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THIRTY-FOURTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED DURING 1927

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The Annual Report of the German Committee on Atomic Weights appeared as usual.[1] Nearly all the following investigations appeared during 1927.

Boron.—Briscoe, Robinson and Smith[2] by means of a standardized float have determined the densities of three specimens of boron trichloride obtained from different sources and have found an extreme variation in the atomic weight of boron of 0.023 unit. Fractionation of two of these samples showed them to be impure and halved the extreme difference. There is no proof that further purification would not have removed the discrepancy entirely.

Carbon.—Sameshima[3] has determined the density and compressibility of acetylene.

Table I

Density of Acetylene, 0°

Pressure	Volume	Density	PV ($(PV)_1 = 1$)
0.5341	143.422	0.6241	1.0053
.6279	143.424	.7348	1.0038
.9988	143.431	1.1739	0.9995
1.0007	143.431	1.1749	1.0005
1.5096	143.441	1.7845	0.9938

By interpolation the normal density is 1.1747 and by extrapolation the limiting density 1.1615. Then C_2H_2 = 26.03 and C = 12.005.

Stock and Ritter[4] have compared oxygen and ethylene in a gas displacement balance and find the weight of the normal liter of ethylene to be 1.26057 and the deviation from Boyle's Law 1.00790. Using 22.415 as the gram molecular volume, the molecular weight of ethylene is 28.034 and the atomic weight of carbon is 12.001.

[1] *Ber.*, **60B**, 1 (1927).

[2] Briscoe, Robinson and Smith, *J. Chem. Soc.*, **1927**, 282.

[3] Sameshima, *Bull. Chem. Soc. Japan*, **1**, 41 (1926).

[4] Stock and Ritter, *Z. physik. Chem.*, **124**, 204 (1926).

Nitrogen.—Moles[5] discusses critically earlier work on the density and compressibility of ammonia and comes to the conclusion that 0.7715 and 1.01534 represent the most probable values of the density and compressibility, respectively. From these figures the atomic weight of nitrogen may be calculated to be 14.008.

Moles[6] reviews the evidence concerning the densities and compressibilities of oxygen and nitrogen and arrives at the following most probable values.

	Density	$(PV)_0/(PV)_1$	At. wt.	Gram molecular vol.
Oxygen	1.42892	1.00091	16.000	22.4148
Nitrogen	1.25046	1.00042	14.0082	.....

Moles and Clavera[7] have redetermined the density of nitrogen prepared by (1) decomposition of ammonium nitrite, (2) reduction of nitric oxide, (3) decomposition of urea by hypobromite, (4) decomposition of urea by sodium nitrite.

Table II

Density of Nitrogen

Method of prep.	Globe 3 455.18 ml.	Globe B, 580.49 ml.	Globe N_1, 585.09 ml.	Globe N_3, 772.393 ml.	Average
			Preliminary Series		
1	1.24989		1.25063		1.25026
1	1.25068		1.25113		1.25090
1	1.25005		1.25122		1.25063
1	1.25016				1.25016
				Average	1.25049
			Final Series		
1	1.25040	1.25042			1.25041
1	1.25018	1.25042			1.25030
1	1.25094	1.25068			1.25081
1	1.25042	1.25048			1.25045
1	1.25018	1.25045			1.25032
1	1.25049	1.25052			1.25051
1	1.25124	1.25044			1.25084
1	1.25054	1.25057			1.25056
				Average	1.25052
2	1.25055	1.25059			1.25057
2	1.25059	1.25066			1.25062
2	1.25041	1.25051			1.25047
2	1.25030	1.25039			1.25034
				Average	1.25049
3	1.25052				1.25052
3	1.25026	1.25037			1.25032
3	1.25045	1.25076			1.25061
				Average	1.25046

[5] Moles, *Anales soc. españ. fís. quím.*, **24**, 717 (1926).

[6] Moles, *Z. anorg. allgem. Chem.*, **167**, 40 (1927).

[7] Moles and Clavera, *ibid.*, **167**, 49 (1927).

Table II (*Concluded*)

Method of prep.	Globe 3 455.18 ml.	Globe B, 580.49 ml.	Globe N_1, 585.09 ml.	Globe N_2, 772.393 ml.	Average
4	1.25074				1.25074
4	1.25025				1.25025
4	1.25075				1.25075
4	1.25018				1.25018
4	1.25060			1.25057	1.25059
4	1.25052			1.25039	1.25046
4	1.25054			1.25028	1.25041
				Average	1.25048
Average	1.25050[a]	1.25052	1.25096	1.25041	1.25050[a]

[a] Omitting preliminary series.

