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TWENTY-SEVENTH ANNUAL REPORT OF COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED DURING 1920.

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In the table adopted by the International Committee on Atomic Weights in its report for 1920,[1] the only change from the table of 1919 is in the atomic weight of scandium, from 44.1 to 45.1. This change is based on Hönigschmid's work noted below.

Carbon.—Timmermans[2] has determined the density of propane. Two methods of preparing the gas were employed: (1) the action of *normal* propyl iodide upon sodium dissolved in ammonia; (2) the action of butyronitrile on sodium. Both specimens were purified by fractional distillation.

The following weights of the normal liter were obtained.

Method of preparation.	Globe I. 564.88 cc.	Globe II. 455.77 cc.	Globe III. 351.91 cc.
1	2.01989	2.01896	2.01712
1	2.02181	2.01775	2.02087
1	2.02038	2.01908	2.02087
1	2.01878	2.02078	2.02214
Average	2.02021	2.01913	2.02025

[1] THIS JOURNAL, **42**, 1761 (1920).

[2] Timmermans, *J. chim. phys.*, **18**, 133 (1920).

Method of preparation.	Globe I. 564.88 cc.	Globe II. 455.77 cc.	Globe III. 351.91 cc.
2	(2.01666)	(2.01645)	(2.01858)
2	2.01775	2.02129	2.01915
2	2.01896	2.01901	2.02320
Average	2.01836	2.02015	2.02117
Average of all determinations			2.01986

Provisional calculation of the molecular weight of propane from the critical constants gave values for the atomic weight of carbon varying from 12.033 to 12.080 according to the method used. The author gives little weight to these results because of uncertainty as to the value of the critical constants.

Fluorine.—Moles and Batuecas[1] have determined the density of methyl fluoride. Two methods of preparation were used: (1) The action of potassium methyl sulfate on potassium fluoride; (2) the action of methyl iodide on silver fluoride. The product of both methods was fractionally distilled.

In the following table are given the weights of the normal liter determined at pressures in the neighborhood of one atmosphere.

Method of preparation.	Globe I. 793.68 cc.	Globe II. 619.35 cc.	Globe III. 220.26 cc.
I	1.54416	1.54371	1.54353
I	1.54286	....	1.54368
I	1.54161	....	....
I	1.54782	....	....
II	1.54782	....	1.54592
II	1.54586	1.54732	....
II	1.54425	....	....
II	1.54161	1.54600	1.54600
II	1.54350	1.54061	1.54336
II	1.54192	1.54629	1.54231
II	1.54222	1.54241	....
Average	1.54478	1.54520	1.54492
Average of all determinations			1.54489
Corrected for error in barometric scale			1.54542

Determinations made at pressures not far from two-thirds atmospheric gave the following results.

	Globe I.	Globe II.	Globe III.
	1.53452	1.53850	1.53174
	1.53633	1.53896	1.53142
	1.53652	1.53952	1.53093
	1.53534	1.53413	1.53338
	1.53723	1.53847	1.63683[a]
Average	1.53599	1.53792	1.53286
Average of all determinations			1.53559
Corrected for error in barometric scale			1.53611

[a] Probably 1.53683.

[1] Moles and Batuecas, *J. chim. phys.*, 17, 537 (1919).

At approximately one-third atmosphere the following figures were obtained.

	Globe I.	Globe II.	Globe III.
	1.52445	1.52445	....
	1.52669	1.52519	1.52480
	1.52819	1.52900	1.52846
Average	1.52644	1.52621	1.52663
Average of all determinations			1.52640
Corrected for error in barometric scale			1.52692

From the 3 values of the weight of the normal liter the value of $1 + \lambda$ at one atmosphere is computed to be 1.0181. Using as the weight of the normal liter of oxygen 1.42905 g. and as the deviation from Avogadro's rule 1.00097, the molecular weight of methyl fluoride is found to be 34.024, and the atomic weight of fluorine 19.001 (C = 12.000; H = 1.0077).

The weight of the normal liter of oxygen was determined with the same apparatus as that used in the methyl fluoride work.

	Globe I.	Globe II.	Globe III.
	1.42854	1.42930	1.42870
	1.42925	1.42935	1.42843
	....	1.42887	1.42827
Average	1.42890	1.42917	1.42847
Average of all determinations			1.42884
Corrected for error in barometric scale			1.42933

Using the latter value for oxygen the molecular weight of methyl fluoride is computed to be 34.018, and the atomic weight of fluorine 18.995. The authors prefer the average value 18.998. This agrees as well as could be expected with Smith and van Haagen's recent work.

