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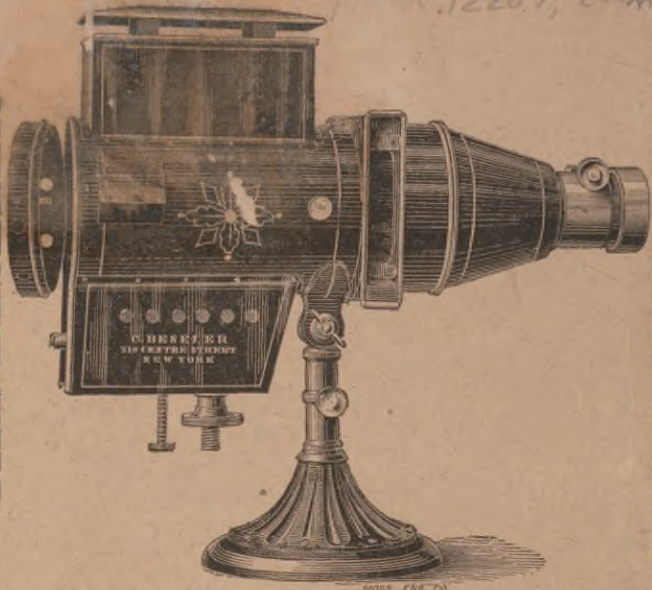


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1-3 " " 35 " " 12 " "	2-3 " " 64 " " 17 " "
1-3 " " 50 " " 19 " "	4-4 " " 83 " " 16 " "
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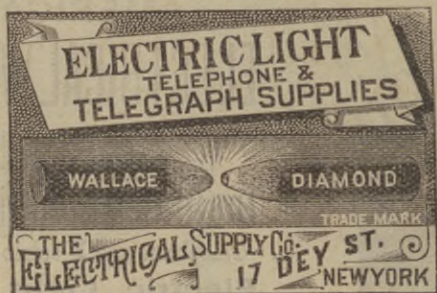
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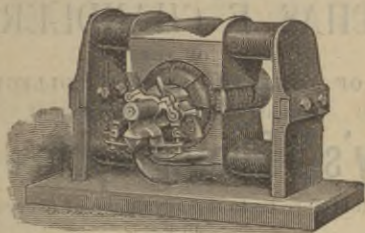
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THE laws of nature are
the thoughts of God.

ORSTED.

✧ CALENDAR. ✧

1885							1885								
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jan.	...	...	...	...	1	2	3	July	...	...	...	1	2	3	4
	4	5	6	7	8	9	10		5	6	7	8	9	10	11
	11	12	13	14	15	16	17		12	13	14	15	16	17	18
	18	19	20	21	22	23	24		19	20	21	22	23	24	25
	25	26	27	28	29	30	31	Aug.	...	...	...	...	...	...	...
Feb.	1	2	3	4	5	6	7		2	3	4	5	6	7	8
	8	9	10	11	12	13	14		9	10	11	12	13	14	15
	15	16	17	18	19	20	21		16	17	18	19	20	21	22
	22	23	24	25	26	27	28		23	24	25	26	27	28	29
Mar.	1	2	3	4	5	6	7	Sept.	...	...	...	...	...	...	...
	8	9	10	11	12	13	14		6	7	8	9	10	11	12
	15	16	17	18	19	20	21		13	14	15	16	17	18	19
	22	23	24	25	26	27	28		20	21	22	23	24	25	26
	29	30	31	...	...	...	...		27	28	29	30	...	...
Apr.	...	...	...	1	2	3	4	Oct.	...	...	...	...	...	...	...
	5	6	7	8	9	10	11		4	5	6	7	8	9	10
	12	13	14	15	16	17	18		11	12	13	14	15	16	17
	19	20	21	22	23	24	25		18	19	20	21	22	23	24
	26	27	28	29	30	...	...		25	26	27	28	29	30	31
May	...	...	...	...	...	1	2	Nov.	...	...	...	...	...	...	...
	3	4	5	6	7	8	9		1	2	3	4	5	6	7
	10	11	12	13	14	15	16		8	9	10	11	12	13	14
	17	18	19	20	21	22	23		15	16	17	18	19	20	21
	24	25	26	27	28	29	30		22	23	24	25	26	27	28
	31	...	...	...	...	...	...		29	30	...	...	...	...
June	...	1	2	3	4	5	6	Dec.	...	...	...	...	...	...	...
	7	8	9	10	11	12	13		6	7	8	9	10	11	12
	14	15	16	17	18	19	20		13	14	15	16	17	18	19
	21	22	23	24	25	26	27		20	21	22	23	24	25	26
	28	29	30	...	...	...	...		27	28	29	30	31	...	

Of all the year were playing holidays
to sport would be as tedious as to work.

FIRST PART—HENRY IV.

EDITORIAL GREETING.

The third annual issue of

THE LABORATORY HANDBOOK

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THE EDITOR.

ASTRONOMICAL NOTES FOR 1885.