New determinations of the deviation from Boyle's Law made by Batuecas are presented.

	$(PV)_0/(PV)_1$
	1.00059
	1.00025
	1.00076
	1.00021
	1.00050
Average	1.00046

By combining the experimental averages for density and compressibility with the value for normal molecular volume, 22.4148, the atomic weight of nitrogen is computed to be 14.008.

Neon.—Baxter and Starkweather[8] have redetermined the density and

Table III

The Density of Neon

0°. g = 980.616

Sample	No. of adsorptions	Globe IV, 2110.95 ml.	Globe VII, 2117.77 ml.	Average
		P = 760 mm.		
1	7		0.89991	
1	9		.89988	
1	11		.89987	
		Average	.89989	
2	23		.89992	
2	27		.89990	
		Average	.89991	
1 + 2	13 and 29	0.89991	.89994	0.89993
1 + 2	15 and 31	.89987	.89996	.89992
1 + 2	17 and 33	.89988	.89991	.89990
1 + 2	18 and 34	.89981	.89990	.89986
1 + 2	19 and 35	.89993	.89992	.89993
1 + 2	20 and 36	.89984	.89997	.89992
	Average	.89987	.89993	.89991
			Average of all	0.89990

[8] Baxter and Starkweather, *Proc. Nat. Acad. Sci.*, **14**, 50 (1928).

TABLE III (*Concluded*)

Sample	No. of adsorptions	Globe IV, 2110.95 ml.	Globe VII, 2117.77 ml.	Average
		P = 506.667 mm.		
1	9		0.60000	0.60000
1 + 2	13 and 29	0.60000	.60007	.60004
1 + 2	17 and 33	.60007	.60010	.60009
1 + 2	18 and 34	.60002	.60014	.60008
1 + 2	21 and 37	.59999	.60006	.60003
1 + 2	22 and 38	.59998	.60006	.60002
	Average	.60001	.60007	.60004
		P = 253.333 mm.		
1	11	0.30000	0.30007	0.30004
1 + 2	15 and 31	.30007	.30009	.30008
1 + 2	19 and 35	.30003	.30010	.30007
1 + 2	20 and 36	.30009	.30018	.30014
1 + 2	21 and 37	.30012	.30010	.30011
1 + 2	22 and 38	.30011	.30012	.30012
	Average	.30007	.30011	.30009

compressibility of neon which had been purified both chemically and by adsorption on chilled, dehydrated chabazite until spectroscopically free from helium and nitrogen.

The deviation from Boyle's Law is calculated in the conventional way from the densities at different pressures to be 0.99942 and the atomic weight of neon 20.182.

Chlorine.—E. Gleditsch and L. Gleditsch[9] have compared the densities of solutions of sodium chloride, saturated at 18°, prepared from salt occurring at different levels in the Alsatian deposits. Since no difference greater than the experimental error was found, the isotopic composition of the chlorine must be the same.

Source	Density of saturated solution
Ordinary (marine)	1.201066
Alsation, Level 1 (highest)	1.201063
Level 2	1.201076
Level 3	1.201070
Level 4 (lowest)	1.201058

Hönigschmid, Chan and Birckenbach[10] purified chlorine by distillation and collected the product in exhausted glass bulbs which were ultimately sealed. These were weighed in air and in water, and were broken under a solution of ammonium arsenite. The glass fragments were collected and weighed. Comparison with silver followed and the silver choride was collected and weighed. The change in weight on fusion in *chlorine* and in air was applied as a correction. Ag = 107.880. Weights are in vacuum.

[9] Gleditsch and Gleditsch, *J. chim. phys.*, **24,** 238 (1927).

[10] Hönigschmid, Chan and Birckenbach, *Z. anorg. allgem. Chem.*, **163,** 315 (1927).

