CHEMICAL CALCULATION TABLES

HORACE L. WELLS

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FOR LABORATORY USE

BY

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SECOND EDITION, REVISED
WITH
A DOUBLE THUMB-INDEXED
LOGARITHM TABLE

NEW YORK
JOHN WILEY & SONS, Inc.
London: CHAPMAN & HALL, Limited
1919

Univ. Farm Income

Stanhope Press
F. H. GILSON COMPANY
BOSTON, U.S.A.

PREFACE

This book of tables for every day use in the chemical laboratory is a revision and modification of my "Tables for Chemical Calculations" published about 16 years ago, and now out of print. The changes in our official atomic weights have made necessary a complete revision of most of the tables. A new table for facilitating the calculation of percentage compositions of organic compounds has been added, while, in order to make the book more compact and thus more convenient for its chief uses, several of the smaller, less important tables have been omitted, while the matter relating to the explanation of the tables and the illustration of their uses has been either left out or much changed and abbreviated.

The table of logarithms of numbers has been provided with a double thumb-index which is believed to be a novel and useful device. With this improvement one can turn from any place in the table to any other reference, backward as well as forward, by practically a single motion, since all indices are visible from every part of the table.

The greatest care has been used to secure accuracy in the data by the duplication, at least, of their derivation, with a complete verification after the plates were cast.

There is no doubt that accurate calculation is exceedingly important in connection with quantitative analysis and other kinds of chemical work, and it is believed that these tables will be of assistance in avoiding errors of calculation, as well as in making the work more rapid and less laborious than is often the case.

H. L. W.

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INTRODUCTION

Five-place logarithms have been adopted in this book because they are satisfactory in usually introducing no inherent errors of calculation into the results obtained from the four-figure and five-figure numbers frequently used as data in chemical computations.

It is true that four-place logarithms will give amply accurate results for a great deal of analytical work, but as these are liable to give incorrect fourth figures in some cases the longer logarithms are to be preferred for general use. It is easy to use these with the conveniently indexed table here supplied, and they have the additional advantage that, since usually only four figures at the most are significant in the results of analytical work, these can be taken from the nearest logarithm without the trouble of interpolating for a fifth figure.

Computers should appreciate, and apply in carrying out their figures, the effects upon their results of the apparent errors of the approximate numbers employed. For general guidance in this matter the following rule may be given: Take as a basis the *smallest* number of apparently reliable figures in any of the approximate numbers used by multiplication and division (not including addition and subtraction) in producing the result. Then, if the number used for the basis begins with a smaller figure than does the result, the number of figures to be preserved in the result will usually be *equal to the basis,* while if the reverse is true in regard to the first figures the number of figures to be considered significant in the result will usually be *one more than the basis.* It should be borne in mind that zeros at the end of decimals may be apparently reliable. For example:

a. 23.00-- × 2.5417-- = 58.46-- (not 58.5 nor 58.459)
b. 0.0089-- × 0.16598-- = 0.00148-- (not 0.0015 nor 0.001475)
c. 0.2301-- ÷ 2.5600-- = 0.08988-- (not 0.0899 nor 0.89883)
d. $\dfrac{0\ 0018\,g \times 0.8034\ \text{(factor)} \times 100}{1.6500\,g\ \text{(substance)}} = 0.088\%\ \text{(not } 0.0876\%\text{)}$

This rule is by no means an absolute one, and it should be modified according to judgment. For instance, in the example *d* given above, since 88 is so much larger than the 18 from which it is derived, it might well be preferred to call the result 0.09%. In some cases it is desirable to preserve a very uncertain last figure, while in other instances it is best to omit it, but it is very bad practice to report more than one evidently uncertain figure, or to leave off or fail to calculate one or more apparently accurate ones. Attention may be called here to the importance of adding a unit to the preceding figure when a figure greater than 5 is left off.

For a more extensive discussion of the use of approximate numbers in calculations, the author's "Text Book of Chemical Arithmetic" may be referred to.

In order that accidental errors of calculation may be avoided it is recommended that entirely independent duplications of all calculations should be carried out, for mistakes are not always discovered by simply looking over the work.

In Tables II and III the logarithms are generally given, for the sake of uniformity, as though the atomic weights were exact, instead of approximate, numbers. For instance, a five-place logarithm is given for the atomic weight of boron, 11.0 – –, just as though it were known to be 11.000. This feature need cause no trouble as far as the gravimetric factors are concerned, since the latter are practically always more accurate than the data to which they are applied, and hence they need not be considered in deciding upon the significant figures of the results of ordinary calculations.

The numerical formula weights in Table III in some cases have an uncertain last figure.

For example, in the addition

$$\begin{array}{lr} \text{Hg} & 200.6 \\ \text{S} & 32.06 \\ \hline & 232.66 \end{array}$$

the last figure in the sum is uncertain because it has been obtained by addition to an unknown (plus or minus) figure. It has been preferred in most cases to retain such uncertain figures, since leaving them off and giving, for instance, HgS as 232.7 would be liable to decrease the accuracy of such formula-weights. In using these numbers for calculations it will usually make no difference whether or not the final figures are apparently accurate, but a glance at the atomic weights will show which is the case.

The student should observe that many of the numerical factors in Table II, when multiplied by 100, give percentages of constituents, and that they may often be conveniently used in this way. For example, $NaCl \rightarrow Na = 0.39444$ shows that $NaCl$ contains 39.44% of Na and 60.56% of Cl. Since the factor 0.39444 is derived from 23.00 – –, its last figure is uncertain and has not been used in giving the percentages (compare the rule previously given).

It should be stated that the value 0.0012510 g. was adopted in Table VI as the weight of 1 cc. of nitrogen gas at 41° latitude, instead of the value 0.0012514 g. at 45° because the former latitude is more suitable for general reference in the United States, but that the change makes a difference of only about one part in 3000 and is entirely inappreciable in nitrogen determinations by the Dumas method.

TABLE I.

ATOMIC WEIGHTS.*

O = 16.

Aluminium	Al	27.1
Antimony	Sb	120.2
Argon	A	39.88
Arsenic	As	74.96
Barium	Ba	137.37
Beryllium (Glucinum)	Be	9.1
Bismuth	Bi	208.0
Boron	B	11.0
Bromine	Br	79.92
Cadmium	Cd	112.40
Cæsium	Cs	132.81
Calcium	Ca	40.07
Carbon	C	12.005
Cerium	Ce	140.25
Chlorine	Cl	35.46
Chromium	Cr	52.0
Cobalt	Co	58.97
Copper	Cu	63.57
Dysprosium	Dy	162.5
Erbium	Er	167.7
Europium	Eu	152.0
Fluorine	F	19.0
Gadolinium	Gd	157.3
Gallium	Ga	69.9
Germanium	Ge	72.5
Gold	Au	197.2
Helium	He	4.00
Holmium	Ho	163.5
Hydrogen	H	1.008
Indium	In	114.8
Iodine	I	126.92
Iridium	Ir	193.1
Iron	Fe	55.84
Krypton	Kr	82.92
Lanthanum	La	139.0
Lead	Pb	207.20
Lithium	Li	6.94
Lutecium	Lu	175.0
Magnesium	Mg	24.32
Manganese	Mn	54.93
Mercury	Hg	200.6
Molybdenum	Mo	96.0
Neodymium	Nd	144.3
Neon	Ne	20.2
Nickel	Ni	58.68
Niobium (Columbium)	Nb	93.1
Niton	Nt	222.4
Nitrogen	N	14.01
Osmium	Os	190.9
Oxygen	O	16.00
Palladium	Pd	106.7
Phosphorus	P	31.04
Platinum	Pt	195.2
Potassium	K	39.10
Praseodymium	Pr	140.9
Radium	Ra	226.0
Rhodium	Rh	102.9
Rubidium	Rb	85.45
Ruthenium	Ru	101.7
Samarium	Sm	150.4
Scandium	Sc	44.1
Selenium	Se	79.2
Silicon	Si	28.3
Silver	Ag	107.88
Sodium	Na	23.00
Strontium	Sr	87.63
Sulphur	S	32.06
Tantalum	Ta	181.5
Tellurium	Te	127.5
Terbium	Tb	159.2
Thallium	Tl	204.0
Thorium	Th	232.4
Thulium	Tm	168.5
Tin	Sn	118.7
Titanium	Ti	48.1
Tungsten	W	184.0
Uranium	U	238.2
Vanadium	V	51.0
Xenon	X	130.2
Ytterbium	Yb	173.5
Yttrium	Yt	88.7
Zinc	Zn	65.37
Zirconium	Zr	90.6

$CO_3^{=} + H_2O \rightleftharpoons HCO_3^- + OH^-$

$[OH^-] = \sqrt{K}$ [illegible]

$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

$[H^+] = \sqrt{K_1 C_{acid}}$

$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$

$HCO_3^- + H_3O^+ \rightarrow H_2CO_3$

$HOH \rightleftharpoons H^+ + OH^-$

$[H^+] = \sqrt{K_1 K_2}$

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* This is the latest International Table.

TABLE II.

GRAVIMETRIC FACTORS.

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
Aluminium, 27.1	Al_2O_3	Al_2	.5303	.72 455
	Al_2	Al_2O_3	1.886	.27 545
	$AlPO_4$	$(\frac{1}{2})Al_2O_3$	.4184	.62 156
Antimony, 120.2	Sb_2O_4	Sb_2	.7898	.89 749
	Sb_2O_4	Sb_2O_3	.9475	.97 656
	Sb_2O_4	Sb_2O_5	1.0526	.02 225
	Sb_2S_3	Sb_2	.7142	.85 384
	Sb_2S_3	Sb_2O_3	.8569	.93 291
	Sb_2S_3	Sb_2O_5	.9519	.97 860
	Sb_2	Sb_2O_3	1.1997	.07 907
	Sb_2	Sb_2O_5	1.3328	.12 476
Arsenic, 74.96	As_2S_3	As_2	.6092	.78 475
	As_2S_3	As_2O_3	.8042	.90 538
	As_2S_3	As_2O_5	.9343	.97 047
	As_2S_3	$(2)AsO_4$	1.1293	.05 281
	As_2S_5	As_2	.4833	.68 419
	$Mg_2As_2O_7$	As_2	.4827	.68 372
	$Mg_2As_2O_7$	As_2O_3	.6373	.80 435
	$Mg_2As_2O_7$	As_2O_5	.7403	.86 944
	$Mg_2As_2O_7$	$(2)AsO_4$	.8949	.95 178
	Ag_3AsO_4	As	.1620	.20 962
	As_2	As_2O_3	1.3202	.12 063
	As_2	As_2O_5	1.5336	.18 572
Barium, 137.37	$BaSO_4$	Ba	.5885	.76 973
	$BaSO_4$	BaO	.6570	.81 758
	$BaCrO_4$	Ba	.5422	.73 413
	$BaCrO_4$	BaO	.6053	.78 198
	$BaCO_3$	Ba	.6960	.84 260
	$BaCO_3$	BaO	.7770	.89 045
	Ba	BaO	1.1165	.04 785
Bismuth, 208.0	Bi_2O_3	Bi_2	.8965	.95 257
	BiOCl	Bi	.8017	.90 399
	BiOCl	$(\frac{1}{2})Bi_2O_3$	.8942	.95 142