ECLIPSES.

In the year 1885 there will be four eclipses, two of the sun and two of the moon.

I. An annular eclipse of the sun on March 16, visible at Washington as a partial eclipse.

CIRCUMSTANCES OF THE ECLIPSE.

	H. M.
Eclipse begins	10 09 A. M.
Central eclipse begins.....	11 31 "
Central eclipse at noon.....	1 06 P. M.
Central eclipse ends.....	1 43 "
Eclipse ends.....	3 06 "

II. A partial eclipse of the moon on March 30, invisible at Washington; visible in the Western Pacific Ocean, Asia and the eastern portion of Europe and Africa.

III. A total eclipse of the sun on September 8, invisible at Washington, but visible in the South Pacific Ocean.

IV. A partial eclipse of the moon on September 23-24, visible at Washington; also on the Atlantic Ocean, North and South America, and the Pacific Ocean.

TIMES OF THE PHASES.

	H. M.
Moon enters penumbra....	11 52 P. M.
Moon enters shadow.....	1 06 A. M.
Middle of the eclipse.....	2 40 "
Moon leaves shadow... ..	4 14 "
Moon leaves penumbra.....	5 28 "

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TABLE BASED ON THE LATEST REVISION OF
ATOMIC AND MOLECULAR WEIGHTS.

(Derived from Professor F. W. Clarke's figures.)

NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.	NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.
Aluminum, Al.....	27.0090	27.	Cobalt, Co.....	58.8870	58.9
Al ₂ O ₃	101.9079	101.9	Copper, Cu.....	63.1730	63.2
Al ₂ (SO ₄) ₃ + (NH ₄) ₂ SO ₄ + 24H ₂ O.....	904.5280	904.5	CuO.....	79.1303	79.1
Antimony, Sb.....	119.9550	120.	CuSO ₄ + 5H ₂ O.....	248.8267	248.8
Sb ₂ O ₄	303.7632	303.8	Didymium, D.....	144.5730	144.6
Sb ₂ S ₃	335.8620	335.9	Erbium, E.....	165.8910	165.9
K Sb O H ₂ O ₄ C ₄ H ₂ O ₂ + 1/2 H ₂ O.....	331.5931	331.6	Fluorine, Fl.....	18.9840	19.
Arsenic, As.....	74.9180	74.9	Gallium, Ga.....	68.8540	68.9
As ₂ O ₃	197.7259	197.7	Glucinum, G.....	9.0850	9.1
As ₂ S ₃	245.7880	245.8	Gold, Au.....	196.1550	196.2
NH ₄ Mg As O ₄ + 12 H ₂ O.....	396.3108	396.3	Hydrogen, H.....	1.0000	1.
Mg ₂ As ₂ O ₇	309.4971	309.5	H ₂ O.....	17.9633	18.
Barium, Ba.....	136.7630	136.8	Indium, In.....	113.3980	113.4
BaCl ₂ + 2H ₂ O.....	243.4296	243.4	Iodine, I.....	126.5570	126.6
BaSO ₄	232.6002	232.6	KI.....	165.5760	165.6
Bismuth, Bi.....	207.5230	207.5	AgI.....	234.2320	234.2
Bi ₂ O ₃	462.9359	462.9	Iridium, Ir.....	192.6510	192.7
BiONO ₃	285.3972	285.4	Iron, Fe.....	55.9130	55.9
Boron, Bo.....	10.9410	10.9	Fe ₂ O ₃	159.7159	159.7
Bromine, Br.....	79.7680	79.8	FeSO ₄ + 7H ₂ O.....	277.4933	277.5
KBr.....	118.7870	118.8	Fe SO ₄ + (NH ₄) ₂ SO ₄ + 6H ₂ O.....	391.4092	391.4
AgBr.....	187.4430	187.4	Fe ₂ (SO ₄) ₃ + (NH ₄) ₂ SO ₄ + 24H ₂ O.....	962.3360	962.3
Cadmium, Cd.....	111.8350	111.8	Lanthanum, La.....	138.5260	138.5
CdO.....	127.7983	127.8	Lead, Pb.....	206.4710	206.5
CdS.....	143.8190	143.8	PbO.....	222.4343	222.4
Cæsium, Cs.....	132.5830	132.6	PbS.....	238.4550	238.5
Calcium, Ca.....	39.9900	40.	Pb(NO ₃) ₂	330.2928	330.3
CaO.....	55.9533	56.	PbSO ₄	302.3082	302.3
CaCO ₃	99.8535	99.0	Lithium, Li.....	7.0073	7.
CaSO ₄	135.8272	135.8	Magnesium, Mg.....	23.9590	24.
Carbon, C.....	11.9736	12.	MgO.....	39.9223	39.9
CO.....	27.9369	27.9	MgSO ₄ + 7H ₂ O.....	245.5393	245.5
CO ₂	43.9002	43.9	Mg ₃ P ₂ O ₇	221.5771	221.6
Cerium, Ce.....	140.4240	140.4	Manganese, Mn.....	53.9060	53.9
Chlorine, Cl.....	35.3700	35.4	MnO.....	69.8693	69.9
AgCl.....	143.0450	143.	MnO ₂	85.8326	85.8
NaCl.....	58.3680	58.4	Mn ₂ O ₄	225.5712	225.6
Chromium, Cr.....	52.0090	52.			
Cr ₂ O ₃	151.9079	151.9			
K ₂ Cr ₂ O ₇	293.7991	293.8			
K ₂ SO ₄ + Cr ₂ (SO ₄) ₃ + 24H ₂ O.....	996.5240	996.5			