Table IV

Atomic Weight of Chlorine

Wt. of Cl	Wt. of Ag	Ratio Cl:Ag	At. wt. of Cl	Wt. of AgCl	Ratio Cl:AgCl	At. wt. of Cl
Preliminary Series—Commercial Chlorine						
1.59759	4.86100	0.328655	35.455	.....	.....	....
1.85886	5.65594	.328656	35.456	7.51482	0.247359	35.455
1.79223	5.45306	.328665	35.456	7.24567	.247352	35.454
1.37498	4.18367	.328654	35.455	5.55893	.247346	35.453
1.40453	4.27340	.328668	35.457	5.67813	.247358	35.455
	Average	.328660	35.456		.247354	35.454
Final Series—Chlorine from $KMnO_4$ + HCl						
2.85458	8.68543	0.328663	35.456	11.54006	0.247363	35.456
2.25569	6.86312	.328668	35.457	9.11885	.247366	35.457
2.38732	7.26367	.328666	35.457	.....	.....	....
2.46049	7.48635	.328664	35.457	9.94697	.247361	35.456
3.35955	10.22139	.328678	35.458	13.58097	.247372	35.458
2.96007	9.00620	.328671	35.457	11.96628	.247368	35.457
2.21357	6.73502	.328666	35.457	8.94856	.247366	35.457
3.04333	9.25949	.328671	35.457	12.30283	.247368	35.457
2.17711	6.62409	.328666	35.457	8.80126	.247363	35.456
	Average	.328668	35.457		.247366	35.457

In another series of experiments silver chloride was synthesized from weighed amounts of silver and hydrochloric acid from different sources. Sample Ia was prepared from ordinary hydrochloric acid by distillation

Table V

Atomic Weight of Chlorine

Sample	Wt. of Ag	Wt. of AgCl	Ratio AgCl:Ag	At. wt. of Cl
Ia	4.29967	5.71283	1.32867	35.457
	4.29980	5.71285	1.32863	35.453
	4.29979	5.71309	1.32869	35.459
	4.29969	5.71291	1.32868	35.458
		Average	1.32867	35.457
Ib	5.46510	7.26138	1.32868	35.458
	4.29656	5.70869	1.32867	35.456
	5.60428	7.44636	1.32869	35.459
	7.05748	9.37695	1.32866	35.455
		Average	1.32867	35.457
II	4.66452	6.19769	1.32869	35.459
	4.70792	6.25510	1.32863	35.453
	5.24426	6.96804	1.32870	35.460
	4.95507	6.58374	1.32869	35.459
	4.77530	6.34466	1.32864	35.454
	6.58505	8.74935	1.32867	35.457
		Average	1.32867	35.457
III	5.56529	7.39451	1.32868	35.458
	5.07732	6.74608	1.32867	35.457
		Average	1.32867	35.457

after removing bromine and iodine. To prepare Sample Ib sodium chloride was crystallized and converted to hydrogen chloride. The solution of the latter was purified as above. Samples II and III were prepared from extreme fractions of carbon tetrachloride which had been repeatedly fractionally distilled with the object of separating the chlorine isotopes. Weights are in vacuum. Ag = 107.880.

The atomic weight of chlorine obtained as the result of these experiments is identical with that found by Richards and Wells.

Scandium.—Smith[11] purified scandium material (1) by solution of the fluoride in ammonium fluoride and (2) by purification of the double ammonium tartrate. The oxide was prepared through the oxalate and was converted to chloride in a current of nitrogen and carbon tetrachloride in an enclosed bottling apparatus. The chloride was then compared with silver. Weights are in vacuum. Cl = 35.457.

Table VI

Atomic Weight of Scandium

Sample	Weight of $ScCl_3$	Weight of Ag	Ratio $ScCl_3$:3Ag	Atomic weight of Sc
1	0.59311	1.26689	0.46815	45.142
1	1.13724	2.42790	.46838	45.225
1	2.14857	4.58924	.46817	45.149
1	1.10970	2.36945	.46832	45.202
		Average	.46825	45.179
2	1.02956	2.19934	.46811	45.132
2	1.50457	3.21486	.46801	45.094
2	0.90557	1.93409	.46822	45.161
2	1.79432	3.83257	.46817	45.151
2	1.71420	3.66083	.46826	45.174
		Average	.46815	45.142

These results confirm the higher value for scandium found by Hönigschmid, 45.10.

Potassium.—Hönigschmid and Goubeau[12] have analyzed potassium chloride. The purified salt was dehydrated successively at 250 and 600° and was finally fused, all in a current of nitrogen. Solution and comparison with silver followed and the silver chloride was quantitatively collected. Samples Ia and Ib were prepared from the most and least volatile fractions of potassium metal which had been subjected to "ideal" distillation by v. Hevesy. Sample IV also was a "heavy" product from an incompleted similar distillation. Samples II, III and V were purified by crystallization as nitrate, chlorate and nitrate, respectively. All were finally crystallized as chloride. Weights are corrected to vacuum. Cl = 35.457.

[11] Smith, This Journal, 49, 1642 (1927).

[12] Hönigschmid and Goubeau, *Z. anorg. allgem. Chem.*, **163**, 93 (1927).

