and collected and from the weight in vacuum and the weight of the bulb the weight of salt was obtained. Comparison of the solutions with silver followed.

The Atomic Weight of Indium.

Ratio $InCl_3 : 3Ag$.

No. of electrolyses.	Wt. of $InCl_3$.	Wt. of Ag.	Ratio $InCl_3 : 3Ag$.	At. Wt. of In.
1	5·64316	8·25759	0·683391	114·802
1	8·35611	12·22754	0·683384	114·799
		Average	0·683388	114·801
1	9·65967	14·13582	0·683347	114·787
1	12·04518	17·62730	0·683325	114·780
1	12·18165	17·82667	0·683339	114·785
		Average	0·683337	114·784
2	5·78802	8·47132	0·683249	114·756
2	5·80139	8·49079	0·683257	114·758
2	5·58558	8·17470	0·683276	114·764
		Average	0·683261	114·759

Ratio $InBr_3 : 3Ag$.

	Wt. of $InBr_3$.	Wt. of Ag.	Ratio $InBr_3 : 3Ag$.	At. Wt. of In.
2	6·38915	5·83299	1·09535	114·750
2	9·07794	8·28699	1·09544	114·782
2	8·91416	8·13810	1·09536	114·755
2	9·24920	8·44420	1·09533	114·745
2	6·22482	5·68250	1·09544	114·779
		Average	1·09538	114·762
			Average of last eight analyses	114·761

The average of the last eight experiments, 114·76, made with material known to be very pure, seems to be nearer the correct value than that heretofore given in the International table.

IODINE.—Guichard (*Compt. rend.*, 1933, **196**, 1024) discusses the advantages of the analysis of iodine pentoxide as a method of determining the atomic weight of iodine, and points out that the results of this analysis by Guichard, 126·915, and by Baxter and Butler, 126·905, together with that of Hönigschmid and Striebel, 126·917, by conversion of silver iodide into silver chloride, indicate a value for the atomic weight of iodine lower than the old value in the International table (126·92).

TELLURIUM.—Hönigschmid, Sachtleben, and Wintersberger (*Z. anorg. Chem.*, 1933, **212**, 242) have prepared and analysed tellurium tetrabromide. Tellurium was purified by fractional distillation of the metal. The chloride was then prepared and fractionally distilled. From the product tellurium was prepared by reduction and again distilled (Sample I). After conversion into basic nitrate this compound was recrystallised from nitric acid. The metal was again obtained by reduction and three times fractionally distilled in vacuum (Sample II). Sample I contained spectroscopic traces of copper and silver, but Sample II was free from silver and probably also from copper. Tellurium tetrabromide was prepared by distilling bromine upon the metal in a closed vessel filled with nitrogen. Excess of bromine was removed by heating in a current of nitrogen, and the product was then fractionated into glass bulbs in a vacuum, in order to avoid formation of dibromide. The bulbs were weighed in air and under water, broken under a solution of tartaric acid, and the glass was collected on a platinum sponge crucible and weighed. The weight of the tetrabromide was obtained as the difference between the vacuum weights of the bulb and glass.

Comparison of the solution with silver in the usual way followed, and the silver bromide was collected and weighed.

The Atomic Weight of Tellurium.

Sample.	Wt. of $TeBr_4$.	Wt. of Ag.	Ratio $TeBr_4 : 4Ag$.	At Wt. of Te.	Wt. of AgBr.	Ratio $TeBr_4 : 4AgBr$.	At. Wt. of Te.
			Preliminary Series.				
I	2·39156				4·01678	0·595392	127·59
I	5·07407				8·52222	0·595393	127·59
I	2·68834				4·51555	0·595352	127·56
I	1·58285	1·52728	1·03639	127·56			
I	2·23181	2·15354	1·03635	127·54			
I	2·44216	2·35609	1·03653	127·62			
		Average	1·03643	127·58	Average	0·595382	127·58
			Final Series.				
I	3·74734	3·61552	1·03646	127·59	6·29383	0·595399	127·59
I	3·45213	3·33043	1·03654	127·62	5·79759	0·595442	127·62
I	2·70643	2·61118	1·03648	127·60	4·54571	0·595381	127·58
I	2·51726	2·42877	1·03643	127·58	4·22774	0·595415	127·60
I	3·09138	2·98265	1·03645	127·59	5·19204	0·595408	127·60
I	4·38655	4·23194	1·03653	127·62	7·36692	0·595439	127·62
I	1·96375	1·89456	1·03652	127·62	3·29790	0·595455	127·63
II	1·86236	1·79680	1·03649	127·60	3·12770	0·595441	127·62
II	4·30945	4·15780	1·03647	127·60	7·23780	0·595409	127·60
II	4·64841	4·48469	1·03651	127·61	7·80641	0·595461	127·64
II	2·48613	2·39864	1·03648	127·60	4·17530	0·595437	127·62
		Average	1·03649	127·60	Average	0·595426	127·61