Aluminum.—Richards and Krepelka[1] synthesized aluminum bromide from the purest bromine and aluminum containing only 0.3% of metallic impurities. After digestion in a current of nitrogen it was fractionally distilled in nitrogen and in a vacuum, the first and last fraction being discarded. The purified material was finally distilled into small sealed glass bulbs. Analysis by comparison with silver and silver bromide gave the following results. Weights are corrected to vacuum. Br = 79.916.

Wt. of $AlBr_3$.	Wt. of AgBr.	Wt. of Ag.	Ratio $AlBr_3 : 3Ag$.	At. wt. Al.
		Preliminary analysis.		
3.23784	6.83996	....	0.47337[a]	26.944
		Final analyses.		
5.03798	....	6.11324	0.824110	26.967
5.40576	....	6.55955	0.824105	26.965
3.41815	....	4.14786	0.824076	26.956
1.98012	....	2.40285	0.824071	26.954
		Average	0.824090	26.960
		Weighted Average	0.824098	26.963

[a] $AlBr_3 : 3AgBr$.

[1] Richards and Krepelka, THIS JOURNAL, **42**, 2221 (1920).

This result is 0.5% lower than the value adopted by the International Committee some time ago, 27.1.

Silicon.—Baxter, Weatherill and Holmes[1] fractionally distilled silicon tetrachloride, prepared by the action of chlorine on silicon, in a sealed and exhausted all-glass apparatus. Weighed glass bulbs containing the purified material were broken under sodium hydroxide solution and the solution was then compared with silver in the usual way. Vacuum weights are given. Cl = 35.457.

Fraction of $SiCl_4$.	Wt. of $SiCl_4$.	Wt. of Ag.	Ratio $SiCl_4$: 4Ag.	At. wt. Si.
12	10.43530	26.49523	0.393856	28.129
3	5.97853	15.18304	0.393764	28.089
9	8.79053	22.32131	0.393814	28.112
6	6.83524	17.35617	0.393828	28.114
			Average	28.111

Scandium.—Hönigschmid[2] converted scandium material, which had been purified by Meyer and Schweig[3] (I) and Sterba-Böhm (II) into bromide by sublimation in a current of bromine from a mixture of oxide and carbon. The sublimate was collected in the weighing tube without exposure to moisture and after being weighed was compared with silver. Weights are in vacuum. Br = 79.916.

SAMPLE I.

Wt. of $ScBr_3$.	Wt. of Ag.	At. wt. Sc.
2.79839	3.17972	45.079
3.32001	3.77235	45.084
3.34311	3.79829	45.108
3.22367	3.66250	45.114
3.11816	3.54255	45.120
2.32284	2.63915	45.103
2.13467	2.42519	45.122
1.96690	2.23460	45.120
	Average	45.105

SAMPLE II.

Wt. of $ScBr_3$.	Wt. of Ag.	At. wt. Sc.
3.13887	3.56645	45.091
2.92675	3.32529	45.103
3.14889	3.57784	45.090
2.79650	3.17719	45.113
2.80219	3.18371	45.108
2.62351	2.98093	45.087
2.59879	2.95270	45.100
2.60299	2.95768	45.080
2.37863	2.70257	45.099
1.41354	1.60630	45.054
	Average	45.093

[1] Baxter, Weatherill and Holmes, THIS JOURNAL, **42**, 1194 (1920).
[2] Hönigschmid, *Z. Elektrochem.*, **25**, 93 (1919).
[3] Meyer and Schweig, *Z. anorg. Chem.*, **108**, 313 (1919).

The average value 45.10 is a unit higher than the former International value.

Tin.—The complete papers by Baxter and Starkweather,[1] by Brauner and Krepelka[2] and by Krepelka[3] have been published. The data have already been included in the last 2 reports.

Tellurium.—Bruylants and Michielsen[4] purified by fractional distillation tellurium hydride which had been prepared by electrolysis of sulfuric acid with a tellurium cathode. The gas was weighed in closed tubes and after decomposition and combustion of the hydrogen the water was collected and weighed.

Wt. of TeH_2.	Wt. of H_2O.	Ratio Te : O.	At. wt. Te.
1.95150	0.27096	7.9833	127.73
0.79827	0.11078	7.9872	127.79
0.49887	0.06945	7.962	(127.4)

Samarium.—Owens, Balke and Kremers[5] purified samarium material by fractional crystallization of magnesium samarium double nitrate. After 180 series of crystallizations had been made bismuth nitrate was added and 190 additional series carried out. Extreme fractions were frequently rejected. Bismuth was removed as sulfide and the samarium converted to chloride through the oxalate and oxide. Finally the carefully dehydrated chloride was compared with silver.