TABLE VII

ATOMIC WEIGHT OF POTASSIUM

Sample	Wt. of KCl	Wt. of Ag	Ratio KCl:Ag	At. wt. K	Wt. of AgCl	Ratio KCl:AgCl	At. wt. K
Ia	3.36688	4.87134	0.691161	39.105			
Ia	3.92490	5.67896	.691130	39.102			
Ia	5.14146	7.43908	.691142	39.103			
		Average	.691144	39.103			
Ib	3.50173	5.06648	.691156	39.105			
Ib	3.80806	5.50967	.691159	39.105			
Ib	4.33410	6.27062	.691176	39.107			
		Average	.691164	39.106			
II	4.35574	6.30199	.691169	39.106	8.37351	0.520181	39.104
II	2.39852	3.47045	.691127	39.102	4.61113	.520159	39.101
II	7.15608	10.35431	.691121	39.102	13.75729	.520166	39.102
II					10.89195	.520177	39.104
		Average	.691139	39.103		.520171	39.103
III	4.56305	6.60205	.691157	39.105	8.77205	.520181	39.104
III	4.60793	8.11400	.691142	39.103	10.78097	.520169	39.103
III	4.92368	7.12366	.691173	39.107	9.46480	.520210	39.108
III	5.92880	8.57837	.691134	39.103	11.39758	.520181	39.104
		Average	.691152	39.105		.520185	39.105
IV	3.90883	5.65532	.691178	39.107	7.51410	.520199	39.107
IV	4.35246	6.29745	.691146	39.104	8.36735	.520172	39.103
IV	5.26221	7.61367	.691153	39.105	10.11599	.520187	39.105
		Average	.691159	39.105		.520186	39.105
V	6.61240	9.56717	.691155	39.105			
V	9.43007	13.64420	.691141	39.104			
V	9.61736	13.91507	.691147	39.104			
		Average	.691148	39.104			
Weighted average of all			.691149	39.104		.520180	39.104

Evidence of isotopic separation is so slight that Hönigschmid and Goubeau have not separated Samples Ia, Ib and IV from the others in computing the average. The result is slightly lower than that found in the same way by Richards and Archibald, 39.106, and by Archibald, but higher than that found later by Richards and Stähler, 39.095, and by Richards and Mueller.

The ratio of silver to silver chloride computed from the above weights is 1.328670, a value identical with that found by Richards and Wells.

Argon.—Moles[13] discusses critically earlier work upon the density and compressibility of argon and arrives at the figures 1.7833 and 1.0009, respectively, as the most probable ones. The atomic weight of argon computed from these figures is 39.94.

Baxter and Starkweather[14] have redetermined the density and compressibility of argon which had been purified both chemically and by

[13] Moles, *Ber.*, **60,** 134 (1927).

[14] Baxter and Starkweather, *Proc. Nat. Acad. Sci.*, **14,** 57 (1928).

fractional adsorption on chilled, dehydrated chabazite until spectroscopically free from all other gases.

TABLE VIII

THE DENSITY OF ARGON

0°. g = 980.616

Sample	Number of adsorptions	Globe IV, 2110.95 ml.	Globe VII, 2117.77 ml.	Average
		P = 760 mm.		
1	3	1.78380	1.78378	1.78379
1	4	1.78366	1.78362	1.78364
1 + 2	4	1.78363	1.78364	1.78364
1 + 2	5	1.78361	1.78356	1.78359
1 + 2	6	1.78378	1.78368	1.78373
1 + 2	7	1.78356	1.78358	1.78357
1 + 2	8	1.78353	1.78361	1.78357
1 + 2	9	1.78355	.....	1.78355
	Average	1.78364	1.78364	1.78364
		P = 506.667 mm.		
1	4	1.18866	1.18869	1.18868
1 + 2	5	1.18877	1.18882	1.18880
1 + 2	6	1.18878	1.18875	1.18877
1 + 2	10	1.18868	.....	1.18868
	Average	1.18872	1.18875	1.18874
		P = 253.333 mm.		
1 + 2	4	0.59420	0.59418	0.59419
1 + 2	7	.59420	.59413	.59417
1 + 2	9	.59422	.....	.59422
1 + 2	10	.59423	.....	.59423
	Average	.59421	.59416	.59419

The deviation from Boyle's Law is calculated in the conventional way from the densities at different pressures to be 1.00090, and the atomic weight 39.943.