TABLE BASED ON THE LATEST REVISION OF
 ATOMIC AND MOLECULAR WEIGHTS.

(Continued.)

NAMES OR FORMULAS.	WEIGHTS.	Approximate Weights.	NAMES OR FORMULAS.	WEIGHTS.	Approximate Weights.
Mercury, Hg.....	199.7120	199.7	Rubidium, Rb.....	85.2510	85.3
HgCl ₂	270.4520	270.5	Ruthenium, Ru.....	104.2170	104.2
HgS.....	231.6960	231.7	Scandium, Sc.....	43.9800	44.
Molybdenum, Mo...	95.5270	95.5	Selenium, Se.....	78.7970	78.8
Nickel, Ni.....	57.9280	57.9	Silicon, Si.....	28.1950	28.2
NiO.....	73.8913	73.9	SiO ₂	60.1216	60.1
Ni SO ₄ + (NH ₄) ₂ SO ₄ +6H ₂ O.....	393.4242	393.4	Silver, Ag.....	107.6750	107.7
Niobium, Nb.....	93.8120	93.8	AgCl.....	143.0450	143.
Nitrogen, N.....	14.0210	14.	AgNO ₃	169.5859	169.6
N ₂ O.....	107.8585	107.9	Sodium, Na.....	22.9980	23.
HNO ₃	62.9109	62.9	NaCl.....	58.3680	58.4
KNO ₃	100.9299	100.9	Na ₂ CO ₃	105.8595	105.9
NH ₃	17.0210	17.	Na ₂ O.....	61.9593	62.
NH ₄	18.0210	18.	Strontium, Sr.....	87.3740	87.4
NH ₄ Cl.....	53.3910	53.4	SrSO ₄	183.2112	183.2
NH ₄ OH.....	34.9843	35.	Sulphur, S.....	31.9840	32.
(NH ₄) ₂ PtCl ₆	442.6770	442.7	SO ₂	63.9106	63.9
Osmium, Os.....	198.4940	198.5	SO ₃	79.8739	79.9
Oxygen, O.....	15.9633	16.	SO ₄	95.8372	95.8
O ₂	31.9266	31.9	H ₂ SO ₄	97.8372	97.8
O ₃	47.8899	47.9	Tantalum, Ta.....	182.1440	182.1
O ₄	63.8532	63.9	Tellurium, Te.....	127.9600	128.
O ₅	79.8165	79.8	Thallium, Tl.....	203.7150	203.7
O ₆	95.7798	95.8	Thorium, Th.....	233.4140	233.4
O ₇	111.7431	111.7	Tin, Sn.....	117.6980	117.7
O ₈	127.7064	127.7	SnCl ₂ +2H ₂ O.....	224.3646	224.4
O ₉	143.6697	143.7	SnO ₂	149.6246	149.6
Palladium, Pd.....	105.7370	105.7	*Titanium, Ti.....	47.9997	48.
Phosphorus, P.....	30.9580	31.	Tungsten, W.....	183.6100	183.6
P ₂ O ₅	141.7325	141.7	Uranium, U.....	238.4820	238.5
Mg ₂ P ₂ O ₇	221.5771	221.6	Vanadium, Va.....	51.2560	51.3
Platinum, Pt.....	194.4150	194.4	Ytterbium, Yb.....	172.7610	172.8
K ₂ PtCl ₆	484.6730	484.7	Yttrium, Y.....	89.8160	89.8
(NH ₄) ₂ PtCl ₆	442.6770	442.7	Zinc, Zn.....	64.9045	64.9
Potassium, K.....	39.0190	39.	ZnO.....	80.8678	80.9
K ₂ O.....	94.0013	94.	ZnSO ₄ +7H ₂ O.....	286.4848	286.5
KCl.....	74.3890	74.4	Zirconium, Zr.....	89.3670	89.4
K ₂ PtCl ₆	484.6730	484.7			
K ₂ SO ₄	173.8752	173.9			
Rhodium, Rh.....	104.0550	104.1			

*Thorpe, T. E., Chemical News, 48: 251.

TABLES OF WEIGHTS AND MEASURES.

ENGLISH WEIGHTS.

TROY WEIGHT.					
<i>Pound.</i>	<i>Ounces.</i>	<i>Pennyweights.</i>	<i>Grains.</i>	<i>French Grammes.</i>	
1	12	240	5760	=	373.2419
	1	20	480	=	31.1035
		1	24	=	1.5552

APOTHECARIES' WEIGHT.