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
	Bi_2S_3	Bi_2	.8122	.90 967
	Bi_2S_3	Bi_2O_3	.9059	.95 710
	Bi_2	Bi_2O_3	1.1154	.04 743
Boron, 11.0	B_2O_3	B_2	.3143	.49 732
	B_2	B_2O_3	3.182	.50 268
Bromine, 79.92	AgBr	Br	.42556	.62 896
	AgBr	HBr	.43092	.63 440
	Br—Cl	Br	1.7976	.25 469
	Br—Cl	AgBr	4.2241	.62 573
	Br	$(\frac{1}{2})O$	.1001	.00 043
Cadmium, 112.40	CdO	Cd	.8754	.94 220
	CdS	Cd	.7781	.89 102
	CdS	CdO	.8888	.94 882
	Cd	CdO	1.1424	.05 780
Cæsium, 132.81	Cs_2SO_4	Cs_2	.7344	.86 593
	Cs_2PtCl_6	Cs_2	.3943	.59 587
	Cs_2	Cs_2O	1.0602	.02 540
Calcium, 40.07	CaO	Ca	.71465	.85 409
	CaO	$CaCO_3$	1.7848	.25 159
	$CaSO_4$	Ca	.2944	.46 886
	$CaSO_4$	CaO	.4119	.61 477
	$CaCO_3$	Ca	.4004	.60 250
	$CaCO_3$	CaO	.5603	.74 840
	Ca	CaO	1.3993	.14 591
	Ca	$CaCO_3$	2.4975	.39 750
	CaO	$CaSO_4$	2.4279	.38 523
Carbon, 12.005	$BaCO_3$	CO_2	.2229	.34 820
	$CaCO_3$	CO_2	.4397	.64 318
	CO_2	C	.2728	.43 586
	C	CO_2	3.6656	.56 414
	CO_2	CO_3	1.3636	.13 468
Chlorine, 35.46	AgCl	Cl	.24738	.39 337
	AgCl	HCl	.2544	.40 555
	Ag	Cl	.3287	.51 680
	Cl	$(\frac{1}{2})O$	.2256	.35 335
	AgCl	$(\frac{1}{2})O$	.05581	.74 672

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
Chromium, 52.0	Cr_2O_3	Cr_2	.6842	.83 519
	Cr_2O_3	$(2)CrO_3$	1.3158	.11 919
	$PbCrO_4$	Cr	.1609	.20 653
	$PbCrO_4$	$(\frac{1}{2})Cr_2O_3$	.2351	.37 134
	$PbCrO_4$	CrO_3	.3094	.49 053
	Cr_2	Cr_2O_3	1.462	.16 481
	Cr	CrO_3	1.923	.28 400
Cobalt, 58.97	$CoSO_4$	Co	.3804	.58 022
	Co_3O_4	Co_3	.7343	.86 589
	Co	CoO	1.2713	.10 426
Copper, 63.57	CuO	Cu	.7989	.90 250
	Cu	CuO	1.2517	.09 750
	Cu_2S	Cu_2	.7986	.90 234
	Cu_2S	$(2)CuO$	.9996	.99 984
	$CuSCN$	Cu	.5226	.71 815
	$CuSCN$	CuO	.6541	.81 565
Cyanogen, 26.015	$AgCN$	CN	.1943	.28 846
	Ag	CN	.2411	.38 228
Fluorine, 19.0	CaF_2	F_2	.4867	.68 730
	SiF_4	F_4	.7287	.86 253
Hydrogen, 1.008	H_2O	H_2	.1119	.04 884
Iodine, 126.92	AgI	I	.5405	.73 283
	PdI_2	I_2	.7041	.84 760
	$I{-}Cl$	I	1.3877	.14 230
	$I{-}Cl$	AgI	2.5672	.40 947
Iron, 55.84	Fe_2O_3	Fe_2	.6994	.84 473
	Fe_2O_3	$(2)FeO$	.8998	.95 415
	Fe_2O_3	$(2)FeS_2$	1.5025	.17 682
	FeS	Fe	.6353	.80 296
	Fe	FeO	1.2865	.10 942
	Fe_2	Fe_2O_3	1.4298	.15 527
Lead, 207.20	$PbSO_4$	Pb	.6833	.83 458
	$PbSO_4$	PbO	.7360	.86 688
	$PbSO_4$	PbS	.7890	.89 706
	$PbCrO_4$	Pb	.6411	.80 692
	$PbCrO_4$	PbO	.6906	.83 922

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
	PbS	Pb	.8660	.93 752
	PbS	PbO	.9329	.96 982
	$PbCl_2$	Pb	.7450	.87 216
	PbO	Pb	.9283	.96 770
	Pb	PbO	1.0772	.03 230
Lithium, 6.94	Li_2SO_4	Li_2	.1263	.10 123
	Li_2SO_4	Li_2O	.2718	.43 422
	Li_3PO_4	Li_3	.1797	.25 455
	Li_2	Li_2O	2.153	.33 299
Magnesium, 24.32	$Mg_2P_2O_7$	Mg_2	.2184	.33 923
	$Mg_2P_2O_7$	(2)MgO	.3621	.55 879
	$Mg_2P_2O_7$	(2)$MgCO_3$	.7572	.87 923
	$MgSO_4$	Mg	.2020	.30 541
	$MgSO_4$	MgO	.3349	.52 497
	MgO	Mg	.6032	.78 044
	MgO	$MgCO_3$	2.0914	.32 044
	Mg	MgO	1.6579	.21 956
Manganese, 54.93	$Mn_2P_2O_7$	Mn_2	.3869	.58 761
	$Mn_2P_2O_7$	(2)MnO	.4996	.69 863
	Mn_3O_4	(3)Mn	.7203	.85 749
	Mn_3O_4	(3)MnO	.9301	.96 851
	MnS	Mn	.6315	.80 034
	MnS	MnO	.8154	.91 136
	$MnSO_4$	Mn	.3638	.56 086
	$MnSO_4$	MnO	.4698	.67 188
	MnO	MnO_2	1.2256	.08 834
	Mn	MnO	1.2913	.11 102
	Mn	MnO_2	1.5826	.19 936
Mercury, 200.6	HgS	Hg	.8622	.93 561
	HgS	HgO	.9310	.96 894
	$HgCl$	Hg	.8498	.92 931
	$HgCl$	HgO	.9176	.96 264
	Hg	HgO	1.0798	.03 333
Molybdenum, 96.0	MoO_3	Mo	.6667	.82 391
	$PbMoO_4$	MoO_3	.3922	.59 346
Nickel, 58.68	$NiSO_4$	Ni	.3792	.57 889

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
	NiO	Ni	.7858	.89 529
	Ni	NiO	1.2727	.10 471
Nitrogen, 14.01	NH_4Cl	N	.2619	.41 807
	NH_4Cl	NH_3	.3184	.50 294
	NH_4Cl	NH_4	.3372	.52 792
	$(NH_4)_2PtCl_6$	$(2)N$	.06310	.80 005
	$(NH_4)_2PtCl_6$	$(2)NH_3$	.07672	.88 492
	$(NH_4)_2PtCl_6$	$(2)NH_4$	.08126	.90 990
	$(NH_4)_2PtCl_6$	$(2)NH_4Cl$	.2410	.38 198
	Pt	$(2)N$	.1435	.15 699
	Pt	$(2)NH_3$	.1745	.24 186
	Pt	$(2)NH_4$	.1849	.26 684
	N	NH_3	1.216	.08 487
	NH_3	N	.8225	.91 513
	N	$(\frac{1}{2})(NH_4)_2O$	1.859	.26 923
	N	$(\frac{1}{2})(NH_4)_2SO_4$	4.716	.67 357
	N	$(\frac{1}{2})N_2O_5$	3.855	.58 603
	N	NO_3	4.426	.64 602
	N	NO_2	3.284	.51 641
	N	NO	2.142	.33 083
Phosphorus, 31.04	$Mg_2P_2O_7$	P_2	.2787	.44 519
	$Mg_2P_2O_7$	P_2O_5	.6379	.80 477
	$Mg_2P_2O_7$	$(2)PO_4$	.8534	.93 117
	$FePO_4$	$(\frac{1}{2})P_2O_5$	.4708	.67 287
	$U_2P_2O_{11}$	P_2O_5	.1989	.29 854
	P_2O_5	P_2	.4369	.64 042
	P_2	P_2O_5	2.289	.35 958
Platinum, 195.2	$(NH_4)_2PtCl_6$	Pt	.4396	.64 306
Potassium, 39.10	KCl	K	.52441	.71 967
	KCl	$(\frac{1}{2})K_2O$	.63170	.80 051
	K_2SO_4	K_2	.44876	.65 201
	K_2SO_4	K_2O	.54056	.73 285
	K_2PtCl_6	K_2	.1609	.20 643
	K_2PtCl_6	K_2O	.1938	.28 727
	K_2PtCl_6	$(2)KCl$	.3067	.48 676
	$KClO_4$	K	.2822	.45 054

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
	$KClO_4$	$(\frac{1}{2})K_2O$	.3399	.53 138
	$KClO_4$	KCl	.5381	.73 087
	K	$(\frac{1}{2})K_2O$	1.2046	.08 084
Rubidium, 85.45	Rb_2SO_4	Rb_2	.6402	.80 629
	Rb_2PtCl_6	Rb_2	.2952	.47 017
	Rb	$(\frac{1}{2})Rb_2O$	1.0936	.03 887
Selenium, 79.2	Se	SeO_2	1.4040	.14 737
	Se	SeO_3	1.6060	.20 576
Silicon, 28.3	SiO_2	Si	.4693	.67 147
	SiO_2	SiO_3	1.265	.10 220
	SiO_2	$(\frac{1}{2})Si_2O_7$	1.398	.14 551
	SiO_2	SiO_4	1.531	.18 488
	Si	SiO_2	2.131	.32 853
Silver, 107.88	$AgCl$	Ag	.75262	.87 657
	$AgCl$	$(\frac{1}{2})Ag_2O$	.80842	.90 764
	$AgBr$	Ag	.57444	.75 924
	AgI	Ag	.45945	.66 224
	Ag_2	Ag_2O	1.0742	.03 107
Sodium, 23.00	$NaCl$	Na	.39344	.59 487
	$NaCl$	$(\frac{1}{2})Na_2O$	.53028	.72 450
	Na_2SO_4	Na_2	.32381	.51 029
	Na_2SO_4	Na_2O	.43644	.63 992
	Na_2CO_3	Na_2	.43394	.63 743
	Na_2CO_3	Na_2O	.58487	.76 706
	Na	$(\frac{1}{2})Na_2O$	1.3478	.12 963
Strontium, 87.63	$SrSO_4$	Sr	.4770	.67 856
	$SrSO_4$	SrO	.5642	.75 140
	$SrCO_3$	Sr	.5936	.77 346
	$SrCO_3$	SrO	.7019	.84 630
	Sr	SrO	1.1826	.07 284
Sulphur, 32.06	$BaSO_4$	S	.13734	.13 780
	$BaSO_4$	SO_2	.27443	.43 843
	$BaSO_4$	SO_3	.34298	.53 526
	$BaSO_4$	SO_4	.41151	.61 438
	$BaSO_4$	H_2SO_4	.42015	.62 340
	S	SO_2	1.9981	.30 063

			Multiply by Factor.	
	Given.	Sought.	N.	Log.
	S	SO_3	2.4972	.39 746
	S	H_2SO_4	3.0591	.48 560
Tellurium, 127.5	Te	TeO_2	1.2510	.09 725
	Te	TeO_3	1.3765	.13 877
Thallium, 204.0	TlI	Tl	.6165	.78 990
	Tl_2PtCl_6	Tl_2	.5000	.69 899
	Tl_2	Tl_2O	1.0392	.01 671
Thorium, 232.4	ThO_2	Th	.8790	.94 398
Tin, 118.7	SnO_2	Sn	.7877	.89 634
	Sn	SnO_2	1.2696	.10 366
Titanium, 48.1	TiO_2	Ti	.6005	.77 852
Tungsten, 184.0	WO_3	W	.7931	.89 933
Uranium, 238.2	U_3O_8	U_3	.8481	.92 844
	U_3O_8	$(3)UO_2$	.9620	.98 319
Vanadium, 51.0	V_2O_5	V_2	.5604	.74 853
	V_2	V_2O_5	1.784	.25 147
	V	VO_4	2.255	.35 313
Zinc, 65.37	ZnO	Zn	.8034	.90 492
	ZnS	Zn	.6710	.82 669
	ZnS	ZnO	.8352	.92 177
	$Zn_2P_2O_7$	Zn_2	.4289	.63 237
	$Zn_2P_2O_7$	(2)ZnO	.5339	.72 745
	Zn	ZnO	1.2447	.09 508
Zirconium, 90.6	ZrO_2	Zr	.7390	.86 864

TABLE III.

