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978-1-108-05067-8 - A Synopsis of Elementary Results in Pure and Applied Mathematics: Containing Propositions, Formulae, and Methods of Analysis, with Abridged Demonstrations: Volume 1

George Shobridge Carr

Excerpt

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MATHEMATICAL TABLES.

INTRODUCTION.

The Centimetre-Gramme-Second system of units.

NOTATION.—The decimal measures of length are the *kilometre*, *hectometre*, *decametre*, *metre*, *decimetre*, *centimetre*, *millimetre*. The same prefixes are used with the *litre* and *gramme* for measures of capacity and volume.

Also, 10^7 metres is denominated a *metre-seven*; 10^{-7} metres, a *seventh-metre*; 10^{15} grammes, a *gramme-fifteen*; and so on.

A gramme-million is also called a *megagramme*; and a millionth-gramme, a *microgramme*; and similarly with other measures.

DEFINITIONS.—The C. G. S. system of units refers all physical measurements to the *Centimetre* (cm.), the *Gramme* (gm.), and the *Second* (sec.) as the units of length, mass, and time.

The quadrant of a meridian is approximately a *metre-seven*. More exactly, one metre = 3·2808694 feet = 39·370432 inches.

The *Gramme* is the *Unit of mass*, and the *weight of a gramme* is the *Unit of weight*, being approximately the weight of a cubic centimetre of water; more exactly, 1 gm. = 15·432349 grs.

The *Litre* is a cubic decimetre: but *one cubic centimetre* is the C. G. S. *Unit of volume*.

1 litre = ·035317 cubic feet = ·2200967 gallons.

The *Dyne* (dn.) is the *Unit of force*, and is the force which, in one second generates in a gramme of matter a velocity of one centimetre per second.

The *Erg* is the *Unit of work and energy*, and is the work done by a dyne in the distance of one centimetre.

The absolute *Unit of atmospheric pressure* is one megadyne per square centimetre = 74·964 cm., or 29·514 in. of mercurial column at 0° at London, where $g = 981·17$ dynes.

Elasticity of Volume = k , is the pressure per unit area upon a body divided by the cubic dilatation.

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Rigidity = n , is the shearing stress divided by the angle of the shear.

Young's Modulus = M , is the longitudinal stress divided by the elongation produced, = $9nk \div (3k+n)$.

Tenacity is the tensile strength of the substance in dynes per square centimetre.

The *Gramme-degree* is the *Unit of heat*, and is the amount of heat required to raise by 1° C. the temperature of 1 gramme of water at or near 0° .

Thermal capacity of a body is the increment of heat divided by the increment of temperature. When the increments are small, this is the thermal capacity *at* the given temperature.

Specific heat is the thermal capacity of unit mass of the body at the given temperature.

The *Electrostatic unit* is the quantity of electricity which repels an equal quantity at the distance of 1 centimetre with the force of 1 dyne.

The *Electromagnetic unit* of quantity = 3×10^{10} *electrostatic units* approximately.

The *Unit of potential* is the potential of unit quantity at unit distance.

The *Ohm* is the common *electromagnetic unit* of resistance, and is approximately = 10^9 *C. G. S. units*.

The *Volt* is the *unit of electromotive force*, and is = 10^8 *C. G. S. units of potential*.

The *Weber* is the *unit of current*, being the current due to an electromotive force of 1 Volt, with a resistance of 1 Ohm. It is = $\frac{1}{10}$ *C. G. S. unit*.

Resistance of a Wire = *Specific resistance* \times *Length* \div *Section*.

Physical constants and Formulæ.

In the latitude of London, $g = 32.19084$ feet per second.
= 981.17 centimetres per second.

In latitude λ , at a height h above the sea level,

$g = (980.6056 - 2.5028 \cos 2\lambda - .000003 h)$ centimetres per second.

Seconds pendulum = $(99.3562 - .2536 \cos 2\lambda - .0000003 h)$ centimetres.

THE EARTH.—Semi-polar axis, 20,854,895 feet* = 6.35411×10^8 centims.

Mean semi-equatorial diameter, 20,926,202 „ * = 6.37824×10^8 „

Quadrant of meridian, 39,377,786 $\times 10^7$ inches* = 1.000196×10^7 metres.

Volume, 1.08279 cubic centimetre-nines.

Mass (with a density $5\frac{1}{2}$) = Six gramme-twenty-sevens nearly.

* These dimensions are taken from Clarke's "Geodesy," 1880.

TABLE I.
Various Measures and their Equivalents in C. G. S. units.