Weights are corrected to vacuum. Cl = 35.46.

Fraction.	Wt. of $SaCl_3$.	Wt. of Ag.	Ratio $SaCl_3$: 3Ag.	At. wt. Sa.
42	6.47502	8.15810	0.793692	150.49
42	4.03877	5.08083	(0.794903)	(150.90)
43	4.25295	5.35928	0.793567	150.45
43	4.34537	5.47663	0.793442	150.41
44	3.84046	4.84002	0.793480	150.42
45	3.32317	4.18820	0.793460	150.42
32	2.96369	3.73504	0.793480	150.42
33	3.34818	4.21936	0.793527	150.44
34	3.27999	4.13333	0.793546	150.44
35	3.00394	3.78769	0.793396	150.40
36	2.36481	2.97970	0.793640	150.47
37	3.68616	4.64577	0.793444	150.41
38	3.17435	4.00020	0.793548	150.44
39	2.81639	3.54932	0.793501	150.43
40	3.13555	3.95155	0.793500	150.43
41	2.91019	3.66744	0.793520	150.44
42	4.15775	5.23973	0.793504	150.43
43	3.32505	4.18952	0.793650	150.47
44	2.06632	2.62950	0.793430	150.41
		Average	0.793518	150.43

[1] Baxter and Starkweather, THIS JOURNAL. **42**, 905 (1920).

[2] Brauner and Krepelka, *ibid.*, **42**, 917 (1920).

[3] Krepelka, *ibid.*, **42**, 925 (1920).

[4] Bruylants and Michielsen, Bull. acad. belg., *Classe Sci.*, **1919**, p. 119.

[5] Owens, Balke and Kremers, THIS JOURNAL, **42**, 515 (1920).

The average result is almost identical with the value recently found by James and Stewart by the same method.

Thulium.—James and Stewart[1] converted carefully fractionated thulium material[2] to chloride. The salt was carefully dehydrated, and after being weighed, was compared with silver in the standard fashion. Fraction A is the purest. Fractions B and C were known to contain neoytterbium. Vacuum weights are given. Cl = 35.457.

Fraction.	Wt. of $TmCl_3$.	Wt. of Ag.	Ratio $TmCl_3$: 3Ag.	At. wt. Tm.
A	2.17052	2.54671	0.85228	169.46
A	4.01446	4.71091	0.85216	169.42
Average			0.85222	169.44
B	2.03868	2.39060	0.85279	169.63
B	1.53851	1.80368	0.85299	169.69
Average			0.85289	169.66
C	2.35242	2.75573	0.85365	169.90

The lowest value is markedly higher than the one in current use, 168.5.

Radioactive Lead.—Richards and Sameshima[3] using the chloride-silver method, compared ordinary lead with lead from a deposit in a hot spring in Formosa containing radioactive elements.

	Wt. of $PbCl_2$.	Wt. of Ag.	Ratio $PbCl_2$: 2Ag.	At. wt. Pb.
Ordinary lead	3.13929	2.43553	1.28895	207.185
	3.09476	2.40100	1.28894	207.183
Average				207.184
Japanese lead	2.16756	1.68212	1.28859	207.11
	1.14536	0.88881	1.28864	207.12
	1.34496	1.04358	1.28879	207.15
Average				207.13

Thorium Lead.—Hönigschmid[4] has analyzed lead chloride prepared from lead extracted from Norwegian thorit of the following composition:

Th, 30.1%; U, 0.45%; Pb, 0.35%.

Wt. of $PbCl_2$.	Wt. of Ag.	Wt. of AgCl.	At. wt. Pb.
2.31995	1.79545	....	207.88
2.32639	....	2.39194	207.90
2.31995	....	2.38516	207.92
		Average	207.90

Lead was extracted also from 3 specimens of thorianite, probably from Ceylon.

[1] James and Stewart, This Journal, **42,** 2022 (1920).

[2] *Ibid.*, **33,** 1332 (1911).

[3] Richards and Sameshima, *ibid.*, **42,** 928 (1920).

[4] Hönigschmid, *Z. Elektrochem.*, **25,** 91 (1919). This work was noted in the 26th annual report, but without the detailed data.