Hönigschmid (*Z. anorg. Chem.*, 1933, **214**, 281) also has quantitatively synthesised silver telluride from weighed quantities of silver. The silver was heated in a current of nitrogen charged with pure tellurium vapour, and the excess of tellurium was removed at elevated temperatures in a vacuum. Normal composition is inferred from the fact that the telluride when heated to constant weight at 500—540° remains constant in weight when further heated to 620°, although at higher temperatures further loss in weight takes place. Further treatment with tellurium vapour in a similar way failed to alter the weight of the product.

The Atomic Weight of Tellurium.

Wt. of Ag.	Wt. of Ag_2Te.	Final Temp.	Ratio $Ag_2Te : 2Ag$.	At. Wt. of Te.
2·00741	3·19464	600°	1·59142	127·605
,,	3·19463	560	1·59142	127·605
,,	3·19468	550	1·59144	127·610
2·85653	4·54586	600	1·59139	127·599
,,	4·54606	600	1·59146	127·614
3·76928	5·99868	600	1·59147	127·614
3·12566	4·97428	600	1·59143	127·608
,,	4·97434	600	1·59145	127·612
,,	4·97430	600	1·59144	127·609
3·28633	5·22997	600	1·59143	127·607
,,	5·23010	580	1·59147	127·616
,,	5·23010	560	1·59147	127·616
,,	5·23992	550	1·59142	127·605
		Average	1·59145	127·609

This result is essentially identical with that obtained by analysis of tellurium tetrabromide, while Bainbridge from the mass spectrum calculates **127·58**. In view of this concordance the value for tellurium in the table is changed from **127·5** to **127·61**.

Cæsium.—Baxter and Thomas (*J. Amer. Chem. Soc.*, **1933**, **55**, 858) have compared cæsium chloride with silver using fractionated material which was found spectroscopically to be free from rubidium and potassium. Weights are corrected to vacuum.

The Atomic Weight of Cæsium.

Wt. of CsCl.	Wt. of Ag.	Ratio CsCl : Ag.	At. Wt. of Cs.
8·96291	5·74296	1·56068	132·91
9·60983	6·15751	1·56067	132·91
9·70288	6·21686	1·56074	132·92
9·53125	6·10708	1·56069	132·91
7·52304	4·82025	1·56072	132·91
	Average	1·56070	132·91

This result is 0·1 unit higher than that obtained by Richards and Archibald and Richards and Francon, but agrees exactly with Aston's corrected value. This value has been adopted for the table.

Erbium.—Hönigschmid and Kapfenberger (*Z. anorg. Chem.*, **1933**, **214**, 97) have prepared and analysed anhydrous erbium chloride, starting with erbium oxide which had been purified by Prandtl (*ibid.*, **1931**, **198**, 157). This material was subjected to *X*-ray analysis by both Prandtl and v. Hevesy, and was found to be essentially free from all other rare earths.

The erbium was first several times precipitated as oxalate with intermediate ignition of the oxalate to oxide. After solution of the final product in hydrochloric acid, the chloride was obtained by evaporating and saturating with hydrogen chloride (Sample I). Recovery of material used in the earlier analyses yielded Sample II.

The salt was dehydrated slowly in a current of nitrogen and hydrogen chloride at gradually increasing temperatures up to 450° without melting it, in order to avoid possible losses of chlorine. Analysis by comparison with silver and weighing the silver chloride followed conventional lines. Weights are corrected to vacuum.

The Atomic Weight of Erbium.