FORMULA = WEIGHTS

Formula.	Weight.	Log.
Ag	107.88	.03 294
Ag_2	215.76	.33 397
Ag_3	323.64	.51 007
Ag_3AsO_4	462.60	.66 521
AgBr	187.80	.27 370
AgCN	133.895	.12 676
AgCl	143.34	.15 637
AgI	234.80	.37 070
$AgIO_3$	282.80	.45 148
$AgNO_3$	169.89	.23 017
Ag_2O	231.76	.36 504
$\frac{1}{2}Ag_2O$	115.88	.06 401
Ag_3PO_4	418.68	.62 188
Ag_2S	247.82	.39 414
Al	27.1	.43 297
Al_2	54.2	.73 400
$AlCl_3$	133.48	.12 542
$AlCl_3{\cdot}6H_2O$	241.58	.38 306
$AlK(SO_4)_2{\cdot}12H_2O$	474.51	.67 625
$AlNH_4(SO_4)_2{\cdot}12H_2O$	453.45	.65 653
$AlNa_3F_6$	210.10	.32 243
Al_2O_3	102.2	.00 945
$\frac{1}{2}Al_2O_3$	51.1	.70 842
$AlPO_4$	122.14	.08 686
$Al_2(SO_4)_3$	342.38	.53 451
$Al_2(SO_4)_3{\cdot}18H_2O$	666.67	.82 391
As	74.96	.87 483
As_2	149.92	.17 586
$AsCl_3$	181.34	.25 850
As_2O_3	197.92	.29 649
$\frac{1}{2}As_2O_3$	98.96	.99 546
$\frac{1}{4}As_2O_3$	49.48	.69 443
As_2O_5	229.92	.36 158
$\frac{1}{2}As_2O_5$	114.96	.06 055
AsO_4	138.96	.14 289
As_2O_8	277.92	.44 392
As_2S_3	246.10	.39 111
As_2S_5	310.22	.49 167
Au	197.2	.29 491
$AuCl_3{\cdot}2H_2O$	339.61	.53 098
B	11.0	.04 139
B_2	22.0	.34 242
B_2O_3	70.0	.84 510
Ba	137.37	.13 789
$BaCO_3$	197.375	.29 530
$BaCl_2$	208.29	.31 867
$BaCl_2{\cdot}2H_2O$	244.32	.38 796
$BaCrO_4$	253.37	.40 376
$Ba(NO_3)_2$	261.39	.41 729
BaO	153.37	.18 574
BaO_2	169.37	.22 884
$BaO_2{\cdot}8H_2O$	313.50	.49 624
$Ba(OH)_2{\cdot}8H_2O$	315.51	.49 901
$BaSO_4$	233.43	.36 816
Be	9.1	.95 904
BeO	25.1	.39 967
Bi	208.0	.31 806
Bi_2	416.0	.61 909
Bi_2O_3	464.0	.66 652
$\frac{1}{2}Bi_2O_3$	232.0	.36 549
BiOCl	259.46	.41 407
$Bi(OH)_2NO_3$	304.03	.48 291
Bi_2S_3	512.18	.70 942
Br	79.92	.90 266
Br_2	159.84	.20 369
Br_3	239.76	.37 978
Br_4	319.68	.50 472
Br_5	399.60	.60 163
Br_6	479.52	.68 081
C	12.005	.07 936
C_2	24.01	.38 039
CH_3	15.03	.17 696
CH_4	16.04	.20 520
C_2H_2	26.03	.41 547
C_2H_5	29.05	.46 315
C_6H_6	78.08	.89 254

Formula.	Weight.	Log.
$C_2H_3O_2$	59.03	.77 107
$C_4H_4O_6$	148.05	.17 041
CN	26.015	.41 522
CNS	58.08	.76 403
CO	28.005	.44 724
CO_2	44.005	.64 350
CO_3	60.005	.77 818
C_2O_4	88.01	.94 453
CON_2H_4	60.06	.77 859
CS_2	76.13	.88 156
Ca	40.07	.60 282
CaC_2	64.08	.80 672
$CaCO_3$	100.08	.00 035
$CaCl_2$	110.99	.04 528
$CaCl_2\cdot 6H_2O$	219.09	.34 062
$CaCl_2O$	126.99	.10 377
CaF_2	78.07	.89 248
CaO	56.07	.74 873
$Ca(OH)_2$	74.09	.86 976
$Ca_3(PO_4)_2$	310.29	.49 177
$CaSO_4$	136.13	.13 396
$CaSO_4\cdot 2H_2O$	172.16	.23 593
$CaSiO_3$	116.37	.06 584
Cd	112.40	.05 077
$CdCO_3$	172.41	.23 657
$CdCl_2\cdot 2H_2O$	219.35	.34 114
$Cd(NO_3)_2\cdot 4H_2O$	308.48	.48 922
CdO	128.40	.10 857
CdS	144.46	.15 975
$CdSO_4$	208.46	.31 903
$CdSO_4\cdot 2\frac{2}{3}H_2O$	256.50	.40 909
Ce	140.25	.14 690
Ce_2O_3	328.50	.51 654
CeO_2	172.25	.23 616
Cl	35.46	.54 974
Cl_2	70.92	.85 077
Cl_3	106.38	.02 686
Cl_4	141.84	.15 180
Cl_5	177.30	.24 871
Cl_6	212.76	.32 789
ClO	51.46	.71 147

Formula.	Weight.	Log.
ClO_3	83.46	.92 148
ClO_4	99.46	.99 765
Cl_2O_5	150.92	.17 875
Cl_2O_7	182.92	.26 226
Co	58.97	.77 063
$CoCl_2\cdot 6H_2O$	237.99	.37 656
$Co(NO_3)_2\cdot 6H_2O$	291.09	.46 402
CoO	74.97	.87 489
Co_3O_4	240.91	.38 186
$CoSO_4$	155.03	.19 041
$CoSO_4\cdot 7H_2O$	281.14	.44 892
Cr	52.0	.71 600
Cr_2	104.0	.01 703
Cr_2O_3	152.0	.18 184
CrO_3	100.0	.00 000
CrO_4	116.0	.06 446
Cr_2O_7	216.0	.33 445
Cs	132.81	.12 323
Cs_2	265.62	.42 426
$CsAl(SO_4)_2\cdot 12H_2O$	568.22	.75 452
$CsCl$	168.27	.22 601
Cs_2O	281.62	.44 966
Cs_2PtCl_6	673.58	.82 839
Cs_2SO_4	361.68	.55 833
Cu	63.57	.80 325
Cu_2	127.14	.10 428
$CuCl$	99.03	.99 577
$CuCl_2$	134.49	.12 869
$CuCl_2\cdot 2H_2O$	170.52	.23 177
CuI	190.49	.27 987
$CuFeS_2$	183.53	.26 371
$Cu(NO_3)_2\cdot 6H_2O$	295.69	.47 083
CuO	79.57	.90 075
Cu_2O	143.14	.15 576
Cu_2S	159.20	.20 194
$CuSCN$	121.65	.08 511
$CuSO_4$	159.63	.20 311
$CuSO_4\cdot 5H_2O$	249.71	.39 744
Fe	55.84	.74 695
Fe_2	111.68	.04 798

Formula.	Weight.	Log.
Fe_3	167.52	.22 406
$FeCO_3$	115.85	.06 390
$FeCl_3$	162.22	.21 010
$FeCl_3 \cdot 6H_2O$	270.32	.43 188
$Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$	392.14	.59 344
$FeNH_4(SO_4)_2 \cdot 12H_2O$	482.19	.68 322
FeO	71.84	.85 637
Fe_2O_3	159.68	.20 325
$\frac{1}{2}Fe_2O_3$	79.84	.90 222
Fe_3O_4	231.52	.36 459
FeS	87.90	.94 399
FeS_2	119.96	.07 904
$FeSO_4 \cdot 7H_2O$	278.01	.44 406
H	1.008	.00 346
H_2	2.016	.30 449
H_3	3.024	.48 058
H_4	4.032	.60 552
H_5	5.040	.70 243
H_6	6.048	.78 161
H_3BO_3	62.02	.79 253
HBr	80.93	.90 811
$HC_2H_3O_2$	60.04	.77 844
HCN	27.023	.43 174
HCO_2H	46.02	.66 295
$H_2C_2O_4$	90.03	.95 439
$H_2C_2O_4 \cdot 2H_2O$	126.06	.10 058
$\frac{1}{2}[H_2C_2O_4 \cdot 2H_2O]$	63.03	.79 955
$H_2C_4H_4O_6$	150.07	.17 629
HCl	36.468	.56 192
$HClO_4$	100.47	.00 204
HF	20.01	.30 125
HI	127.93	.10 697
$HKCO_3$	100.11	.00 048
HNO_3	63.02	.79 948
$HNaCO_3$	84.01	.92 433
$HNa_2PO_4 \cdot 12H_2O$	358.24	.55 418
HO	17.008	.23 065
H_2O	18.016	.25 565
H_2O_2	34.02	.53 173
H_3PO_4	98.06	.99 149
H_2S	34.08	.53 250
H_2SO_4	98.08	.99 158
$\frac{1}{2}H_2SO_4$	49.04	.69 055
H_2SiF_6	144.32	.15 933
Hg	200.6	.30 233
$Hg(CN)_2$	252.63	.40 248
$HgCl$	236.06	.37 302
$HgCl_2$	271.52	.43 380
HgI_2	454.44	.65 748
HgO	216.6	.33 566
HgS	232.66	.36 672
I	126.92	.10 353
I_2	253.84	.40 456
I_3	380.76	.58 065
I_4	507.68	.70 559
I_5	634.60	.80 250
I_6	761.52	.88 168
I_2O_5	333.84	.52 354
IO_3	174.92	.24 284
IO_4	190.92	.28 085
K	39.10	.59 218
K_2	78.20	.89 321
K_3	117.30	.06 930
K_4	156.40	.19 424
$KAl(SO_4)_2 \cdot 12H_2O$	474.51	.67 625
KBr	119.02	.07 562
$KBrO_3$	167.02	.22 277
KCN	65.12	.81 371
K_2CO_3	138.21	.14 054
KCl	74.56	.87 251
$2KCl$	149.12	.17 354
$KClO_3$	122.56	.08 835
$KClO_4$	138.56	.14 164
K_2CrO_4	194.20	.28 825
$K_2Cr_2O_7$	294.20	.46 864
$\frac{1}{6}K_2CrO_7$	49.033	.69 049
$KCr(SO_4)_2 \cdot 12H_2O$	499.41	.69 846
$K_3Fe(CN)_6$	329.23	.51 750
$K_4Fe(CN)_6$	368.33	.56 624
$K_4Fe(CN)_6 \cdot 3H_2O$	422.38	.62 570
$KHCO_3$	100.11	.00 048
KI	166.02	.22 016
KIO_3	214.02	.33 045
$\frac{1}{6}KIO_3$	35.67	.55 230
$KMnO_4$	158.03	.19 874
$2KMnO_4$	316.06	.49 977
$\frac{1}{5}KMnO_4$	31.606	.49 977