The densities of oxygen, nitrogen, neon and argon at different pressures as found by Baxter and Starkweather are then weighted according to their probable errors and combined in least squares solutions of the best straight line equations for the deviations from Boyle's Law. From these equations are calculated the following values, the limiting value of a molal volume being 22.4146 liters.

TABLE IX

CALCULATED VALUES

	Normal density, obs.	Normal density, calcd.	$\frac{(PV)_0}{(PV)_1}$	Atomic weight
Oxygen	1.42896 (5)	1.428965	1.00093	16.000
Nitrogen	1.25036	1.25037	1.00040	14.008
Neon	0.89990	0.89990	0.99941	20.183
Argon	1.78364	1.78364	1.00089	39.944

Yttrium.—Hönigschmid and H. Frh. Auer von Welsbach[15] have continued the work of Hönigschmid and Meuwsen on yttrium (see Report for 1924) using the purest of the three specimens of material previously employed. This sample, which had been purified by Prandtl, originally gave the value 88.95. Further purification from a trace of erbium was effected by Prandtl by removing a ferrocyanide fraction. Conversion to chloride through the oxalate and oxide and gradual dehydration of the chloride in a current of nitrogen and hydrogen chloride was followed by comparing the chloride with silver and weighing the silver chloride. Weights are in vacuum. Cl = 35.457.

Table X

Atomic Weight of Yttrium

Wt. of YCl_3	Wt. of Ag	Ratio YCl_3:3Ag	At. wt. of Y	Wt. of AgCl	Ratio YCl_3:3Ag	At. wt. of Y
2.24375	.....	.....	....	4.94021	0.454181	88.931
2.15306	3.56803	0.603431	88.924	4.74088	.454148	88.918
2.18124	3.61466	.603443	88.927	4.80278	.454162	88.925
2.43852	4.04100	.603445	88.928	5.36920	.454168	88.926
2.61345	4.33091	.603441	88.927	5.75442	.454164	88.924
2.88846	4.78663	.603443	88.927	6.35993	.454165	88.925
2.60421	4.31565	.603434	88.924	5.73423	.454152	88.919
2.32309	3.84963	.603458	88.931	5.11499	.454173	88.928
2.38370	3.95020	.603438	88.926	5.24859	.454160	88.923
2.60220	4.31226	.603442	88.927	5.72964	.454165	88.925
2.82846	4.68724	.603438	88.926	.....	.....	....
	Average	.603441	88.927		.454164	88.924

Silver.—Hönigschmid, Zintl and Thilo[16] carefully purified silver nitrate and prepared it for weighing by fusion in a current of pure, dry air. Then the salt was reduced to metal in a current of hydrogen, eventually at 800°. The silver nitrate and silver in most of the experiments were weighed in air and corrected to vacuum in the usual way. In a few experiments, after being weighed in air, both substances were weighed in an exhausted

Table XI

Atomic Weight of Silver

Wt. of $AgNO_3$	Wt. of Ag	Ratio $AgNO_3$:Ag	At. wt. of Ag
10.33791	6.56464	1.57479	107.880
12.33106	7.83023	1.57480	107.877
10.07649	6.39864	1.57479	107.880
10.73593	6.81733	1.57480	107.877
12.97718	8.24067	1.57477	107.883
11.98142	7.60828	1.57479	107.880
11.32714	7.19276	1.57480	107.878
9.71370	6.16829	1.57478	107.881
12.46620	7.91609	1.57479	107.879

[15] Hönigschmid and von Welsbach, *Z. anorg. allgem. Chem.*, **165,** 284 (1927).

[16] Hönigschmid, Zintl and Thilo, *ibid.*, **163,** 65 (1927).

Table XI (*Concluded*)

Wt. of $AgNO_3$	Wt. of Ag	Ratio $AgNO_3$:Ag	At. wt. of Ag
11.95961	7.59441	1.57479	107.879
11.38824	7.23156	1.57480	107.878
17.18614	10.91325	1.57480	107.878
12.48205	7.92620	1.57478	107.881
13.96264	8.86633	1.57479	107.879
	Average	1.57479	107.879
	Weighings in exhausted vessel		
11.38833	7.23158	1.57481	107.877
17.18609	10.91327	1.57479	107.880
12.48212	7.92624	1.57478	107.880
13.96267	8.86635	1.57479	107.879
	Average	1.57479	107.879

weighing bottle. The latter procedure *raised* very slightly the weights of both substances but in the same proportion. N = 14.008.

The average ratio of silver nitrate to silver is identical with that previously found by Richards and Forbes.