<i>lb.</i>	<i>Ounces.</i>	<i>Drachms.</i>	<i>Scruples.</i>	<i>Grains.</i>	<i>French Grammes.</i>	
1	12	96	288	5760	=	373.2419
	1	8	24	480	=	31.1035
		1	3	60	=	3.8779
			1	20	=	1.2959
				1	=	.0648

AVOIRDUPOIS WEIGHT.

<i>Pound.</i>	<i>Ounces.</i>	<i>Drachms.</i>	<i>Grains.</i>	<i>French Grammes.</i>	
1	16	256	7000	=	453.5926
	1	16	437.5	=	28.3495
		1	27.343	=	1.7718

METRIC MEASURES.

MEASURES OF LENGTH.

1 Millimetre	=	0.001 of a metre.	
1 Centimetre	=	0.010 of a metre.	
1 Decimetre	=	0.100 of a metre	= about 4 inches.
1 Metre	=	1.000 Metre	= 39.37 inches.
1 Decametre	=	10 000 metres.	
1 Hectometre	=	100.000 metres.	
1 Kilometre	=	1,000 000 metres	= about $\frac{5}{8}$ of a mile.
1 Myriametre	=	10,000,000 metres	= about $6\frac{1}{5}$ miles.

MEASURES OF SURFACE.

1 Centiare	=	1 Square metre	= about $1\frac{1}{5}$ square yards.
1 Are	=	100 Square metres.	
1 Hectare	=	10,000 Square metres	= about $2\frac{1}{2}$ acres.

MEASURES OF VOLUME.

1 Cubic Metre	=	1000 Cubic Decimetres.
	=	1000 Litres, or one Kilolitre.
	=	1 Stere.

MEASURES OF CAPACITY.

1 Litre	=	{ 1 cubic decimetre, / or 1000 cubic centimetres }	= about 1 quart.
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MEASURES OF WEIGHT.

1 Milligramme	=	0.001 of a gramme	= about $\frac{1}{65}$ of a grain.
1 Centigramme	=	0.010 of a gramme.	
1 Decigramme	=	0.100 of a gramme.	
1 Gramme	=	1.000 Gramme	= about $15\frac{1}{2}$ grains.
1 Decagramme	=	10.000 grammes.	
1 Hectogramme	=	100.000 grammes.	
1 Kilo(gramme)	=	1000.000 grammes	= about $2\frac{1}{5}$ lbs.
1 Tonneau	=	1000. Kilo's	= about 1 ton.

ALPHABETICAL TABLE OF EQUIVALENT VALUES OF
WEIGHTS AND MEASURES.

1 Are = 100 sq. metres	119.6 sq. yards.
1 Centiare = 1 sq. metre, = 100 sq. centimetres	1550. sq. inches.
1 Centimetre = $\frac{1}{100}$ of a metre .....	.3937 inches.
1 Cubic centimetre; (of dist. water, weighs 1 gm.) .....	.0610 cub. inches.
1 Cubic decimetre, (same as 1 litre)	1000 C. C.
1 " " of distilled water, weighs 1000 gms., or	1 kilogramme.
1 " " in English or imperial measure .....	.8804 quarts.
1 " " in American or wine measure	1.0567 quarts.
1 Cubic foot (1728 cubic inches)	28,315.3119 cub. cent.
1 " " of water (at 62° F.) weighs	62.3210 lbs. Av.
1 Cubic inch	16.3861 cub. cent.
1 " " of water (at 62 F.) weighs	252.458 grains.
1 " " of water (at 60° F.) weighs	252.5 grains.
1 Cubic metre (1 Stere), = 1,000,000. C. C., or	1000. litres.
1 Fluid ounce, imperial, = 28.4 C. C.	1.7329 cub. inches.
1 " " wine measure, = 29 5 C. C.	1.8047 cub. inches.
1 " " imperial, of water (62° F.) weighs	437.5 grains.
1 " " wine measure, of water (60° F.) weighs	456.0 grains.
1 Foot	30.48 centimetres.
1 Gallon, imperial, = 277.274 cubic inches	4.5435 litres.
1 " " of water, weighs (62° F.) 10 lbs. or	70,000 grains.
1 Gallon, wine measure, = 231. cubic inches	3 7852 litres.
1 " " of water, weighs (60° F.) 8.34 lbs. or	58,372.2 grains.
1 Gramme (weight of 1 C. C. of dist. water, 4° C.)	15.4323 grains.
1 Inch	2.54 centimetres.
1 Kilogramme (1000 grammes)	2.2046 lbs. Av.
1 Litre (see cubic decimetre).	
1 Metre (1 40-mill' th of Earth's meridian) 3 ft. 3 in. $\frac{3}{8}$ in., nearly.	39.3708 inches.
1 Pint, wine meas., = 16 fluid oz. = of water (60° F.) 7296.5 gr. . .	473.148 cub. cent.
1 " imperial, = 20 fluid oz. = of water (62° F.) 8750. gr.	567.932 cub. cent.
1 Quart, wine measure, = 32 fluid ounces .....	.9463 litres.
1 " imperial, = 40 fluid ounces	1.1358 litres.
1 Ton Avoirdupois (2000 lbs.)	29,166 $\frac{3}{4}$. oz. Troy.
1 Tonneau, = 1,000,000 gms.	1000 kilo's.