Formula.	Weight.	Log.
KNO_2	85.11	.92 998
KNO_3	101.11	.00 479
$KNaC_4H_4O_6 \cdot 4H_2O$	282.22	.45 059
K_2O	94.20	.97 405
$\frac{1}{2}K_2O$	47.10	.67 302
KOH	56.11	.74 904
K_2PtCl_6	486.16	.68 678
$\frac{1}{2}K_2PtCl_6$	243.08	.38 575
$KSCN$	97.18	.98 758
K_2SO_4	174.26	.24 120
$\frac{1}{2}K_2SO_4$	87.13	.94 017
K_2SiF_6	220.5	.34 341
Li	6.94	.84 136
Li_2	13.88	.14 239
Li_2CO_3	73.89	.86 859
$LiCl$	42.40	.62 737
Li_2O	29.88	.47 538
$\frac{1}{2}Li_2O$	14.94	.17 435
Li_3PO_4	115.86	.06 393
Li_2SO_4	109.94	.04 116
Mg	24.32	.38 596
$Mg_2As_2O_7$	310.56	.49 214
$MgCO_3$	84.325	.92 596
$MgCl_2 \cdot 6H_2O$	203.34	.30 822
MgO	40.32	.60 552
$Mg_2P_2O_7$	222.72	.34 776
$MgSO_4$	120.38	.08 055
$MgSO_4 \cdot 7H_2O$	246.49	.39 180
$MgSiO_3$	100.62	.00 268
Mn	54.93	.73 981
Mn_2	109.86	.04 084
$MnCO_3$	114.94	.06 047
$MnCl_2 \cdot 4H_2O$	197.91	.29 647
MnO	70.93	.85 083
Mn_2O_3	157.86	.19 828
Mn_3O_4	228.79	.35 944
MnO_2	86.93	.93 917
Mn_2O_7	221.86	.34 608
$Mn_2P_2O_7$	283.94	.45 323
MnS	86.99	.93 947
$MnSO_4$	150.99	.17 895
$MnSO_4 \cdot 4H_2O$	223.05	.34 840
$MnSO_4 \cdot 7H_2O$	277.10	.44 264
Mo	96.0	.98 227
MoO_3	144.0	.15 836
MoS_2	160.1	.20 439
N	14.01	.14 644
N_2	28.02	.44 747
NH_2	16.026	.20 482
NH_3	17.034	.23 131
NH_4	18.042	.25 629
$(NH_4)_2$	36.084	.55 732
$NH_4Al(SO_4)_2 \cdot 12H_2O$	453.45	.65 653
$(NH_4)_2C_2O_4 \cdot H_2O$	142.11	.15 262
N_2H_4CO	60.06	.77 859
NH_4Cl	53.502	.72 837
$NH_4Fe(SO_4)_2 \cdot 12H_2O$	482.19	.68 322
$(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$	392.14	.59 344
$NH_4NaHPO_4 \cdot 4H_2O$	209.15	.32 046
$(NH_4)_2O$	52.084	.71 670
NH_4OH	35.05	.54 469
NH_4NO_3	80.05	.90 336
$(NH_4)_2PtCl_6$	444.04	.64 742
NH_4SCN	76.12	.88 150
$(NH_4)_2SO_4$	132.144	.12 104
N_2O	44.02	.64 365
NO	30.01	.47 727
NO_2	46.01	.66 285
NO_3	62.01	.79 246
N_2O_3	76.02	.88 093
N_2O_5	108.02	.03 350
$\frac{1}{2}N_2O_5$	54.01	.73 247
Na	23.00	.36 173
Na_2	46.00	.66 276
Na_3AlF_6	210.1	.32 243
$Na_2B_4O_7$	202.0	.30 535
$Na_2B_4O_7 \cdot 10H_2O$	382.16	.58 225
$NaBr$	102.92	.01 250
$NaC_2H_3O_2$	82.03	.91 397
$NaC_2H_3O_2 \cdot 3H_2O$	136.08	.13 379
Na_2CO_3	106.005	.02 533
$Na_2CO_3 \cdot 10H_2O$	286.17	.45 662
$NaHCO_3$	84.01	.92 433
$NaCl$	58.46	.76 686
$NaClO_3$	106.46	.02 719
$NaClO_4$	122.46	.08 799

Formula.	Weight.	Log.
NaF	42.0	.62 325
$Na_2HPO_4 \cdot 12H_2O$	358.24	.55 418
$NaHSO_3$	104.07	.01 733
$NaHSO_4$	120.07	.07 943
NaI	149.92	.17 586
$NaNO_2$	69.01	.83 891
$NaNO_3$	85.01	.92 947
Na_2O	62.00	.79 239
$\frac{1}{2}Na_2O$	31.00	.49 136
Na_2O_2	78.00	.89 209
NaOH	40.01	.60 217
$NaPO_3$	102.04	.00 877
$Na_4P_2O_7$	266.08	.42 501
Na_2S	78.06	.89 243
Na_2SO_4	142.06	.15 247
$Na_2SO_4 \cdot 10H_2O$	322.22	.50 816
$Na_2S_2O_3 \cdot 5H_2O$	248.20	.39 480
Ni	58.68	.76 849
$NiCl_2 \cdot 6H_2O$	237.70	.37 603
$Ni(NO_3)_2 \cdot 6H_2O$	290.80	.46 359
NiO	74.68	.87 320
NiS	90.74	.95 780
$NiSO_4$	154.74	.18 960
$NiSO_4 \cdot 6H_2O$	262.84	.41 969
$NiSO_4 \cdot 7H_2O$	280.85	.44 848
$Ni(NH_4)_2(SO_4)_2 \cdot 6H_2O$	394.98	.59 658
O	16.00	.20 412
O_2	32.00	.50 515
O_3	48.00	.68 124
O_4	64.00	.80 618
O_5	80.00	.90 309
O_6	96.00	.98 227
OH	17.008	.23 065
P	31.04	.49 192
P_2	62.08	.79 295
PCl_3	137.42	.13 805
PCl_5	208.34	.31 877
P_2O_5	142.08	.15 253
$\frac{1}{2}P_2O_5$	71.04	.85 150
PO_4	95.04	.97 791
$2PO_4$	190.08	.27 894
P_2O_3	110.08	.04 171
P_2O_7	174.08	.24 075
Pb	207.20	.31 639
$Pb(C_2H_3O_2)_2 \cdot 3H_2O$	379.32	.57 900
$PbCO_3$	267.21	.42 686
$PbCl_2$	278.12	.44 423
$PbCrO_4$	323.20	.50 947
$Pb(NO_3)_2$	331.22	.52 012
PbO	223.20	.34 869
PbO_2	239.20	.37 876
Pb_3O_4	685.60	.83 607
PbS	239.26	.37 887
$PbSO_4$	303.26	.48 181
Pd	106.7	.02 816
PdI_2	360.54	.55 696
Pt	195.2	.29 048
$PtCl_4$	337.04	.52 768
$PtCl_6$	407.96	.61 062
Rb	85.45	.93 171
$RbAl(SO_4)_2 \cdot 12H_2O$	520.86	.71 672
RbCl	120.91	.08 246
Rb_2O	186.90	.27 161
Rb_2PtCl_6	578.86	.76 257
Rb_2SO_4	266.96	.42 645
S	32.06	.50 596
S_2	64.12	.80 699
SCN	58.075	.76 399
SO_2	64.06	.80 659
SO_3	80.06	.90 342
SO_4	96.06	.98 254
Sb	120.2	.07 990
2Sb	240.4	.38 093
$SbCl_3$	226.58	.35 522
$SbCl_5$	297.50	.47 349
Sb_2O_3	288.4	.46 000
$\frac{1}{2}Sb_2O_3$	144.2	.15 897
Sb_2O_5	320.4	.50 569
$\frac{1}{2}Sb_2O_5$	160.2	.20 466
Sb_2O_4	304.4	.48 344
SbOCl	171.7	.23 477
$SbOKC_4H_4O_6 \cdot \frac{1}{2}H_2O$	332.36	.52 161
Sb_2S_3	336.6	.52 711
Sb_2S_5	400.7	.60 282

Formula.	Weight.	Log.
Se	79.2	.89 873
SeO_2	111.2	.04 610
SeO_3	127.2	.10 449
Si	28.3	.45 179
Si_2	56.6	.75 282
SiF_4	104.3	.01 828
SiF_6	142.3	.15 320
SiO_2	60.3	.78 032
SiO_3	76.3	.88 252
SiO_4	92.3	.96 520
Si_3O_8	212.9	.32 818
Sn	118.7	.07 445
$SnCl_2$	189.62	.27 789
$SnCl_2 \cdot 2H_2O$	225.65	.35 344
$SnCl_4$	260.54	.41 587
SnO	134.7	.12 937
SnO_2	150.7	.17 811
SnS	150.76	.17 828
SnS_2	182.82	.26 203
Sr	87.63	.94 265
$SrCO_3$	147.64	.16 920
$SrCl_2 \cdot 6H_2O$	266.65	.42 594
$Sr(NO_3)_2$	211.65	.32 562
SrO	103.63	.01 549
$Sr(OH)_2 \cdot 8H_2O$	265.77	.42 450
$SrSO_4$	183.69	.26 409
Te	127.5	.10 551
TeO_2	159.5	.20 276
TeO_3	175.5	.24 428
$TeO_3 \cdot 3H_2O$	229.55	.36 088
Th	232.4	.36 624
ThO_2	264.4	.42 226
Ti	48.1	.68 215
TiO_2	80.1	.90 363
Tl	204.0	.30 963
TlCl	239.46	.37 923
TlI	330.92	.51 973
$TlNO_3$	266.01	.42 490
Tl_2PtCl_6	815.96	.91 167
U	238.2	.37 694
UO_2	270.2	.43 169
U_3O_8	842.6	.92 562
$UO_2(C_2H_3O_2)_2 \cdot 2H_2O$	424.30	.62 767
$UO_2(NO_3)_2 \cdot 6H_2O$	502.32	.70 098
$U_2P_2O_{11}$	714.48	.85 399
V	51.0	.70 757
V_2O_5	182.0	.26 007
W	184.0	.26 482
WO_3	232.0	.36 549
Zn	65.37	.81 538
$ZnCO_3$	125.38	.09 823
$ZnCl_2$	136.29	.13 446
ZnO	81.37	.91 046
ZnS	97.43	.98 869
$ZnSO_4$	161.43	.20 798
$ZnSO_4 \cdot 7H_2O$	287.54	.45 870
Zr	90.6	.95 713
ZrO_2	122.6	.08 849