Zintl and Goubeau[17] have converted potassium nitrate into potassium chloride by heating in a current of hydrogen chloride. The nitrate, after purification by crystallization, was cautiously fused in bulk and powdered preparatory to weighing. Weighings were first made in air of known density and corrected to vacuum, and then were repeated in an exhausted container. The latter were always smaller with potassium nitrate but usually larger with potassium chloride.

Table XII

The Atomic Weight of Silver

Air weight corrected to vacuum

Weight of KNO_3	Weight of KCl	Ratio KNO_3:KCl
6.88504	5.07669	1.35620
6.88501	5.07663	1.35622
7.70387	5.68084	1.35614
7.70382	5.68075	1.35613
8.14246	6.00415	1.35611
8.14263	6.00404	1.35606
7.81347	5.76152	1.35615
7.81352	5.76144	1.35618
12.78860	9.42974	1.35617
12.78874	9.42995	1.35621
13.04268	9.61686	1.35623
13.04260	9.61716	1.35618
	Average	1.35617

[17] Zintl and Goubeau, *Z. anorg. allgem. Chem.*, **163**, 302 (1927).

TABLE XII (*Concluded*)

Weights determined in exhausted container

Weight of KNO_3	Weight of KCl	Ratio KNO_3:KCl
6.88476	5.07678	1.356127
7.70331	5.68051	1.356099
8.14250	6.00438	1.356093
8.96711	6.61239	1.356109
7.81340	5.76163	1.356109
12.78839	9.43007	1.356129
13.04224	9.61737	1.356113
	Average	1.356111

With the ratios KCl/Ag = 0.691149 and AgCl/Ag = 1.328668, the following atomic weights are obtained:

N = 14.008

KNO_3:KCl	Ag	K	Cl
1.35617	107.872	39.102	35.454
1.356111	107.879	39.104	35.456

Brauner[18] suggests that in Baker and Riley's analyses of silver oxide (see Report for 1926) by reduction, silver might have been lost by volatilization. Baker and Riley[19] reply that owing to abundant opportunity for condensation loss of silver was unlikely, especially in view of the fact that ultimately the weight of the containing tube and silver remained constant on repeated fusion. Brauner[20] contends that a loss of silver by volatilization and condensation as smoke might readily have escaped visual detection, while the relatively small surface offered by fused silver might reduce the rate of volatilization after fusion. Baker and Riley[21] describe experiments to prove that silver, heated as in their experiments for reducing silver oxide in hydrogen, does not escape from the containing tube.

Antimony.—Krishnaswami[22] synthesized antimony tribromide from carefully purified metal which had been extracted from minerals occurring in India and Burma. The tribromide was purified by sublimation in a vacuum and collected in glass bulbs. The various fractions of tribromide, after being weighed, were dissolved in tartaric acid solution and the glass was collected and weighed. Precipitation and quantitative determination of the silver bromide was in two cases preceded by comparison with silver. Vacuum weights are given. Br = 79.920.

Dysprosium.—Hönigschmid and H. Frh. Auer von Welsbach[23] used as a starting point dysprosium sulfate which had been purified by C. Auer von Welsbach. This material was found by x-ray analysis to contain only 0.1% of holmium and a trace of terbium as impurities.

[18] Brauner, *Nature*, **119**, 348 (1927).

[19] Baker and Riley, *ibid.*, **119**, 349 (1927).

[20] Brauner, *ibid.*, **119**, 526 (1927).

[21] Baker and Riley, *ibid.*, **119**, 703 (1927).

[22] Krishnaswami, *J. Chem. Soc.*, **1927**, 2534.

[23] Hönigschmid and von Welsbach, *Z. anorg. allgem. Chem.*, **165**, 289 (1927).