<i>Dimensions.</i>		<i>Pressure.</i>	
1 inch	= 2·5400 cm.	1 gm. persq. cm.	= 981 dynes persq. cm.
1 foot	= 30·4797 "	1 lb. per sq. foot	= 479 "
1 mile	= 160933 "	1 lb. per sq. in.	= 68971 "
1 nautical do.	= 185230 "	76 centimetres of mercury at 0° C.	} = 1,014,000 "
1 sq. inch	= 6·4516 sq. cm.	lbs. per sq. in.	
1 sq. foot	= 929·01 "	<i>Force of Gravity.</i>	
1 sq. yard	= 8361·13 "	upon 1 gramme	= 981 dynes
1 sq. mile	= 2·59 × 10 ¹⁰ "	" 1 grain	= 63·56777 "
1 cb. inch	= 16·387 cb. cm.	" 1 oz.	= 2·7811 × 10 ⁴ "
1 cb. foot	= 28316 "	" 1 lb.	= 4·4497 × 10 ⁵ "
1 cb. yard	= 764535 "	" 1 cwt.	= 4·9837 × 10 ⁷ "
1 gallon	= 4541 "	" 1 ton	= 9·9674 × 10 ⁸ "
	= 277·274 cb. in. or the volume of 10 lbs. of water at 62° Fah., Bar. 30 in.	<i>Work (g = 981).</i>	
<i>Mass.</i>		1 gramme-centimetre	= 981 ergs.
1 grain	= 06479895 gm.	1 kilogram-metre	= 981 × 10 ⁵ "
1 ounce	= 28·3495 "	1 foot-grain	= 1·937 × 10 ⁸ "
1 pound	= 453·5926 "	1 foot-pound	= 1·356 × 10 ⁷ "
1 ton	= 1,016047 "	1 foot-ton	= 3·04 × 10 ¹⁰ "
1 kilogramme	= 2·20462125 lbs.	1 'horse power' p. sec.	= 7·46 × 10 ⁹ "
1 pound Avoir.	= 7000 grains	<i>Heat.</i>	
1 pound Troy	= 5760 "	1 gramme-degree C.	= 42 × 10 ⁶ ergs.
<i>Velocity.</i>		1 pound-degree	= 191 × 10 ⁸ "
1 mile per hour	= 44·704 cm. per sec.	1 pound-degree Fah.	= 106 × 10 ⁸ "
1 kilometre	" = 27·777 "		

TABLE II.
Pressure of Aqueous Vapour in dynes per square centim.

Temp.	Pressure.	Temp.	Pressure.
-20°	1236	40°	73200
-15°	1866	50°	122600
-10°	2790	60°	198500
- 5°	4150	80°	472900
0°	6133	100°	1014000
5°	8710	120°	1988000
10°	12220	140°	3626000
15°	16930	160°	6210000
20°	23190	180°	10060000
25°	31400	200°	15600000
30°	42050		

TABLE III.
Values for the principal Lines of the Spectrum in air at 160° C. with Bar. 76 cm.

	Wave-length in centims.	No. of vibrations per second.
A	7·604 × 10 ⁻⁵	3·950 × 10 ¹⁴
B	6·867 "	4·373 "
C	6·56201 "	4·577 "
D (mean)	5·89212 "	5·097 "
E	5·26913 "	5·700 "
F	4·86072 "	6·179 "
G	4·30725 "	6·973 "
H ₁	3·96801 "	7·569 "
H ₂	3·93300 "	7·636 "

TABLE IV. in C. G. S. units.

	Density Water = 1.	Young's Modulus <i>M</i> .	Rigidity <i>n</i> .	Elasticity of volume <i>k</i> .	Tenacity.	Expansion of Volume per degree C.	Linear Expansion between 0 & 100 C.	Specific Heat be- tween 0 & 100 C.	Relative Conduc- tivity.	Rate of Conduction of Sound in cm. per sec.	Elect. Magn. Specific Resistance at 0° C.
Platinum	21	—	—	—	—	·000027	·000875	·0335	881	2·69 × 10 ⁵	9158
Gold	19·26	—	—	—	—	·000045	·001433	—	1000	1·74 "	2081
Mercury	13·596	—	—	0·542 × 10 ¹²	—	·000180	—	·0330	—	—	96190
Lead	11·35	·059 × 10 ¹²	—	—	2·28 × 10 ⁸	·000086	·002861	·0557	180	1·23 "	19350
Silver	10·47	—	—	—	—	·000061	·00196	·0949	973	2·61 "	1521
Copper	8·843	—	4·47 × 10 ¹¹	1·684 "	41·4 "	·000054	·00175	·0949	898	3·74 "	1615
Brass, drawn	8·471	1·234 "	3·66 "	—	33·8 "	·000038	·001111	—	—	4·32 "	—
Iron, cast	7·235	1·075 "	5·32 "	0·964 "	—	·000040	·001258	·1098	374	5·06 "	9827
Iron, wrought	7·677	1·849 "	7·69 "	1·456 "	58·6 "	·000037	·001260	—	—	—	—
Steel	7·849	1·963 "	8·19 "	1·841 "	79·3 "	·000063	·00227	—	304	5·22 "	13360
Tin, cast	7·29	—	—	—	3·17 "	·000088	·00294	·0927	863	—	5690
Zinc, cast	7·19	—	—	—	5·17 "	·000015	·00081	·1770	—	—	—
Glass, flint	2·942	0·603 "	2·40 "	0·415 "	—	—	—	—	—	4·53 "	—

TABLE V.