H_2O	18.016	.25 565
$2H_2O$	36.032	.55 668
$3H_2O$	54.048	.73 278
$4H_2O$	72.064	.85 771
$5H_2O$	90.08	.95 463
$6H_2O$	108.10	.03 383
$7H_2O$	126.11	.10 075
$8H_2O$	144.13	.15 875
$9H_2O$	162.14	.20 989
$10H_2O$	180.16	.25 565
$11H_2O$	198.18	.29 706
$12H_2O$	216.19	.33 484
$13H_2O$	234.21	.36 961
$14H_2O$	252.22	.40 178
$15H_2O$	270.24	.43 175
$16H_2O$	288.26	.45 978
$17H_2O$	306.27	.48 611
$18H_2O$	324.29	.51 094
$19H_2O$	342.30	.53 441
$20H_2O$	360.32	.55 668
$21H_2O$	378.34	.57 788
$22H_2O$	396.35	.59 808
$23H_2O$	414.37	.61 739
$24H_2O$	432.38	.63 587

TABLE IV.

INDIRECT ANALYSES.

Mixture. *a.*	Determined. *b.*	Formula.
$AgBr$ AgI	Loss by fusing in chlorine	$AgBr = 2.5496\,a - 6.5454\,b$ (log .40 647) (log .81 594) $AgI = -1.5496\,a + 6.5454\,b$ (log .19 022) (log .81 594)
$AgBr$ AgI	Loss by fusing in chlorine.	$Br = 1.0850\,a - 2.7855\,b$ (log .03 543) (log .44 490) $I = -.83758\,a + 3.5380\,b$ (log .92 303) (log .54 876)
$NaCl$ KCl	Cl	$NaCl = -3.6310\,a + 7.6348\,b$ (log .56 003) (log .88 280) $KCl = 4.6310\,a - 7.6348\,b$ (log .66 567) (log .88 280)
Na_2SO_4 K_2SO_4	$BaSO_4$	$Na_2SO_4 = -4.4108\,a + 3.2928\,b$ (log .64 452) (log .51 756) $K_2SO_4 = 5.4108\,a - 3.2928\,b$ (log .73 326) (log .51 756)
Na_2SO_4 Li_2SO_4	$BaSO_4$	$Na_2SO_4 = 4.4228\,a - 2.0830\,b$ (log .64 570) (log .31 869) $Li_2SO_4 = -3.4228\,a + 2.0830\,b$ (log .53 438) (log .31 869)
Rb_2PtCl_6 Cs_2PtCl_6	Rb_2SO_4 Cs_2SO_4	$Rb_2SO_4 = 3.2682\,a - 6.0866\,b$ (log .51 431) (log .78 437) $Cs_2SO_4 = -3.2682\,a + 7.0866\,b$ (log .51 431) (log .85 044)

Note. — This table is given to show a few convenient formulas for calculating the results of indirect analyses in cases where two transformations occur together. The formulas themselves may be readily derived from the proper factors by the use of algebra. For instance, for the third pair of formulas given above we have:

$$NaCl + KCl = a, \text{ and } .60656\ NaCl + .47559\ KCl = b,$$

and the solution of these simultaneous equations gives the formulas.

Of the formulas given in the table, the first two pairs represent a process that has been frequently employed, and is capable of giving good results. The student should be warned, however, against the use of most of the methods of complex indirect determination, except for the purpose of obtaining approximate results, because the errors in the determinations are largely increased in the final results. For example, the formulas indicate that an error of one part in 100 in the determination of chlorine in a mixture of NaCl and KCl would produce errors of 7.6 parts in 100 in the calculated amounts of the salts.

TABLE V.

REDUCTION OF GAS-VOLUMES TO 0° AND 760 MM.

Vol. at 0° and 760 mm $= v.\ F.\ (h - w)$.

v = Volume of gas (cc);

t = Temperature of gas (C.°);

w = Tension of aqueous vapor (mm).

F = Factor from table $= \frac{1}{760(1+.00367t)}$;

h = Barometer-height, corrected, (mm);

t°.	Log F.*	w.
0	.11 919	4.6
0.5	.11 839	4.8
1	.11 760	4.9
1.5	.11 681	5.1
2	.11 602	5.3
2.5	.11 523	5.5
3	.11 444	5.7
3.5	.11 365	5.9
4	.11 286	6.1
4.5	.11 208	6.3
5	.11 129	6.5
5.5	.11 051	6.7
6	.10 973	7.0
6.5	.10 895	7.2
7	.10 817	7.5
7.5	.10 740	7.7
8	.10 662	8.0
8.5	.10 585	8.3
9	.10 508	8.5
9.5	.10 430	8.8
10	.10 354	9.1
10.5	.10 277	9.4
11	.10 201	9.8
11.5	.10 124	10.1
12	.10 048	10.4
12.5	.09 972	10.8
13	.09 896	11.1
13.5	.09 820	11.5
14	.09 744	11.9
14.5	.09 668	12.3
15	.09 592	12.7
15.5	.09 517	13.1
16	.09 441	13.5
16.5	.09 366	13.9
17	.09 291	14.4
17.5	.09 216	14.9
18	.09 141	15.3
18.5	.09 067	15.8
19	.08 992	16.3
19.5	.08 918	16.8
20	.08 843	17.4
20.5	.08 769	17.9
21	.08 695	18.5
21.5	.08 621	19.0
22	.08 547	19.6
22.5	.08 474	20.2
23	.08 400	20.9
23.5	.08 327	21.5
24	.08 253	22.2
24.5	.08 180	22.8
25	.08 107	23.5
25.5	.08 034	24.2
26	.07 961	25.0
26.5	.07 888	25.7
27	.07 816	26.5
27.5	.07 743	27.3
28	.07 671	28.1
28.5	.07 599	28.9
29	.07 527	29.7
29.5	.07 455	30.6
30	.07 383	31.5

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* The characteristic of all the logarithms is -3.

TABLE VI.

CALCULATION OF PERCENTAGE OF NITROGEN FROM THE GAS-VOLUME.

$$\%N = \frac{v.F.\,(h - w)}{S}.$$

(100 g. H_2O + 30 g. KOH = 23.1% KOH)

v = Volume of nitrogen (cc).
F = Factor (table) = $\frac{.0012510 \times 100}{760\,(1 + .00367\,t)}$.
h = Height of barometer, corrected (mm).
w = Tension of aqueous vapor (mm).
S = Weight of substance (g).
t = Temperature of gas (C.°).

		23.1% KOH	H_2O.
t°.	Log. F.*	w.	w.
0	.21 645	3.7	4.6
0.5	.21 565	3.8	4.8
1	.21 486	3.9	4.9
1.5	.21 407	4.1	5.1
2	.21 328	4.2	5.3
2.5	.21 249	4.4	5.5
3	.21 170	4.5	5.7
3.5	.21 091	4.7	5.9
4	.21 012	4.9	6.1
4.5	.20 934	5.0	6.3
5	.20 855	5.2	6.5
5.5	.20 777	5.4	6.7
6	.20 699	5.6	7.0
6.5	.20 621	5.8	7.2
7	.20 543	6.0	7.5
7.5	.20 466	6.2	7.7
8	.20 388	6.4	8.0
8.5	.20 311	6.6	8.3
9	.20 234	6.8	8.5
9.5	.20 156	7.0	8.8
10	.20 080	7.3	9.1
10.5	.20 003	7.6	9.4
11	.19 927	7.8	9.8
11.5	.19 850	8.1	10.1
12	.19 774	8.3	10.4
12.5	.19 698	8.6	10.8
13	.19 622	8.9	11.1
13.5	.19 546	9.2	11.5
14	.19 470	9.5	11.9
14.5	19 394	9.8	12.3
15	.19 318	10.1	12.7
15.5	.19 243	10.5	13.1
16	.19 167	10.8	13.5
16.5	.19 092	11.2	13.9
17	.19 017	11.5	14.4
17.5	.18 942	11.9	14.9
18	.18 867	12.3	15.3
18.5	.18 793	12.7	15.8
19	.18 718	13.1	16.3
19.5	.18 644	13.5	16.8
20	.18 569	13.9	17.4
20.5	.18 495	14.4	17.9
21	.18 421	14.8	18.5
21.5	.18 347	15.3	19.0
22	.18 273	15.8	19.6
22.5	.18 200	16.3	20.2
23	.18 126	16.8	20.9
23.5	.18 053	17.3	21.5
24	.17 979	17.8	22.2
24.5	.17 906	18.4	22.8
25	.17 833	18.9	23.5
25.5	.17 760	19.5	24.2
26	.17 687	20.1	25.0
26.5	.17 614	20.7	25.7
27	.17 542	21.3	26.5
27.5	.17 469	21.9	27.3
28	.17 397	22.6	28.1
28.5	.17 325	23.3	28.9
29	.17 253	24.0	29.7
29.5	.17 181	24.7	30.6
30	.17 109	25.4	31.5

Note. — The table is based on Lord Rayleigh's weight of nitrogen, at latitude 41° and sea-level, 0.0012510 g.

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* The characteristic of all the logarithms is −4.

TABLE VII.

BAROMETER CORRECTIONS.

FOR TEMPERATURE.