TABLE XIII

ATOMIC WEIGHT OF ANTIMONY

Source	Wt. of $SbBr_3$	Wt. of AgBr	Ratio, $SbBr_3$: 3AgBr	At. wt. of Sb
Commercial Sb_2O_3	4.44079	6.92064	0.641664	121.753
	3.15437	4.91639	(.641603)	(121.719)
	3.64246	5.67747	(.641566)	(121.701)
	3.97152	6.18954	.641650	121.746
	3.47255	5.41185	.641654	121.750
	3.80868	5.93549	.641679	121.762
	3.44766[a]	5.37296	.641669	121.756
	4.12164[a]	6.42335	.641665	121.754
		Average	.641664	121.754
Mysore Stibnite	4.29146	6.6 901	(.641569)	(121.700)
	4.03746	6.2 236	.641645	121.743
	3.85444	6.00720	.641637	121.738
	4.25750	6.63517	.641656	121.749
	4.16876	6.49684	.641659	121.751
	3.40170	5.30160	.641636	121.738
		Average	.641647	121.744
Mysore Cervantite	3.35625	5.23081	.641631	121.735
	3.98107	6.20437	.641659	121.751
	3.82381	5.95934	.641650	121.746
		Average	.641647	121.744
Amherst Stibnite	4.61169	7.18715	.641657	121.750
	4.61851	7.19785	.641651	121.746
	4.11282	6.40990	.641635	121.737
	3.50233	5.45818	.641666	121.755
	3.98801	6.21524	.641650	121.745
		Average	.641652	121.747
S. Shan States Stibnite	3.74847	5.84185	.641658	121.750
	4.94145	7.70114	.641652	121.747
	3.82442	5.96012	.641668	121.756
		Average	.641659	121.751

[a] In these two analyses comparison with silver gave the values 121.751 and 121.735.

Krishnaswami believes the differences between samples of different origin to be within the experimental error. This outcome contradicts Muzaffar's previous findings.

TABLE XIV

ATOMIC WEIGHT OF DYSPROSIUM

Wt. of $DyCl_3$	Wt. of Ag	Ratio, $DyCl_3$: 3Ag	At. wt. of Dy	Wt. of AgCl	Ratio, $DyCl_3$: 3AgCl	At. wt. of Dy
2.49132	2.99933	0.830625	162.453	3.98506	0.625165	162.457
2.77037	3.33519	.830648	162.460	.....	.....	.....
2.42773	2.92275	.830632	162.455	3.88325	.625180	162.463
2.76304	3.32629	.830667	162.466	4.41978[a]	.625153	162.452
2.75327	3.31454	.830664	162.465	4.40393	.625185	162.465
2.95998	3.56349	.830641	162.458	4.73475	.625161	162.455
3.23623	3.89607	.830640	162.457	5.17653	.625174	162.460
	Average	.830645	162.459		.625170	162.459

[a] The weight of dysprosium chloride used in this analysis is apparently given incorrectly as 2.46304.

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	Symbol	At. number	At. weight		Symbol	At. number	At. weight
Aluminum	Al	13	26.97	Mercury	Hg	80	200.61
Antimony	Sb	51	121.77	Molybdenum	Mo	42	96.0
Argon	A	18	39.94	Neodymium	Nd	60	144.27
Arsenic	As	33	74.96	Neon	Ne	10	20.183
Barium	Ba	56	137.37	Nickel	Ni	28	58.69
Beryllium	Be	4	9.02	Nitrogen	N	7	14.008
Bismuth	Bi	83	209.00	Osmium	Os	76	190.8
Boron	B	5	10.82	Oxygen	O	8	16.000
Bromine	Br	35	79.916	Palladium	Pd	46	106.7
Cadmium	Cd	48	112.41	Phosphorus	P	15	31.027
Calcium	Ca	20	40.07	Platinum	Pt	78	195.23
Carbon	C	6	12.000	Potassium	K	19	39.096
Cerium	Ce	58	140.25	Praseodymium	Pr	59	140.92
Cesium	Cs	55	132.81	Radium	Ra	88	225.95
Chlorine	Cl	17	35.457	Radon	Rn	86	222
Chromium	Cr	24	52.01	Rhodium	Rh	45	102.91
Cobalt	Co	27	58.94	Rubidium	Rb	37	85.44
Columbium	Cb	41	93.1	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	167.7	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	157.26	Sodium	Na	11	22.997
Gallium	Ga	31	69.72	Strontium	Sr	38	87.63
Germanium	Ge	32	72.60	Sulfur	S	16	32.064
Gold	Au	79	197.2	Tantalum	Ta	73	181.5
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	1.008	Thorium	Th	90	232.15
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	82.9	Uranium	U	92	238.17
Lanthanum	La	57	138.90	Vanadium	V	23	50.96
Lead	Pb	82	207.22	Xenon	Xe	54	130.2
Lithium	Li	3	6.940	Ytterbium	Yb	70	173.6
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

Conversion to chloride through the oxalate and oxide was followed by gradual dehydration in a stream of nitrogen and hydrogen chloride. The weighed, anhydrous chloride was compared with silver in the usual way, and the resulting silver chloride was collected and determined. Weights are in vacuum. Cl = 35.457.

The correction for holmium impurity is only −0.003 unit. The corrected value, 162.456, is somewhat lower than that found by Kremers, Hopkins and Engle, 162.52.