Sample.	Wt. of $ErCl_3$.	Wt. of Ag.	Ratio $ErCl_3 : 3Ag$.	At. Wt. of Er.	Wt. of AgCl.	Ratio $ErCl_3 : 3AgCl$.	At. Wt. of Er.
I	1·88695	2·24872	0·839122	165·202	2·98792	0·631526	165·192
I	1·98625	2·36703	0·839132	165·206	3·14516	0·631526	165·192
I	2·30845	2·75114	0·839089	165·192	3·65527	0·631340	165·198
I	2·93390	3·49630	0·839144	165·210	4·64550	0·631557	165·206
I	2·89514	3·45006	0·839156	165·214	4·58401	0·631574	165·213
II	3·18253	3·79248	0·839169	165·217	5·03906	0·631572	165·212
II	3·05257	3·63780	0·839125	165·204	4·83354	0·631539	165·198
		Average	0·839134	165·206	Average	0·631551	165·202

In view of the fact that Baxter and Chapin (*J. Amer. Chem. Soc.*, **1911**, **33**, 22) found 0·003 per cent. water in neodymium chloride which had been dried in an exactly similar fashion, it seems likely that the above results are subject to a small uncertainty from this source.

The value 165·2 is 2·2 units lower than the value 167·46 previously found by Boss and Hopkins. The committee has refrained from changing the value in the table, O. Hönigschmid being occupied with another investigation starting with an erbium oxide prepared recently by Prandtl.

YTTERBIUM.—Hönigschmid and Striebel (*Z. anorg. Chem.*, 1933, **212**, 385) have analysed ytterbium chloride prepared from oxide which had been purified by Prandtl (*ibid.*, 1932, **209**, 13), and which showed evidence of great purity when subjected to *X*-ray analysis. The preparation of the salt for weighing and the analysis followed closely the method already described in the case of erbium. Fusion was found impossible owing to dissociation of the salt. The material used in the analyses of Sample I was repurified for the analyses of Sample II. Weights are corrected to vacuum.

The Atomic Weight of Ytterbium.

Sample.	Wt. of $YbCl_3$.	Wt. of Ag.	Ratio $YbCl_3 : 3Ag$.	At. Wt. of Yb.	Wt. of AgCl.	Ratio $YbCl_3 : 3AgCl$.	At. Wt. of Yb.
I	2·07410	2·40255	0·86329	173·025	3·19205	0·64977	173·037
I	1·71782	1·98986	0·86329	173·023	2·64378	0·64976	173·033
I	1·81933	2·10732	0·86334	173·040	2·79979	0·64981	173·054
I	2·33706	2·70695	0·86336	173·045	3·59653	0·64981	173·054
I	2·31349	2·67968	0·86335	173·042	3·56054	0·64976	173·032
I	2·78037	3·22053	0·86333	173·036	4·27915	0·64975	173·029
II	2·08726	2·41783	0·86328	173·020	3·21248	0·64973	173·022
II	1·81001	2·09650	0·86335	173·043	2·78551	0·64979	173·048
II	2·53341	2·93447	0·86333	173·036	3·69892	0·64977	173·038
		Average	0·86332	173·037	Average	0·64977	173·039

From the standpoints of purity of material and suitability of method, this investigation seems superior to earlier work on ytterbium. Therefore the value 173·04 has been adopted for the table. Auer von Welsbach obtained the value 173·0, while Blumenfeld and Urbain found 173·5.

OSMIUM.—Gilchrist (*U.S. Bureau of Standards Journal of Research*, 1932, **9**, 279) has determined the percentage of osmium in ammonium chloro-osmate and ammonium bromo-osmate. Osmium was freed from other platinum metals by two distillations as tetroxide from nitric acid solution. The metal, obtained by electrolysis, was oxidised to tetroxide and then reduced by boiling with pure hydrochloric or hydrobromic acid to chloro-osmic or bromo-osmic acid. Precipitation as the ammonium salts followed, and the salts were recrystallised, except in the case of ammonium chloro-osmate Sample II. After being dried over phosphorus pentoxide, the salts were prepared for weighing by prolonged heating to constant weight at about 150°.

The weighed salt was reduced in a current of pure hydrogen, the final temperature, 700—725°, being maintained long enough to secure constant weight of the resulting metal. Removal of hydrogen from the reduction tube by a current of nitrogen was found necessary in order to avoid oxidation when the metal was exposed to the air. Weights are corrected to vacuum.

The Atomic Weight of Osmium.