Glass Scale (Bunsen). mm. to be deducted.						Brass Scale (Delcros). mm. to be deducted.					
t°.	Reading.					t°.	Reading.				
	700	720	740	760	780		700	720	740	760	780
1	0.120	0.123	0.127	0.130	0.133	*1*	0.113	0.116	0.119	0.123	0.126
2	0.2	0.2	0.3	0.3	0.3	*2*	0.2	0.2	0.2	0.3	0.3
3	0.4	0.4	0.4	0.4	0.4	*3*	0.3	0.4	0.4	0.4	0.4
4	0.5	0.5	0.5	0.5	0.5	*4*	0.5	0.5	0.5	0.5	0.5
5	0.6	0.6	0.6	0.7	0.7	*5*	0.6	0.6	0.6	0.6	0.6
6	0.7	0.7	0.8	0.8	0.8	*6*	0.7	0.7	0.7	0.7	0.8
7	0.8	0.9	0.9	0.9	0.9	*7*	0.8	0.8	0.8	0.9	0.9
8	1.0	1.0	1.0	1.0	1.1	*8*	0.9	0.9	1.0	1.0	1.0
9	1.1	1.1	1.1	1.2	1.2	*9*	1.0	1.0	1.1	1.1	1.1
10	1.2	1.2	1.3	1.3	1.3	*10*	1.1	1.2	1.2	1.2	1.3
11	1.3	1.4	1.4	1.4	1.5	*11*	1.2	1.3	1.3	1.4	1.4
12	1.4	1.5	1.5	1.6	1.6	*12*	1.4	1.4	1.4	1.5	1.5
13	1.6	1.6	1.7	1.7	1.7	*13*	1.5	1.5	1.6	1.6	1.6
14	1.7	1.7	1.8	1.8	1.9	*14*	1.6	1.7	1.7	1.7	1.8
15	1.8	1.8	1.9	2.0	2.0	*15*	1.7	1.8	1.8	1.8	1.9
16	1.9	2.0	2.0	2.1	2.1	*16*	1.8	1.9	1.9	2.0	2.0
17	2.0	2.1	2.2	2.2	2.3	*17*	1.9	2.0	2.0	2.1	2.1
18	2.2	2.2	2.3	2.3	2.4	*18*	2.0	2.1	2.2	2.2	2.3
19	2.3	2.3	2.4	2.5	2.5	*19*	2.1	2.2	2.3	2.3	2.4
20	2.4	2.5	2.5	2.6	2.7	*20*	2.3	2.3	2.4	2.5	2.5
21	2.5	2.6	2.7	2.7	2.8	*21*	2.4	2.5	2.5	2.6	2.7
22	2.6	2.7	2.8	2.9	2.9	*22*	2.5	2.6	2.6	2.7	2.8
23	2.8	2.8	2.9	3.0	3.1	*23*	2.6	2.7	2.8	2.8	2.9
24	2.9	3.0	3.0	3.1	3.2	*24*	2.7	2.8	2.9	2.9	3.0
25	3.0	3.1	3.2	3.3	3.3	*25*	2.8	3.0	3.1	3.0	3.2
26	3.1	3.2	3.3	3.4	3.5	*26*	2.9	3.1	3.1	3.2	3.3
27	3.2	3.3	3.4	3.5	3.6	*27*	3.1	3.2	3.2	3.3	3.4
28	3.4	3.4	3.5	3.6	3.7	*28*	3.2	3.3	3.3	3.4	3.5
29	3.5	3.6	3.7	3.8	3.9	*29*	3.3	3.4	3.5	3.6	3.7
30	3.6	3.7	3.8	3.9	4.0	*30*	3.4	3.5	3.6	3.7	3.8

Notes on Densities of Gases and Vapors. — The molecular weight in grams of any gas or vapor has a volume of 22.4 liters at 0° and 760 mm. Hence:

Mol. wt. = 22.4 × wt. of 1 liter in grams.

and Wt. of 1 liter in grams. = mol. wt. ÷ 22.4.

In most cases the values derived from these formulas do not correspond precisely with the observed values, but they suffice for most practical purposes. For instance, the volume of 32 g. of oxygen is 22.390 instead of 22.4 l., and in other cases there is still greater variation.

It happens that the relation between grams and liters is practically the same as that between ounces, avoirdupois and cubic feet, hence:

Wt. of 1 cu. ft. in ounces, av. = mol. wt. ÷ 22.4.

The density of air corresponds to a mean molecular weight of 29, or more precisely 28.95 when compared with O_2 as 32. Hence the molecular weight of a gas or vapor divided by 29 gives its density compared with air at the same temperature and pressure. 1 l. air at 0° and 760 mm. = 1.2928 g.

TABLE VIII.

MULTIPLES FOR ORGANIC COMPOUNDS.

	Number.	Log.		Number.	Log.		Number.	Log.
H	1.008	.00 346	C	12.005	.07 936	N	14.01	.14 644
H_2	2.016	.30 449	C_2	24.01	.38 039	N_2	28.02	.44 747
H_3	3.024	.48 058	C_3	36.02	.55 654	N_3	42.03	.62 356
H_4	4.032	.60 552	C_4	48.02	.68 142	N_4	56.04	.74 850
H_5	5.040	.70 243	C_5	60.03	.77 837	N_5	70.05	.84 541
H_6	6.048	.78 161	C_6	72.03	.85 751	N_6	84.06	.92 459
H_7	7.056	.84 856	C_7	84.04	.92 449	N_7	98.07	.99 154
H_8	8.064	.90 655	C_8	96.04	.98 245	N_8	112.08	.04 953
H_9	9.072	.95 770	C_9	108.05	.03 362	S	32.06	.50 596
H_{10}	10.08	.00 346	C_{10}	120.05	.07 936	S_2	64.12	.80 699
H_{11}	11.09	.04 493	C_{11}	132.06	.12 077	S_3	96.18	.98 308
H_{12}	12.10	.08 279	C_{12}	144.06	.15 854	S_4	128.24	.10 802
H_{13}	13.10	.11 727	C_{13}	156.07	.19 332	S_5	160.30	.20 493
H_{14}	14.11	.14 953	C_{14}	168.07	.22 549	S_6	192.36	.28 412
H_{15}	15.12	.17 955	C_{15}	180.08	.25 546	Cl	35.46	.54 974
H_{16}	16.13	.20 763	C_{16}	192.08	.28 348	Cl_2	70.92	.85 077
H_{17}	17.14	.23 401	C_{17}	204.09	.30 982	Cl_3	106.38	.02 686
H_{18}	18.14	.25 864	C_{18}	216.09	.33 463	Cl_4	141.84	.15 180
H_{19}	19.15	.28 217	C_{19}	228.10	.35 813	Cl_5	177.30	.24 871
H_{20}	20.16	.30 449	C_{20}	240.10	.38 039	Cl_6	212.76	.32 789
H_{21}	21.17	.32 572	C_{21}	252.11	.40 159	Br	79.92	.90 266
H_{22}	22.18	.34 596	C_{22}	264.11	.42 179	Br_2	159.84	.20 369
H_{23}	23.18	.36 511	C_{23}	276.12	.44 110	Br_3	239.76	.37 978
H_{24}	24.19	.38 364	C_{24}	288.12	.45 957	Br_4	319.68	.50 472
H_{25}	25.20	.40 140	C_{25}	300.13	.47 731	I	126.92	.10 353
H_{26}	26.21	.41 847	C_{26}	312.13	.49 433	I_2	253.84	.40 456
H_{27}	27.22	.43 489	C_{27}	324.14	.51 073	I_3	380.76	.58 065
H_{28}	28.22	.45 056	C_{28}	336.14	.52 652	I_4	507.68	.70 559
H_{29}	29.23	.46 583	C_{29}	348.15	.54 177	O_{11}	176	.24 551
H_{30}	30.24	.48 058	C_{30}	360.15	.55 648	O_{12}	192	.28 330
H_{31}	31.25	.49 485	O	16	.20 412	O_{13}	208	.31 806
H_{32}	32.26	.50 866	O_2	32	.50 515	O_{14}	224	.35 025
H_{33}	33.26	.52 192	O_3	48	.68 124	O_{15}	240	.38 021
H_{34}	34.27	.53 491	O_4	64	.80 618	O_{16}	256	.40 824
H_{35}	35.28	.54 753	O_5	80	.90 309	O_{17}	272	.43 457
H_{36}	36.29	.55 979	O_6	96	.98 227	O_{18}	288	.45 939
H_{37}	37.30	.57 171	O_7	112	.04 922	O_{19}	304	.48 287
H_{38}	38.30	.58 320	O_8	128	.10 721	O_{20}	320	.50 515
H_{39}	39.31	.59 450	O_9	144	.15 836	O_{21}	336	.52 634
H_{40}	40.32	.60 552	O_{10}	160	.20 412	O_{22}	352	.54 654

TABLE IX.

CONSTANTS FOR MOLECULAR-WEIGHT DETERMINATIONS.

(The constants are taken from Ostwald-Luther "Physiko-Chemische Messungen.")

The formula is $M=K\frac{s}{\Delta L}$, where M is the molecular weight of the dissolved substance, s its weight in grams, L the weight of the solvent in grams, Δ the observed change in temperature, and K is the constant, which depends upon the nature of the solvent.

By Depression of Freezing-point.

		K.	
Solvent.	Melts at.	N.	Log.
Water	0°	1850	.2672
Benzole	5.5	5000	.6990
Naphthaline	80	7000	.8451
Phenanthrene	96	12000	.0792
Phenol	39	7500	.8751
Glacial acetic acid	17.7	3900	.5911
Nitrobenzole	5.3	7000	.8451
P. toluidine	42.5	5100	.7076

By Elevation of Boiling-point.

		K.	
Solvent.	Boils at.	N.	Log.
Ethyl ether	35°	2160	.3345
Benzole	80	2610	.4166
Chloroform	61	3590	.5551
Carbon bisulphide	46	2350	.3711
Glacial acetic acid	118	2530	.4031
Ethyl alcohol	78	1170	.0682
Ethyl acetate	75	2680	.4281
Acetone	56	1720	.2355
Water	100	510	.7076
Ethylene bromide	132	6450	.8096
Aniline	182	3220	.5079
Phenol	132	3040	.4829

TABLE X.

WEIGHTS AND MEASURES.

LENGTH.

Given.	Sought.	Multiply by Factor.	
		N.	Log.
Inches	Centimeters	2.540	.40 483
Centimeters	Inches	.39370	.59 517
Feet	Meters	.30480	.48 402
Meters	Feet	3.2808	.51 598
Miles	Kilometers	1.6093	.20 665
Kilometers	Miles	.62137	.79 335

AREA.

Sq. Inches	Sq. Centimeters	6.4516	.80 967
Sq. Centimeters	Sq. Inches	.1550	.19 033
Sq. Feet	Sq. Meters	.09290	.96 803
Sq. Meters	Sq. Feet	10.764	.03 197

VOLUME.

Cu. Inches	Cu. Centimeters	16.387	.21 450
Cu. Centimeters	Cu. Inches	.06102	.78 550
Cu. Feet	Cu. Meters	.02832	.45 205
Cu. Meters	Cu. Feet	35.314	.54 795

CAPACITY.

U. S. Fluid Ounces	Cu. Centimeters	29.574	.47 091
Cu. Centimeters	U. S. Fluid Ounces	.03381	.52 909
U. S. Quarts	Liters	.94635	.97 605
Liters	U. S. Quarts	1.0567	.02 395
U. S. Gallons	Liters	3.7854	.57 812
Liters	U. S. Gallons	.26417	.42 188

WEIGHT.

Grains	Grams	.06480	.81 157
Grams	Grains	15.432	.18 843
Ounces, troy	Grams	31.103	.49 281
Grams	Ounces, troy	.03215	.50 719
Ounces, av.	Grams	28.350	.45 255
Grams	Ounces, av.	.03527	.54 745
Pounds, av.	Grams	453.59	.65 667
Kilograms	Pounds, av.	2.2046	.34 333

NOTES ON THE USE OF LOGARITHMS.

In these tables the "characteristics" of the logarithms, or the figures before their decimal points which fix the decimal points of the numbers, have been omitted, because in ordinary chemical calculations it is usually easier to find the positions of the decimal points by simple inspection of the numbers employed than by the use of characteristics.

For example, suppose we have;

.4693 g. AgCl (log .67145)

to be multiplied by the factor which gives the amount of chlorine in it,

.24738 (log .39336).

SA WB $[OH^-] = \sqrt{K_b [A^-]}$

$[H^+] = \sqrt{\frac{K_w}{K_b} C_{salt}}$

The addition of the logs gives the log .06481, corresponding to the numerical figures 11610.