TABLE SHOWING CORRESPONDING DEGREES ON THE SCALES OF
THE FAHRENHEIT AND CENTIGRADE
THERMOMETERS.

FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.
32...	0.	62 ..	16.6	91.4..	33.	121 ..	49.4	152...	66.6	182...	83.3
33....	.5	62.6..	17.	92....	33.3	122...	50.	152.6.	67	183...	83.8
33.8..	1.	63 ...	17.2	93....	33.8	123...	50.5	153...	67.2	183.2.	84
34... ..	1.1	64....	17.7	93.2..	34.	123.8.	51.	154...	67.7	184...	84.4
35....	1.6	64.4..	18.	94....	34.4	124...	51.1	154.4.	68.	185...	85.
35.6..	2.	65....	18.3	95....	35.	125....	51.6	155....	68.3	186....	85.5
36....	2.2	66 ...	18.8	96....	35.5	125.6.	52.	156....	68.8	186.8.	86.
37 ...	2.7	66.2..	19.	96.8..	36.	126....	52.2	156.2.	69.	187...	86.1
37.4..	3.	67....	19.4	97....	36.1	127....	52.7	157...	69.4	188...	86.6
38....	3.3	68....	20.	98....	36.6	127.4.	53.	158...	70.	188.6.	87.
39....	3.8	69....	20.5	98.6..	37.	128...	53.3	159...	70.5	189....	87.2
39.2..	4.	69.8..	21.	99....	37.2	129...	53.8	159.8.	71.	190....	87.7
40....	4.4	70....	21.1	100....	37.7	129.2.	54.	160....	71.1	190.4.	88.
41....	5.	71....	21.6	100.4.	38.	130....	54.4	161 ..	71.6	191....	88.3
42....	5.5	71.6..	22.	101....	38.3	131. .	55.	161.6.	72.	192...	88.8
42.8..	6.	72....	22.2	102...	38.8	132...	55.5	162...	72.2	192.2.	89.
43....	6.1	73....	22.7	102.2.	39.	132.8.	56.	163....	72.7	193....	89.4
44....	6.6	73.4..	23.	103..	39.4	133....	56.1	163.4.	73.	194....	90.
44.6..	7.	74....	23.3	104...	40.	134...	56.6	164...	73.3	195...	90.5
45....	7.2	75....	23.8	105....	40.5	134.6.	57.	165...	73.8	195.8.	91.
46....	7.7	75.2..	24.	105.8.	41.	135....	57.2	165.2.	74.	196....	91.1
46.4..	8.	76 ...	24.4	106....	41.1	136...	57.7	166....	74.4	197....	91.6
47 ...	8.3	77....	25.	107....	41.6	136.4.	58.	167....	75.	197.6.	92.
48....	8.8	78....	25.5	107.6.	42.	137...	58.3	168....	75.5	198....	92.2
48.2..	9.	78.8..	26.	108....	42.2	138 ..	58.8	168.8.	76.	199....	92.7
49....	9.4	79....	26.1	109....	42.7	138.2.	59.	169...	76.1	199.4.	93.
50....	10.	80....	26.6	109.4.	43.	139...	59.4	170....	76.6	200....	93.3
51....	10.5	80.6..	27.	110....	43.3	140....	60.	170.6.	77.	201....	93.8
51.8..	11.	81....	27.2	111....	43.8	141....	60.5	171...	77.2	201.2.	94.
52....	11.1	82....	27.7	111.2.	44.	141.8.	61.	172...	77.7	202...	94.4
53....	11.6	82.4..	28.	112...	44.4	142....	61.1	172.4.	78.	203...	95.
53.6..	12.	83....	28.3	113...	45.	143....	61.6	173....	78.3	204...	95.5
54....	12.2	84....	28.8	114....	45.5	143.6.	62.	174....	78.8	204.8.	96.
55....	12.7	84.2..	29.	114.8.	46.	144....	62.2	174.2.	79.	205...	96.1
55.4..	13.	85....	29.4	115....	46.1	145...	62.7	175...	79.4	206....	96.6
56....	13.3	86....	30.	116....	46.6	145.4.	63.	176...	80.	206.6.	97.
57 ...	13.8	87....	30.5	116.6.	47.	146....	63.3	177...	80.5	207...	97.2
57.2..	14.	87.8..	31.	117...	47.2	147...	63.8	177.8.	81.	208...	97.7
58....	14.4	88....	31.1	118....	47.7	147.2.	64.	178...	81.1	208.4.	98.
59 ...	15.	89....	31.6	118.4.	48.	148....	64.4	179...	81.6	209...	98.3
60	15.5	89.6..	32.	119....	48.3	149....	65.	179.6.	82.	210...	98.8
60.8..	16.	90....	32.2	120....	48.8	150....	65.5	180....	82.2	210.2.	99.
61....	16.1	91....	32.7	120.2.	49.	150.8.	66.	181...	82.7	211...	99.4
						151....	66.1	181.4.	83.	212...	100.