Sample.	Wt. of $(NH_4)_2OsCl_6$.	Wt. of Os.	$(NH_4)_2OsCl_6$.	At. Wt. of Os.
1	3·81131	1·65758	0·43491	191·50
1	3·46016	1·50505	0·43496	191·54
1	1·11090	0·48320	0·43497	191·55
		Average	0·43495	191·53
2	7·80602	3·39547	0·43499	191·56
2	7·21775	3·13949	0·43496	191·54
2	7·04888	3·06644	0·43502	191·58
2	7·54170	3·27946	0·43484	191·44
		Average	0·43495	191·53
		Average of all	0·43495	191·53
1	5·85596	1·58647	0·27091	191·57
1	5·59080	1·51471	0·27093	191·59
1	3·91834	1·06117	0·27082	191·48
		Average	0·27089	191·55
2	4·98331	1·35016	0·27093	191·59
2	4·53546	1·22899	0·27097	191·63
		Average	0·27095	191·61
		Average of all	0·27091	191·57

Since this work seems superior to earlier work on osmium, the value 191·5 has been adopted for the table of atomic weights.

THALLIUM.—Baxter and Thomas (*J. Amer. Chem. Soc.*, 1933, **55**, 2384) have compared thallous chloride with silver. Thallous sulphate was several times recrystallised and converted to chloride. The chloride was then recrystallised. Sample A contained a spectroscopic trace of silver introduced accidentally. Sample B was found by spectroscopic examination to be free from the impurities contained in the original thallium. Sample C, the purest, was not examined spectroscopically. The salt was prepared for weighing by distillation in nitrogen and refusion in nitrogen. In the third analysis the final fusion atmosphere was air. Comparison with silver followed the conventional lines. Weights are corrected to vacuum.

The Atomic Weight of Thallium.

Sample TlCl.	Wt. of TlCl.	Wt. of Ag.	Ratio TlCl : Ag.	At. Wt. of Tl.
A	6·03004	2·71269	(2·22290)	(204·349)
A	7·16504	3·22265	2·22334	204·397
A	7·26645	3·26832	2·22330	204·393
B	11·54708	5·19357	2·22334	204·397
B	11·94726	5·37358	2·22333	204·396
B	9·87039	4·43931	2·22341	204·404
B	13·11388	5·89818	2·22338	204·401
C	8·97358	4·03636	2·22319	204·381
C	9·71404	4·36898	2·22341	204·404
C	10·23369	4·60270	2·22341	204·404
B	12·79964	5·75681	2·22339	204·402
C	9·97133	4·48459	2·22347	204·411
		Average excluding Analysis 1	2·22336	204·399

The result, 204·40, confirms the work of Hönigschmid, Birckenbach, Kother, and Striebel, who found 204·39, and of Aston, 204·39, but is higher than that found by Briscoe, Kikuchi, and Peel, 204·34.

LEAD.—Several determinations of the atomic weight of lead from radioactive minerals have appeared. Baxter and Alter (*J. Amer. Chem. Soc.*, 1933, **55**, 1445) extracted lead from cyrtolite occurring in Bedford, New York, U.S.A. This mineral was nearly if not quite free from thorium. Purification included precipitation as sulphide, as chromate, and as sulphate, crystallisation as nitrate and chloride, and distillation in dry hydrogen chloride. Lead from Swedish kolm was similarly purified. Common lead was crystallised as nitrate and as chloride. Analysis of the lead chloride was effected by comparison with silver. Weights are in vacuum.

In a later investigation (*ibid.*, p. 2785) lead was obtained from Katanga pitchblende by extracting the yellow secondary product with hydrochloric acid, and then the lead in the primary pitchblende was obtained. Both samples were purified in essentially the manner already described. For comparison a new determination with the Bedford sample was carried out as well as two with common lead. For convenience analyses with the same sample are grouped together.

The Atomic Weight of Lead.

Sample.	Wt. of $PbCl_2$.	Wt. of Ag.	Ratio $PbCl_2$: 2Ag.	At. Wt. of Pb.
Common	2·47843	1·92274	1·28901	207·203
	2·80252	2·17405	1·28908	207·218
	2·56818	1·99234	1·28903	207·207
	4·34481	3·37050	1·28907	207·216
		Average	1·28905	207·211
Kolm Cyrtolite	3·42063	2·66515	1·28347	206·007*
	0·99965	0·77906	1·28315	205·938
	0·99219	0·77325	1·28314	205·936
	0·76907	0·59946	1·28294	205·893
	0·73596	0·57358	1·28310	205·928
	0·59044	0·46015	1·28315	205·938
		Average	1·28310	205·927
Katanga Pitchblende extract	2·62575	2·04615	1·28326	205·962
	3·75342	2·92474	1·28333	205·977
	3·28327	2·55867	1·28327	205·964
	3·19222	2·48745	1·28333	205·977
		Average	1·28330	205·970
Katanga Pitchblende	4·57229	3·56261	1·28341	205·995
	6·20083	4·83143	1·28344	206·001
	4·45460	3·47094	1·28340	205·992
		Average	1·28342	205·996

* Baxter and Bliss found 206·013 (*J. Amer. Chem. Soc.*, 1930, **52**, 4848).