Now by inspection, since .24738 is nearly $\frac{1}{4}$, or since .4693 is nearly $\frac{1}{2}$, it is evident that the result must be not far from $\frac{1}{4}$ of .4693 or $\frac{1}{2}$ of .24738, so that the decimal point must be placed to correspond; that is, .11610.

Now if we divide the amount of chlorine by the weight of substance taken for analysis, say .2603 g. (log .41547) we have .06481 − .41547 = .64934, corresponding to the number .44601, the decimal point of which is found by inspection, since the result must be about 4 times .11610. Multiplying this by 100 we find 44.60% of chlorine. The fifth figure in this result is an uncertain one because it is derived from the datum .2603; hence it is best not to report it. In this case the trouble of interpolating for a fifth figure might have been avoided by taking four figures corresponding to the nearest logarithm.

By the use of a co-logarithm (i.e., 1 − log) of the division the preceding calculation may be made by a single addition:

SA SB

SB WA $[H^+] = \sqrt{K_a [HA]}$

AgCl,	.4693	log	.67145
Factor,	.24738	log	.39336
Substance,	.2603	1 − log	.58453
			.64934 → 44.60%

$[H^+]$ (using base added) = K_a (using acid left)

$[OH^-] = \sqrt{\frac{K_w}{K_a} C_{salt}}$

An inspection of the numbers employed above shows the position of the decimal point. The result could not possibly be 4.460%.

The student who is not skilful in the use of logarithms should practice multiplications and divisions with numbers giving known results until he acquires proficiency.

The easily remembered logarithm of 2, which is .30103, is often of considerable assistance in calculations. For instance, the logarithm of the atomic weight of Mg, 24.32, is .38596; hence the log of 2 Mg is .68699 and that of $\frac{1}{2}$ Mg is .08493.

LOGARITHMS OF NUMBERS

FIVE-PLACE TABLE

WITH

DOUBLE THUMB-INDEX

N.	0	1	2	3	4	5	6	7	8	9
100	00 000	043	087	130	173	217	260	303	346	389
101	432	475	518	561	604	647	689	732	775	817
102	860	903	945	988	*030	*072	*115	*157	*199	*242
103	01 284	326	368	410	452	494	536	578	620	662
104	703	745	787	828	870	912	953	995	*036	*078
105	02 119	160	202	243	284	325	366	407	449	490
106	531	572	612	653	694	735	776	816	857	898
107	938	979	*019	*060	*100	*141	*181	*222	*262	*302
108	03 342	383	423	463	503	543	583	623	663	703
109	743	782	822	862	902	941	981	*021	*060	*100
110	04 139	179	218	258	297	336	376	415	454	493
111	532	571	610	650	689	727	766	805	844	883
112	922	961	999	*038	*077	*115	*154	*192	*231	*269
113	05 308	346	385	423	461	500	538	576	614	652
114	690	729	767	805	843	881	918	956	994	*032
115	06 070	108	145	183	221	258	296	333	371	408
116	446	483	521	558	595	633	670	707	744	781
117	819	856	893	930	967	*004	*041	*078	*115	*151
118	07 188	225	262	298	335	372	408	445	482	518
119	555	591	628	664	700	737	773	809	846	882
120	918	954	990	*027	*063	*099	*135	*171	*207	*243
121	08 279	314	350	386	422	458	493	529	565	600
122	636	672	707	743	778	814	849	884	920	955
123	991	*026	*061	*096	*132	*167	*202	*237	*272	*307
124	09 342	377	412	447	482	517	552	587	621	656
125	691	726	760	795	830	864	899	934	968	*003
126	10 037	072	106	140	175	209	243	278	312	346
127	380	415	449	483	517	551	585	619	653	687
128	721	755	789	823	857	890	924	958	992	*025
129	11 059	093	126	160	193	227	261	294	327	361
130	394	428	461	494	528	561	594	628	661	694
131	727	760	793	826	860	893	926	959	992	*024
132	12 057	090	123	156	189	222	254	287	320	352
133	385	418	450	483	516	548	581	613	646	678
134	710	743	775	808	840	872	905	937	969	*001
135	13 033	066	098	130	162	194	226	258	290	322
136	354	386	418	450	481	513	545	577	609	640
137	672	704	735	767	799	830	862	893	925	956
138	988	*019	*051	*082	*114	*145	*176	*208	*239	*270
139	14 301	333	364	395	426	457	489	520	551	582
140	613	644	675	706	737	768	799	829	860	891
141	922	953	983	*014	*045	*076	*106	*137	*168	*198
142	15 229	259	290	320	351	381	412	442	473	503
143	534	564	594	625	655	685	715	746	776	806
144	836	866	897	927	957	987	*017	*047	*077	*107
145	16 137	167	197	227	256	286	316	346	376	406
146	435	465	495	524	554	584	613	643	673	702
147	732	761	791	820	850	879	909	938	967	997
148	17 026	056	085	114	143	173	202	231	260	289
149	319	348	377	406	435	464	493	522	551	580
N.	0	1	2	3	4	5	6	7	8	9

P. P.

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9	29	28	27

P. P.

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N.		0	1	2	3	4	5	6	7	8	9
150	17	609	638	667	696	725	754	782	811	840	869
151		898	926	955	984	*013	*041	*070	*099	*127	*156
152	18	184	213	241	270	298	327	355	384	412	441
153		469	498	526	554	583	611	639	667	696	724
154		752	780	808	837	865	893	921	949	977	*005
155	19	033	061	089	117	145	173	201	229	257	285
156		312	340	368	396	424	451	479	507	535	562
157		590	618	645	673	700	728	756	783	811	838
158		866	893	921	948	976	*003	*030	*058	*085	*112
159	20	140	167	194	222	249	276	303	330	358	385
160		412	439	466	493	520	548	575	602	629	656
161		683	710	737	763	790	817	844	871	898	925
162		952	978	*005	*032	*059	*085	*112	*139	*165	*192
163	21	219	245	272	299	325	352	378	405	431	458
164		484	511	537	564	590	617	643	669	696	722
165		748	775	801	827	854	880	906	932	958	985
166	22	011	037	063	089	115	141	167	194	220	246
167		272	298	324	350	376	401	427	453	479	505
168		531	557	583	608	634	660	686	712	737	763
169		789	814	840	866	891	917	943	968	994	*019
170	23	045	070	096	121	147	172	198	223	249	274
171		300	325	350	376	401	426	452	477	502	528
172		553	578	603	629	654	679	704	729	754	779
173		805	830	855	880	905	930	955	980	*005	*030
174	24	055	080	105	130	155	180	204	229	254	279
175		304	329	353	378	403	428	452	477	502	527
176		551	576	601	625	650	674	699	724	748	773
177		797	822	846	871	895	920	944	969	993	*018
178	25	042	066	091	115	139	164	188	212	237	261
179		285	310	334	358	382	406	431	455	479	503
180		527	551	575	600	624	648	672	696	720	744
181		768	792	816	840	864	888	912	935	959	983
182	26	007	031	055	079	102	126	150	174	198	221
183		245	269	293	316	340	364	387	411	435	458
184		482	505	529	553	576	600	623	647	670	694
185		717	741	764	788	811	834	858	881	905	928
186		951	975	998	*021	*045	*068	*091	*114	*138	*161
187	27	184	207	231	254	277	300	323	346	370	393
188		416	439	462	485	508	531	554	577	600	623
189		646	669	692	715	738	761	784	807	830	852
190		875	898	921	944	967	989	*012	*035	*058	*081
191	28	103	126	149	171	194	217	240	262	285	307
192		330	353	375	398	421	443	466	488	511	533
193		556	578	601	623	646	668	691	713	735	758
194		780	803	825	847	870	892	914	937	959	981
195	29	003	026	048	070	092	115	137	159	181	203
196		226	248	270	292	314	336	358	380	403	425
197		447	469	491	513	535	557	579	601	623	645
198		667	688	710	732	754	776	798	820	842	863
199		885	907	929	951	973	994	*016	*038	*060	*081
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P. P.

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P. P.

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200	30 103	125	146	168	190	211	233	255	276	298
201	320	341	363	384	406	428	449	471	492	514
202	535	557	578	600	621	643	664	685	707	728
203	750	771	792	814	835	856	878	899	920	942
204	963	984	*006	*027	*048	*069	*091	*112	*133	*154
205	31 175	197	218	239	260	281	302	323	345	366
206	387	408	429	450	471	492	513	534	555	576
207	597	618	639	660	681	702	723	744	765	785
208	806	827	848	869	890	911	931	952	973	994
209	32 015	035	056	077	098	118	139	160	181	201
210	222	243	263	284	305	325	346	366	387	408
211	428	449	469	490	510	531	552	572	593	613
212	634	654	675	695	715	736	756	777	797	818
213	838	858	879	899	919	940	960	980	*001	*021
214	33 041	062	082	102	122	143	163	183	203	224
215	244	264	284	304	325	345	365	385	405	425
216	445	465	486	506	526	546	566	586	606	626
217	646	666	686	706	726	746	766	786	806	826
218	846	866	885	905	925	945	965	985	*005	*025
219	34 044	064	084	104	124	143	163	183	203	223
220	242	262	282	301	321	341	361	380	400	420
221	439	459	479	498	518	537	557	577	596	616
222	635	655	674	694	713	733	753	772	792	811
223	830	850	869	889	908	928	947	967	986	*005
224	35 025	044	064	083	102	122	141	160	180	199
225	218	238	257	276	295	315	334	353	372	392
226	411	430	449	468	488	507	526	545	564	583
227	603	622	641	660	679	698	717	736	755	774
228	793	813	832	851	870	889	908	927	946	965
229	984	*003	*021	*040	*059	*078	*097	*116	*135	*154
230	36 173	192	211	229	248	267	286	305	324	342
231	361	380	399	418	436	455	474	493	511	530
232	549	568	586	605	624	642	661	680	698	717
233	736	754	773	791	810	829	847	866	884	903
234	922	940	959	977	996	*014	*033	*051	*070	*088
235	37 107	125	144	162	181	199	218	236	254	273
236	291	310	328	346	365	383	401	420	438	457
237	475	493	511	530	548	566	585	603	621	639
238	658	676	694	712	731	749	767	785	803	822
239	840	858	876	894	912	931	949	967	985	*003
240	38 021	039	057	075	093	112	130	148	166	184
241	202	220	238	256	274	292	310	328	346	364
242	382	399	417	435	453	471	489	507	525	543
243	561	578	596	614	632	650	668	686	703	721
244	739	757	775	792	810	828	846	863	881	899
245	917	934	952	970	987	*005	*023	*041	*058	*076
246	39 094	111	129	146	164	182	199	217	235	252
247	270	287	305	322	340	358	375	393	410	428
248	445	463	480	498	515	533	550	568	585	602
249	620	637	655	672	690	707	724	742	759	777
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P.P.

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P.P.