SPECIFIC GRAVITIES OF SOLID AND LIQUID ELEMENTS. (WATER=1.)

Lithium.....	.59	Zinc.....	7.10 — 7.20
Potassium .....	.86	Tin.....	7.29 — 7.30
Sodium.....	.97	Iron.....	7.79 — 7.84
Chlorine (liquid).....	1.33	Manganese.....	8.01 — 8.03
Calcium.....	1.58	Cobalt.....	8.49 — 8.51
Magnesium	1.70 — 1.74	Nickel.....	8.60 — 8.82
Phosphorus.....	1.83 — 1.96	Cadmium.....	8.45 — 8.69
Sulphur.....	1.98 — 2.07	Molybdenum.....	8.62 — 8.64
Glucinum.....	2.10	Copper.....	8.93 — 8.95
Carbon.....	2.27 — 3.52	Bismuth.....	9.78 — 9.80
Silicon.....	2.49	Silver.....	10.40 — 10.57
Aluminum.....	2.50 — 2.67	Rhodium.....	11.00 — 11.20
Strontium	2.54	Lead.....	11.33 — 11.39
Bromine (liquid)	2.99 — 3.19	Palladium... ..	11.80
Selenium.....	4.28 — 4.80	Mercury (liquid.).....	13.60
Iodine.....	4.95	Tungsten.....	17.20 — 18.30
Arsenic	5.63 — 5.67	Uranium	18.40
Tellurium	6.18 — 6.24	Gold.. ..	19.26 — 19.34
Antimony.....	6.72	Platinum	21.50
Chromium.....	7.01	Iridium.....	21.80

SIMPLE FORMULAS FOR CALCULATING AREAS, SURFACES AND VOLUMES.

$$\pi = 3.1416.$$

PLANE AREAS.

Triangle, (altitude, a ; base, b).....	Area =	$\frac{1}{2} ab$.
Circle, (radius, R ; diameter, D).....	" =	πR^2 or $\frac{1}{4} \pi D^2$
Ellipse, (semi-axes, a and b).....	" =	πab .

SURFACES OF SOLIDS.

Sphere, (radius, R ; diameter, D).....	Surface =	$4 \pi R^2$ or πD^2 .
Cylinder, (radius, R ; height, h).....	" =	$2(\pi R^2) + (2\pi R)h = 2\pi R(R+h)$.

VOLUMES OF SOLIDS.

Sphere, (radius, R ; diameter, D).....	Volume =	$\frac{4}{3} \pi R^3$ or $\frac{1}{6} \pi D^3$.
Cylinder or Prism, (height, h ; area of base, a).....	" =	ah .
Cone or Pyramid, (height, h ; area of base, a).....	" =	$\frac{1}{3} ah$.

THE C. G. S. SYSTEM OF UNITS.

The C. G. S. System of Units is the result of an attempt to express all quantities with which physical science deals, in terms of three fundamental units:—

A Unit of Length, the centimetre:—

A Unit of Mass, the gramme;

A Unit of Time, the second.

From these the following units are derived:—

Unit of *Surface*; the square centimetre.

“ “ *Volume*; the cubic centimetre.

“ “ *Velocity*; the velocity of one centimetre per second.

“ “ *Acceleration*; the acceleration which imparts unit velocity to a body, in one second.

“ “ *Force*; the dyne; the force, which, acting on a gramme mass for one second, imparts to it a unit of velocity.

“ “ *Work*; the erg; the work done by a dyne working through one centimetre.

“ “ *Energy*; also the erg: since the energy of a body is measured by the amount of work it can do.

“ “ *Heat*; the amount of heat required to raise one gramme of water from 0° to 1° C.

“ “ *Magnetic Strength*; a magnetic pole has unit strength when it repels a similar pole of equal strength, one centimetre distant, with the force of a dyne.

“ “ *Electric Current* (electro-magnetic system); a current of such strength that one centimetre of its circuit, bent so that every point of it is one centimetre distant from a unit magnetic pole, exerts upon this pole the force of a dyne.

“ “ *Electric Quantity* (electro-magnetic system); the quantity conveyed by a unit current in one second.

“ “ *Difference of Potential* (electro magnetic system); two points have unit difference of potential when one erg of work must be expended to bring a unit of + electricity from one to the other against the electric force.

“ “ *Electric Resistance* (electro-magnetic system); a conductor possesses unit resistance when a unit difference of potential between its ends, causes a unit current to flow through it.