Hönigschmid, Sachtleben, and Baudrexler (*Z. anorg. Chem.*, **1933**, **214**, 104) also have worked with lead samples obtained from uranium ores. The procedures of purification and analysis seem to have followed closely those outlined above.

Common.

Wt. of $PbCl_2$.	Wt. of Ag.	Ratio $PbCl_2 : 2Ag$.	At. Wt. of Pb.	Wt. of $PbCl_2$.	Wt. of Ag.	Ratio $PbCl_2 : 2Ag$.	At. Wt. of Pb.
4·11815	3·19483	1·28900	207·202	3·90714	3·03113	1·28900	207·202
4·11159	3·18947	1·28911	207·225	3·35776	2·60494	1·28900	207·200
3·53084	2·73927	1·28897	207·196	5·13712	3·98519	1·28905	207·212
4·91028	3·80923	1·28905	207·211	5·64511	4·37935	1·28903	207·207
2·99549	2·32378	1·28906	207·214		Average	1·28903	207·208

Morogoro Uraninite.

Wt. of $PbCl_2$.	Wt. of Ag.	Ratio $PbCl_2 : 2Ag$.	At. Wt. of Pb.	Wt. of AgCl.	Ratio $PbCl_2 : 2AgCl$.	At. Wt. of Pb.
3·53584	2·75474	1·28355	206·024	3·66003	0·966069	206·033
2·90725	2·26502	1·28354	206·023	3·00924	0·966108	206·044
3·58682	2·79436	1·28359	206·034	3·71286	0·966053	206·028
2·95643	2·30324	1·28360	206·035	3·06012	0·966116	206·046
3·33674	2·59956	1·28358	206·031	3·45379	0·966110	206·045
3·81379	2·97121	1·28358	206·032	3·94773	0·966072	206·034
3·40612	2·65356	1·28360	206·036	3·52564	0·966100	206·042
2·91617	2·27187	1·28360	206·035	3·01854	0·966086	206·038
2·56153	1·99561	1·28358	206·032			
2·62269	2·04323	1·28360	206·036	2·71481	0·966068	206·033
	Average	1·28358	206·032	Average	0·966086	206·038

Katanga Curite.

2·70844	2·11006	1·28358	206·032			
2·73861	2·11361	1·28355	206·026			
2·91250	2·26912	1·28354	206·022			
5·67156	4·41839	1·28363	206·041			
6·13816	4·78194	1·28361	206·038	6·35368	0·966079	206·036
5·58752	4·35310	1·28359	206·030			
6·93922				7·18385	0·966044	206·026
	Average	1·28358	206·031	Average	0·966062	206·031

Hydrochloric Acid Extract of Katanga Pitchblende.

2·81263	2·19143	1·28347	206·007			
3·08813	2·40591	1·28356	206·027			
4·90560	3·82191	1·28355	206·024	5·07791	0·966067	206·032
	Average	1·28353	206·020	Average	0·966067	206·032

It is interesting that both groups of investigators find common lead to have the atomic weight 207·21, a value 0·01 unit lower than that in the International table.

Cawood and Patterson (J., 1933, 619) have determined experimentally the compressibilities of ethylene, carbon dioxide, nitrous oxide, sulphur dioxide, and methyl ether at pressures between 1 and 3 metres and at various temperatures. Within the error of the experiments, the isothermals were found to be straight lines. Since log $\frac{d\,(pv)}{dp}$ when plotted against log T gave straight lines, the value of $1 + \lambda$ for SO_2 was found by extrapolation from the values at 30° and 50°, 1·01681 and 1·01340 respectively, to be 1·0249. Molecular and atomic weights are calculated from these values and mean values of the densities.