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250	39	794	811	829	846	863	881	898	915	933	950
251		967	985	*002	*019	*037	*054	*071	*088	*106	*123
252	40	140	157	175	192	209	226	243	261	278	295
253		312	329	346	364	381	398	415	432	449	466
254		483	500	518	535	552	569	586	603	620	637
255		654	671	688	705	722	739	756	773	790	807
256		824	841	858	875	892	909	926	943	960	976
257		993	*010	*027	*044	*061	*078	*095	*111	*128	*145
258	41	162	179	196	212	229	246	263	280	296	313
259		330	347	363	380	397	414	430	447	464	481
260		497	514	531	547	564	581	597	614	631	647
261		664	681	697	714	731	747	764	780	797	814
262		830	847	863	880	896	913	929	946	963	979
263		996	*012	*029	*045	*062	*078	*095	*111	*127	*144
264	42	160	177	193	210	226	243	259	275	292	308
265		325	341	357	374	390	406	423	439	455	472
266		488	504	521	537	553	570	586	602	619	635
267		651	667	684	700	716	732	749	765	781	797
268		813	830	846	862	878	894	911	927	943	959
269		975	991	*008	*024	*040	*056	*072	*088	*104	*120
270	43	136	152	169	185	201	217	233	249	265	281
271		297	313	329	345	361	377	393	409	425	441
272		457	473	489	505	521	537	553	569	584	600
273		616	632	648	664	680	696	712	727	743	759
274		775	791	807	823	838	854	870	886	902	917
275		933	949	965	981	996	*012	*028	*044	*059	*075
276	44	091	107	122	138	154	170	185	201	217	232
277		248	264	279	295	311	326	342	358	373	389
278		404	420	436	451	467	483	498	514	529	545
279		560	576	592	607	623	638	654	669	685	700
280		716	731	747	762	778	793	809	824	840	855
281		871	886	902	917	932	948	963	979	994	*010
282	45	025	040	056	071	086	102	117	133	148	163
283		179	194	209	225	240	255	271	286	301	317
284		332	347	362	378	393	408	423	439	454	469
285		484	500	515	530	545	561	576	591	606	621
286		637	652	667	682	697	712	728	743	758	773
287		788	803	818	834	849	864	879	894	909	924
288		939	954	969	984	*000	*015	*030	*045	*060	*075
289	46	090	105	120	135	150	165	180	195	210	225
290		240	255	270	285	300	315	330	345	359	374
291		389	404	419	434	449	464	479	494	509	523
292		538	553	568	583	598	613	627	642	657	672
293		687	702	716	731	746	761	776	790	805	820
294		835	850	864	879	894	909	923	938	953	967
295		982	997	*012	*026	*041	*056	*070	*085	*100	*114
296	47	129	144	159	173	188	202	217	232	246	261
297		276	290	305	319	334	349	363	378	392	407
298		422	436	451	465	480	494	509	524	538	553
299		567	582	596	611	625	640	654	669	683	698
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P. P.

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P. P.

N.		0	1	2	3	4	5	6	7	8	9	P.P.
300	47	712	727	741	756	770	784	799	813	828	842	15
301		857	871	885	900	914	929	943	958	972	986	1 2
302	48	001	015	029	044	058	073	087	101	116	130	2 3
303		144	159	173	187	202	216	230	244	259	273	3 5
304		287	302	316	330	344	359	373	387	401	416	4 6
305		430	444	458	473	487	501	515	530	544	558	5 8
306		572	586	601	615	629	643	657	671	686	700	6 9
307		714	728	742	756	770	785	799	813	827	841	7 11
308		855	869	883	897	911	926	940	954	968	982	8 12
309		996	*010	*024	*038	*052	*066	*080	*094	*108	*122	9 14
310	49	136	150	164	178	192	206	220	234	248	262	
311		276	290	304	318	332	346	360	374	388	402	
312		415	429	443	457	471	485	499	513	527	541	
313		554	568	582	596	610	624	638	651	665	679	
314		693	707	721	734	748	762	776	790	803	817	14
315		831	845	859	872	886	900	914	927	941	955	1 1
316		969	982	996	*010	*024	*037	*051	*065	*079	*092	2 3
317	50	106	120	133	147	161	174	188	202	215	229	3 4
318		243	256	270	284	297	311	325	338	352	365	4 6
319		379	393	406	420	433	447	461	474	488	501	5 7
320		515	529	542	556	569	583	596	610	623	637	6 8
321		651	664	678	691	705	718	732	745	759	772	7 10
322		786	799	813	826	840	853	866	880	893	907	8 11
323		920	934	947	961	974	987	*001	*014	*028	*041	9 13
324	51	055	068	081	095	108	121	135	148	162	175	
325		188	202	215	228	242	255	268	282	295	308	
326		322	335	348	362	375	388	402	415	428	441	
327		455	468	481	495	508	521	534	548	561	574	13
328		587	601	614	627	640	654	667	680	693	706	1 1
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716	491	497	503	509	516	522	528	534	540	546	
717	552	558	564	570	576	582	588	594	600	606	
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774	874	880	885	891	897	902	908	913	919	925	
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805	580	585	590	596	601	607	612	617	623	628	
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853	095	100	105	110	115	120	125	131	136	141	
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875	201	206	211	216	221	226	231	236	240	245	
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891	988	993	998	*002	*007	*012	*017	*022	*027	*032	
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893	085	090	095	100	105	109	114	119	124	129	
894	134	139	143	148	153	158	163	168	173	177	
895	182	187	192	197	202	207	211	216	221	226	
896	231	236	240	245	250	255	260	265	270	274	
897	279	284	289	294	299	303	308	313	318	323	
898	328	332	337	342	347	352	357	361	366	371	
899	376	381	386	390	395	400	405	410	415	419	
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901	472	477	482	487	492	497	501	506	511	516	
902	521	525	530	535	540	545	550	554	559	564	
903	569	574	578	583	588	593	598	602	607	612	
904	617	622	626	631	636	641	646	650	655	660	
905	665	670	674	679	684	689	694	698	703	708	
906	713	718	722	727	732	737	742	746	751	756	
907	761	766	770	775	780	785	789	794	799	804	
908	809	813	818	823	828	832	837	842	847	852	
909	856	861	866	871	875	880	885	890	895	899	
910	904	909	914	918	923	928	933	938	942	947	5
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912	999	*004	*009	*014	*019	*023	*028	*033	*038	*042	2 1
913	96 047	052	057	061	066	071	076	080	085	090	3 2
914	095	099	104	109	114	118	123	128	133	137	4 2
915	142	147	152	156	161	166	171	175	180	185	5 3
916	190	194	199	204	209	213	218	223	227	232	6 3
917	237	242	246	251	256	261	265	270	275	280	7 4
918	284	289	294	298	303	308	313	317	322	327	8 4
919	332	336	341	346	350	355	360	365	369	374	9 5
920	379	384	388	393	398	402	407	412	417	421	
921	426	431	435	440	445	450	454	459	464	468	
922	473	478	483	487	492	497	501	506	511	515	
923	520	525	530	534	539	544	548	553	558	562	
924	567	572	577	581	586	591	595	600	605	609	
925	614	619	624	628	633	638	642	647	652	656	
926	661	666	670	675	680	685	689	694	699	703	
927	708	713	717	722	727	731	736	741	745	750	
928	755	759	764	769	774	778	783	788	792	797	
929	802	806	811	816	820	825	830	834	839	844	
930	848	853	858	862	867	872	876	881	886	890	4
931	895	900	904	909	914	918	923	928	932	937	1 0
932	942	946	951	956	960	965	970	974	979	984	2 1
933	988	993	997	*002	*007	*011	*016	*021	*025	*030	3 1
934	97 035	039	044	049	053	058	063	067	072	077	4 2
935	081	086	090	095	100	104	109	114	118	123	5 2
936	128	132	137	142	146	151	155	160	165	169	6 2
937	174	179	183	188	192	197	202	206	211	216	7 3
938	220	225	230	234	239	243	248	253	257	262	8 3
939	267	271	276	280	285	290	294	299	304	308	9 4
940	313	317	322	327	331	336	340	345	350	354	
941	359	364	368	373	377	382	387	391	396	400	
942	405	410	414	419	424	428	433	437	442	447	
943	451	456	460	465	470	474	479	483	488	493	
944	497	502	506	511	516	520	525	529	534	539	
945	543	548	552	557	562	566	571	575	580	585	
946	589	594	598	603	607	612	617	621	626	630	
947	635	640	644	649	653	658	663	667	672	676	
948	681	685	690	695	699	704	708	713	717	722	
949	727	731	736	740	745	749	754	759	763	768	
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951	818	823	827	832	836	841	845	850	855	859	
952	864	868	873	877	882	886	891	896	900	905	
953	909	914	918	923	928	932	937	941	946	950	
954	955	959	964	968	973	978	982	987	991	996	
955	98 000	005	009	014	019	023	028	032	037	041	
956	046	050	055	059	064	068	073	078	082	087	
957	091	096	100	105	109	114	118	123	127	132	
958	137	141	146	150	155	159	164	168	173	177	
959	182	186	191	195	200	204	209	214	218	223	
960	227	232	236	241	245	250	254	259	263	268	5
961	272	277	281	286	290	295	299	304	308	313	1 1
962	318	322	327	331	336	340	345	349	354	358	2 1
963	363	367	372	376	381	385	390	394	399	403	3 2
964	408	412	417	421	426	430	435	439	444	448	4 2
965	453	457	462	466	471	475	480	484	489	493	5 3
966	498	502	507	511	516	520	525	529	534	538	6 3
967	543	547	552	556	561	565	570	574	579	583	7 4
968	588	592	597	601	605	610	614	619	623	628	8 4
969	632	637	641	646	650	655	659	664	668	673	9 5
970	677	682	686	691	695	700	704	709	713	717	
971	722	726	731	735	740	744	749	753	758	762	
972	767	771	776	780	784	789	793	798	802	807	
973	811	816	820	825	829	834	838	843	847	851	
974	856	860	865	869	874	878	883	887	892	896	
975	900	905	909	914	918	923	927	932	936	941	
976	945	949	954	958	963	967	972	976	981	985	
977	989	994	998	*003	*007	*012	*016	*021	*025	*029	
978	99 034	038	043	047	052	056	061	065	069	074	
979	078	083	087	092	096	100	105	109	114	118	
980	123	127	131	136	140	145	149	154	158	162	4
981	167	171	176	180	185	189	193	198	202	207	1 0
982	211	216	220	224	229	233	238	242	247	251	2 1
983	255	260	264	269	273	277	282	286	291	295	3 1
984	300	304	308	313	317	322	326	330	335	339	4 2
985	344	348	352	357	361	366	370	374	379	383	5 2
986	388	392	396	401	405	410	414	419	423	427	6 2
987	432	436	441	445	449	454	458	463	467	471	7 3
988	476	480	484	489	493	498	502	506	511	515	8 3
989	520	524	528	533	537	542	546	550	555	559	9 4
990	564	568	572	577	581	585	590	594	599	603	
991	607	612	616	621	625	629	634	638	642	647	
992	651	656	660	664	669	673	677	682	686	691	
993	695	699	704	708	712	717	721	726	730	734	
994	739	743	747	752	756	760	765	769	774	778	
995	782	787	791	795	800	804	808	813	817	822	
996	826	830	835	839	843	848	852	856	861	865	
997	870	874	878	883	887	891	896	900	904	909	
998	913	917	922	926	930	935	939	944	948	952	
999	957	961	965	970	974	978	983	987	991	996	
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