ALPHABETICAL TABLE OF UNITS USED IN PHYSICAL SCIENCE.

- Ampère; unit of electric current; 10^{-1} C. G. S. units; the current produced by the difference of potential of a volt through the resistance of an ohm.
- Calorie; French unit of heat; quantity of heat required to raise one kilogramme of water from 0° to 1° C; equals 3.968 Eng. units of heat. (See *Heat, English unit of.*)
- Capacity, unit of electric. See *Farad.*
- Cheval-de-vapeur. See *Force-de-cheval.*
- Coulomb; unit of electric quantity; 10^{-1} C. G. S. units; quantity conveyed by the current of an ampère in a second.
- Current, unit of electric. See *Ampère.*
- Electro-motive force, unit of. See *Volt.*
- Farad; unit of electric capacity; 10^{-9} C. G. S. units; quantity which, with the electro-motive force of a volt, would flow through the resistance of an ohm in one second.
- Foot-pound; English unit of work; work required to raise one pound through one foot in opposition to the force of gravity.
- Force, units of. See *Kilogramme* and *Pound.*
- Force-de-cheval; French unit of power; .9864 horse-power; power of doing 75 kilogrammetres (542.5 foot-pounds) of work per second.
- Heat, English unit of; heat required to raise one pound of water from 32° to 33° F. (See *Calorie.*)
- Horse-power; English unit of power; power required to perform 550 foot-pounds of work per second.
- Kilogramme; French unit of mass, and also of force. (See *Pound.*)
- Kilogrammetre; French unit of work; work required to raise one kilogramme of mass through one metre in opposition to force of gravity.
- Mass, units of. See *Kilogramme* and *Pound.*
- Ohm; unit of electric resistance; 10^9 C. G. S. units; is the resistance offered to a current of electricity by a wire of pure silver or copper one millimetre in diameter and 48.61 metres long at 65° F (18.3° C).
- Potential, unit difference of. See *Volt.*
- Pound; English unit of mass; regarded as a *weight* it is used also as the unit of force, i. e. the force exercised by the mass of a pound (where $g = 981$; London).
- Power, unit of. See *Force-de-cheval* and *Horse-power.*
- Power, unit of electric. See *Watt.*
- Quantity, unit of electric. See *Coulomb.*
- Quantity, unit of magnetic. See *Weber.*
- Resistance, unit of electric. See *Ohm.*
- Volt; unit of electro-motive force; 10^8 C. G. S. units; equals .9268 of the force of one Daniell cell.
- Watt; unit of electric power; 10^7 C. G. S. units; power exerted by the current of an ampère through the difference of potential of a volt.
- Weber; unit of magnetic quantity; 10^9 C. G. S. units.
- Work, units of. See *Foot-pound* and *Kilogrammetre.*

TABLE OF LOGARITHMS.

Nat. Numb.	PROPORTIONAL PARTS.									
	1	2	3	4	5	6	7	8	9	
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010

TABLE OF LOGARITHMS.

Nat. Numb.	PROPORTIONAL PARTS.									
	0	1	2	3	4	5	6	7	8	9
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222
42	6243	6243	6253	6263	6274	6284	6294	6304	6314	6325
43	6345	6345	6355	6365	6375	6385	6395	6405	6415	6425
44	6444	6444	6454	6464	6474	6484	6493	6503	6513	6522
45	6542	6542	6551	6561	6571	6580	6590	6599	6609	6618
46	6628	6628	6646	6656	6665	6675	6684	6693	6702	6712
47	6721	6721	6739	6749	6758	6767	6776	6785	6794	6803
48	6812	6812	6830	6839	6848	6857	6866	6875	6884	6893
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551
57	7566	7574	7582	7590	7598	7606	7614	7622	7630	7637
58	7644	7652	7660	7668	7676	7684	7692	7700	7708	7716
59	7723	7731	7739	7747	7755	7763	7771	7779	7787	7795
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445

TABLE OF LOGARITHMS.

Nat. Numb.	PROPORTIONAL PARTS.									
	0	1	2	3	4	5	6	7	8	9
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440
88	9445	9450	9455	9460	9465	9470	9474	9479	9484	9489
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863
97	9868	9872	9877	9881	9885	9890	9894	9899	9903	9908
98	9912	9917	9921	9926	9930	9934	9938	9943	9948	9952
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996

TABLE OF ANTI-LOGARITHMS.

Logs.	PROPORTIONAL PARTS.									
	0	1	2	3	4	5	6	7	8	9
.0	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021
.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069
.03	1072	1074	1076	1079	1081	1084	1085	1087	1091	1094
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172
.07	1175	1178	1180	1183	1185	1188	1191	1194	1197	1199
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346
.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991

TABLE OF ANTI-LOGARITHMS.

Logs	PROPORTIONAL PARTS.									
	0	1	2	3	4	5	6	7	8	9
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234
.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339
.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877
.46	2884	2891	2897	2904	2911	2918	2924	2931	2938	2944
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228
.51	3236	3243	3251	3258	3266	3273	3281	3288	3296	3304
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972

TABLE OF ANTI-LOGARITHMS.