	ThO_2. %	UO_2. %	Pb. %
I	68.9	11.8	2.3
II	62.7	20.2	3.1
III	57.0	26.8	3.5

Sample.	Wt. of $PbCl_2$.	Wt. of Ag.	Wt. of AgCl.	At. wt. Pb.
I	3.55514	2.75795	....	207.21
	4.85116	3.76332	....	207.21
	2.70841	....	2.79196	207.18
	3.55514	....	3.66408	207.24
	4.85116	....	5.00011	207.22
			Average	207.21
II	3.08009	2.39231	....	206.88
	4.18353	3.24896	....	206.91
	2.39883	....	3.50716	206.91
	3.08009	....	3.17832	206.90
	4.13353	....	4.31608	206.96
			Average	206.91
III	4.75163	3.69124	....	206.83

The values to be expected from the relative proportions of uranium and thorium are: (I) 207.26–.45; (II) 206.75–.98; (III) 206. 79–.99.

Bismuth.—Hönigschmid[1] has redetermined the atomic weight of bismuth by analysis of the chloride. Several specimens of carefully purified bismuth metal were converted to chloride in an atmosphere of dry chlorine, and the salt, after sublimation in a current of nitrogen in a weighed quartz tube, was transferred to a weighing bottle without exposure to moisture. Analysis by comparison with silver and silver chloride followed. Since it was necessary to dissolve the salt in 3 *N* nitric acid to avoid hydrolysis, comparative experiments with potassium chloride were carried out to show that this procedure was not attended with loss of chlorine or occlusion of silver nitrate. Weights are reduced to vacuum. Cl = 35.457.

	Wt. of KCl.	Wt. of AgCl.	At. wt. K.
Acid	3.52723	6.78151	39.096
Acid	4.12307	7.92696	39.097
Neutral	4.14578	7.97062	39.097

Preliminary series.

Sample.	Wt. of $BiCl_3$.	Wt. of AgCl.	Ratio $BiCl_3$: 3AgCl.	At. wt. Bi.
1	4.85142	6.61496	0.733401	209.000
1	3.48631	4.75395	0.733350	208.978
1	5.49138	7.48790	0.733367	208.985
1	3.81900	5.20711	0.733420	209.008
1	3.77786	5.15091	0.733435	209.014
Total	21.42597	29.21483	0.733395	208.997

[1] Hönigschmid, *Z. Elektrochem.*, **26**, 403 (1920).

Final series.

Sample.	Wt. of $BiCl_3$.	Wt. of Ag.	Ratio $BiCl_3 : 3Ag$.	At. wt. Bi.
1	3.29894	3.38522	0.974513	209.020
1	3.54331	3.63594	0.974524	209.024
1	4.74125	4.86523	0.974517	209.022
1	2.64020	2.70934	0.974481	209.010
1	4.49476	4.61203	0.974573	209.040
1	5.19912	5.33506	0.974519	209.022
2	4.99471	5.12542	0.974498	209.015
2	5.29284	5.43129	0.974509	209.019
2	4.62983	4.75076	0.974545	209.031
2	5.67213	5.82053	0.974504	209.017
5	5.69460	5.84367	0.974490	209.013
5	5.96312	6.11923	0.974489	209.012
4*b*	6.24054	6.40379	0.974507	209.019
2	6.30709	6.47219	0.974491	209.013
Total	68.71244	70.50970	0.974508	209.020

Sample.	Wt. of $BiCl_3$.	Wt. of AgCl.	Ratio $BiCl_3 : 3AgCl$.	At. wt. Bi.
1	3.29894	4.49789	0.733442	209.022
1	3.54331	4.83067	0.733503	209.043
1	4.74125	6.46455	0.733423	209.009
1	2.64020	3.59956	0.733479	209.033
1	4.49476	6.12841	0.733430	209.012
1	5.19912	7.08896	0.733411	209.004
1	4.36220	5.94742	0.733461	209.025
1	4.42249	6.02960	0.733463	209.026
3	4.82566	6.57976	0.733408	209.003
2	4.99471	6.80969	0.733471	209.030
2	5.29284	7.21652	0.733434	209.014
2	4.62983	6.31252	0.733436	209.015
2	5.67213	7.73383	0.733418	209.007
5	5.69460	7.76479	0.733388	208.994
5	5.96312	8.13087	0.733393	208.996
4	5.57877	7.60652	0.733419	209.007
4*b*	6.24054	8.50911	0.733395	208.997
2	6.30709	8.60003	0.733380	208.990
Total	87.90156	119.85070	0.733431	209.013

The rounded average, 209.02, is 1.02 unit, or almost 0.5% higher than the value in use at the present time, 208.0.

Wourtzel[1] discusses the application of the method of limiting densities to the determination of the molecular weights of easily liquefiable gases, with special reference to sulfur dioxide.

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[1] Wourtzel, *J. chim. phys.*, **18**, 150 (1920).