Moles[24] discusses gas density methods and results obtained in recent years. The best values for atomic weights determined in this way are found to be as follows: H = 1.0078; N = 14.008; F = 19.00; Cl = 35.458; Br = 79.918; Ag = 107.880; I = 126.92.

Zintl and Goubeau[25] find the weights of finely divided potassium nitrate and potassium chloride determined by weighing in air and correcting for the buoyant effect of the air in the usual way to be inconstant. Upon fusion the weight of potassium nitrate became constant but the weight was always less than that of the powdered material. Fused, powdered potassium nitrate when weighed in air and corrected to vacuum showed almost invariably a loss in weight (0.00–0.07 mg. per gram) when weighed in an exhausted container, and the weights determined by the latter method were more constant than those determined by the former. On the other hand potassium chloride sometimes weighed less but usually weighed *more* in a vacuum (0.00–0.05 mg. per gram). The conclusion by the authors is that the results may be explained by variable air adsorption on the surface of the finely divided material.

With the use of an improved mass spectrograph of greater resolving power and accuracy than earlier instruments Aston[26] has determined the deviations from integral values of the masses of the atoms of the following simple or complex elements.

H	1.00778	Cl^{37}	36.980
He	4.00216	A^{36}	35.976
Li^{6}	6.012	A^{40}	39.971
Li^{7}	7.012	As	74.934
B^{10}	10.0135	Br^{79}	78.929
B^{11}	11.0110	Br^{81}	80.926
C	12.0036	Kr^{78}	77.926
N	14.008	Kr^{80}	79.926
F	19.0000	Kr^{81}	80.926
Ne^{20}	20.0004	Kr^{82}	81.927
Ne^{22}	22.0048 (?)	Kr^{83}	82.927
P	30.9825	Kr^{84}	83.928
Cl^{35}	34.983	Kr^{86}	85.929

[24] Moles, *Gazz. chim. ital.*, **56**, 915 (1926).

[25] Zintl and Goubeau, *Z. anorg. allgem. Chem.*, **163**, 105 (1927).

[26] Aston, *Proc. Roy. Soc. (London)*, **115A**, 487 (1927).

I	126.932	The other isotopes of
Sn^{120}	119.912	tin, xenon and mercury
Xe^{134}	133.929	show the same differences
Hg^{200}	200.016	from integral values

The resolution of the lines of tin, xenon, mercury and lead points to the following composition of these elements (see also Aston, *Nature* **120**, 224 (1927)).

	Atomic number	Atomic weight	Mass numbers of isotopes in order of intensity
Sn	50	118.70	120, 118, 116, 124, 119, 117, 122, 121, 112, 114, 115
Xe	54	130.2	129, 132, 131, 134, 136, 128, 130, 126, 124
Hg	80	200.61	202, 200, 199, 198, 201, 204, 196
Pb	82	207.22	208, 207, 206, 209 (?), 203 (?), 204 (?)

Aston[27] was unable to distinguish between the mass spectra of ordinary mercury and that found in coal tar.

In the table of atomic weights on page 615, for which the author of this report solely is responsible, changes from the 1927 table are made in the cases of helium,[28] argon, dysprosium, neon and yttrium. The atomic weight of potassium seems to be in some doubt, but further evidence should be awaited before a change.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF CALIFORNIA]

THEORIES OF UNIMOLECULAR GAS REACTIONS AT LOW PRESSURES. II

BY OSCAR KNEFLER RICE AND HERMAN C. RAMSPERGER

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Certain gas reactions, termed by Hinshelwood quasi-unimolecular, are unimolecular at high pressures but fall off in rate below the unimolecular law at low pressures. In a recent paper[1] we have attempted, on the basis of collision hypotheses and classical statistical mechanics, to develop equations giving the relation between pressure and rate of reaction. We considered chiefly two theories which led to equations (5) and (19), respectively.

In the former article[1] we applied the theories to the decomposition of propionic aldehyde, which had been studied by Hinshelwood and Thomp-

[27] Aston, *Nature*, **119**, 489 (1927).

[28] A recent unpublished determination of the compressibility of helium below one atmosphere by Mr. R. B. Ellestad and the author has yielded the value for $(PV)_0/(PV)_1$ of 0.9995. This value combined with the density found by Baxter and Starkweather, 0.17846, gives as the atomic weight of helium 4.002, a result identical with that found by Aston with the mass spectrograph.

[1] Rice and Ramsperger, THIS JOURNAL, **49**, 1617 (1927).