Logs.	PROPORTIONAL PARTS.									
	0	1	2	3	4	5	6	7	8	9
.60	3981	3999	4009	4018	4027	4036	4046	4055	4064	4074
.61	4074	4083	4092	4102	4111	4120	4130	4140	4150	4159
.62	4160	4178	4188	4198	4207	4217	4227	4236	4246	4256
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775
.68	4785	4797	4808	4819	4831	4842	4853	4864	4875	4887
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358
.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610
.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925

TABLE OF ANTI-LOGARITHMS.

Log.	PROPORTIONAL PARTS.									
	1	2	3	4	5	6	7	8	9	
.90	7943	7980	7998	8017	8035	8054	8072	8091	8110	2 4 6 7 9 11 13 15 17
.91	8128	8166	8185	8204	8222	8241	8260	8279	8299	2 4 6 8 9 11 13 15 17
.92	8318	8356	8375	8395	8414	8433	8453	8472	8492	2 4 6 8 10 12 14 15 17
.93	8511	8531	8550	8570	8590	8610	8630	8650	8690	2 4 6 8 10 12 14 16 18
.94	8710	8730	8750	8790	8810	8831	8851	8872	8892	2 4 6 8 10 12 14 16 18
.95	8913	8933	8954	8995	9016	9036	9057	9078	9099	2 4 6 8 10 12 15 17 19
.96	9120	9141	9162	9204	9226	9247	9268	9290	9311	2 4 6 8 11 13 15 17 19
.97	9333	9354	9377	9419	9441	9462	9484	9506	9528	2 4 7 9 11 13 15 17 20
.98	9550	9572	9594	9638	9661	9683	9705	9727	9750	2 4 7 9 11 13 15 18 20
.99	9772	9795	9817	9863	9886	9908	9931	9954	9977	2 5 7 9 11 14 16 18 20

GUIDE TO THE USE OF THE FOREGOING TABLES.

Logarithm	2080	Logarithm	3.3181	Logarithm	2.08	.....	.3181
"	208	"	2.3181	" .....	.208	.....	1.3181
"	20.8	"	1.3181	" .....	.0208	.....	2.3181

Find Logarithm of 4026.

Logarithm 4020	3.6042	Find Natural Number for Logarithm 3.2432.	
Proportional part for 6	6	Number for Logarithm 3.2430	1750.
Logarithm required	3.6048	Add proportional part for 2,	1.
		Natural number required,	1751.

To MULTIPLY by use of Logarithms: Add together the logarithms of the numbers to be multiplied; the sum is a logarithm whose natural number is the product required.

To DIVIDE by use of Logarithms: Subtract the logarithm of the divisor from the logarithm of dividend; the difference is a logarithm whose natural number is the quotient required.

To EXTRACT A ROOT by use of Logarithms: Divide the logarithm of the number (whose root is to be extracted) by the index of the root; the quotient is the logarithm of the required root.

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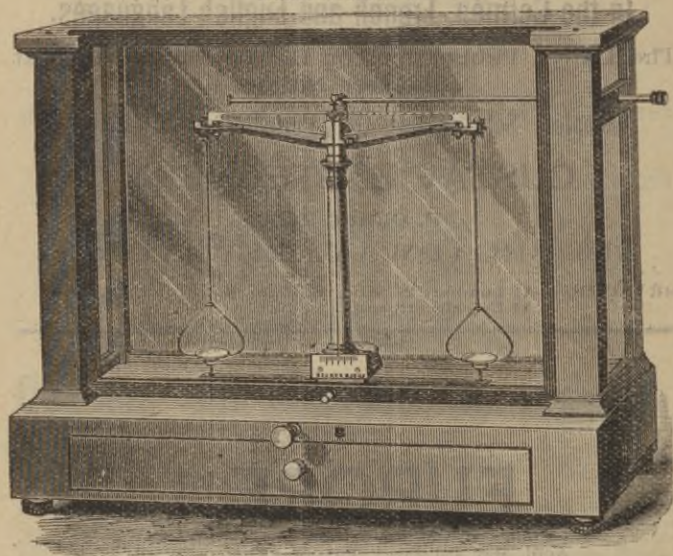
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
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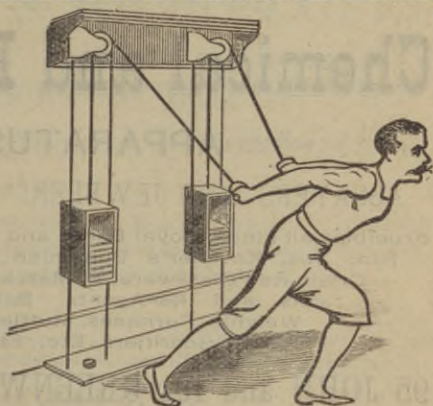
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