	$1 + \lambda$.	Density.	Observers.	Mol. wt.	
O_2	1·00094	1·42896	Baxter and Starkeweather	32·000	
C_2H_4	1·00732	1·2606	Leduc, Stahrfoss, Batuecas, Stock, and Ritter	28·051	C = 12·010
CO_2	1·00668	1·9767	Leduc, Rayleigh, Guye, Guye and Pintza	44·014	C = 12·014
SO_2	1·0249	2·9265	Jacquerod and Scheuer, Baume, Cooper, and Maas	64·004	S = 32·00
N_2O	1·00714	1·9777	Leduc, Rayleigh, Guye and Pintza,	44·016	N = 14·008
$(C_2H_5)_2O$	1·02811	2·1100	Baume, Maas, and Russell	46·003	C = 11·98

TANTALUM and NIOBIUM.—Aston (*Nature*, 1932, **130**, 130), using the mass spectrograph, finds tantalum and niobium to be probably simple elements with the atomic weights 180·89 and 92·90 respectively. The large differences between these values and those in the table indicate the advisability of obtaining further estimations of the atomic weight of Ta and Nb by chemical methods.

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ATOMIC WEIGHTS, 1934.

	Symbol.	At. No.	At. wt.		Symbol.	At. No.	At. wt.
Aluminium	Al	13	26·97	Neodymium	Nd	60	144·27
Antimony	Sb	51	121·76	Neon	Ne	10	20·183
Argon	A	18	39·944	Nickel	Ni	28	58·69
Arsenic	As	33	74·91	Niobium	Nb		
Barium	Ba	56	137·36	(Columbium)	(Cb)	41	93·3
Beryllium	Be	4	9·02	Nitrogen	N	7	14·008
Bismuth	Bi	83	209·00	Osmium	Os	76	191·5
Boron	B	5	10·82	Oxygen	O	8	16·0000
Bromine	Br	35	79·916	Palladium	Pd	46	106·7
Cadmium	Cd	48	112·41	Phosphorus	P	15	31·02
Cæsium	Cs	55	132·91	Platinum	Pt	78	195·23
Calcium	Ca	20	40·08	Potassium	K	19	39·096
Carbon	C	6	12·00	Praseodymium	Pr	59	140·92
Cerium	Ce	58	140·13	Radium	Ra	88	225·97
Chlorine	Cl	17	35·457	Radon	Rn	86	222
Chromium	Cr	24	52·01	Rhenium	Re	75	186·31
Cobalt	Co	27	58·94	Rhodium	Rh	45	102·91
Copper	Cu	29	63·57	Rubidium	Rb	37	85·44
Dysprosium	Dy	66	162·46	Ruthenium	Ru	44	101·7
Erbium	Er	68	167·64	Samarium	Sm	62	150·43
Europium	Eu	63	152·0	Scandium	Sc	21	45·10
Fluorine	F	9	19·00	Selenium	Se	34	78·96
Gadolinium	Gd	64	157·3	Silicon	Si	14	28·06
Gallium	Ga	31	69·72	Silver	Ag	47	107·880
Germanium	Ge	32	72·60	Sodium	Na	11	22·997
Gold	Au	79	197·2	Strontium	Sr	38	87·63
Hafnium	Hf	72	178·6	Sulphur	S	16	32·06
Helium	He	2	4·002	Tantalum	Ta	73	181·4
Holmium	Ho	67	163·5	Tellurium	Te	52	127·61
Hydrogen	H	1	1·0078	Terbium	Tb	65	159·2
Indium	In	49	114·76	Thallium	Tl	81	204·39
Iodine	I	53	126·92	Thorium	Th	90	232·12
Iridium	Ir	77	193·1	Thulium	Tm	69	169·4
Iron	Fe	26	55·84	Tin	Sn	50	118·70
Krypton	Kr	36	83·7	Titanium	Ti	22	47·90
Lanthanum	La	57	138·92	Tungsten	W	74	184·0
Lead	Pb	82	207·22	Uranium	U	92	238·14
Lithium	Li	3	6·940	Vanadium	V	23	50·95
Lutecium	Lu	71	175·0	Xenon	Xe	54	131·3
Magnesium	Mg	12	24·32	Ytterbium	Yb	70	173·04
Manganese	Mn	25	54·93	Yttrium	Y	39	88·92
Mercury	Hg	80	200·61	Zinc	Zn	30	65·38
Molybdenum	Mo	42	96·0	Zirconium	Zr	40	91·22