	Greatest distance from Sun. Earth's mean distance = 1.	Least distance from Sun.	Sidereal Revolution in Days.	Inclination of Orbit to Ecliptic.	Time of Rotation.	Diameter in Miles.	Mass.	Density.
				° ' "	h. m. s.			
Sun	—	—	—	0 0 0	600 0 0	888000	354936	0·25
Mercury	0·46669	0·30750	87·969	7 0 8	24 5 28	3000	0·118	2·01
Venus	0·72826	0·71840	224·701	3 23 31	23 21 21	7700	0·883	0·97
Earth	1·01678	0·98322	365·256	1 51 5	23 56 4	7926	1·000	1·00
Mars	1·66578	1·38160	686·980	1 51 5	24 37 22	4500	0·132	0·72
Jupiter	5·45378	4·95182	4332·585	1 18 40	9 55 26	92000	338·034	0·24
Saturn	10·07328	9·00442	10759·220	2 29 28	10 29 17	75000	101·064	0·13
Uranus	20·07612	18·28916	30686·821	4 6 30	—	36000	14·789	0·15
Neptune	30·29888	29·77506	60126·722	1 46 59	—	35000	24·648	0·27

TABLE VI.—*Functions of π and e .*

$\pi = 3.1415926$	$\pi^{-1} = .3183099$	$e = 2.71828183$
$\pi^2 = 9.8696044$	$\pi^{-2} = .1013212$	$e^2 = 7.38905611$
$\pi^3 = 31.0062761$	$\pi^{-3} = .0322515$	$e^{-1} = 0.3678794$
$\sqrt{\pi} = 1.7724539$	$200^\circ \div \pi = 63^\circ.6619772$	$e^{-2} = 0.1353353$
$\log_{10} \pi = 1.4971499$	$180^\circ \div \pi = 57^\circ.2957795$	$\log_{10} e = 0.43429448$
$\log_e \pi = 0.6679358$	$= 206264''.8$	$\log_e 10 = 2.30258509$

TABLE VII.

No.	Square root.	Cube root.
2	1.4142136	1.2599210
3	1.7320508	1.4422496
4	2.0000000	1.5874011
5	2.2360680	1.7099759
6	2.4494897	1.8171206
7	2.6457513	1.9129312
8	2.8284271	2.0000000
9	3.0000000	2.0800837
10	3.1622777	2.1544347
11	3.3166248	2.2239801
12	3.4641016	2.2894286
13	3.6055513	2.3513347
14	3.7416574	2.4101422
15	3.8729833	2.4662121
16	4.0000000	2.5198421
17	4.1231056	2.5712816
18	4.2426407	2.6207414
19	4.3588939	2.6684016
20	4.4721360	2.7144177
21	4.5825757	2.7589243
22	4.6904158	2.8020393
23	4.7958315	2.8438670
24	4.8989795	2.8844991
25	5.0000000	2.9240177
26	5.0990195	2.9624960
27	5.1961524	3.0000000
28	5.2915026	3.0365889
29	5.3851648	3.0723168
30	5.4772256	3.1072325

TABLE VIII.

N .	$\log_{10} N$.	$\log_e N$.
2	.3010300	.69314718
3	.4771213	1.09861229
5	.6989700	1.60943791
7	.8450980	1.94591015
11	1.0413927	2.39789527
13	1.1139434	2.56494936
17	1.2304489	2.83321334
19	1.2787536	2.94443898
23	1.3617278	3.13549422
29	1.4623980	3.36729583
31	1.4913617	3.43398720
37	1.5682017	3.61091791
41	1.6127839	3.71357207
43	1.6334685	3.76120012
47	1.6720979	3.85014760
53	1.7242759	3.97029191
59	1.7708520	4.07753744
61	1.7853298	4.11087386
67	1.8260748	4.20469262
71	1.8512583	4.26267988
73	1.8633229	4.29045944
79	1.8976271	4.36944785
83	1.9190781	4.41884061
89	1.9493900	4.48863637
97	1.9867717	4.57471098
101	2.0043214	4.61512052
103	2.0128372	4.63472899
107	2.0293838	4.67282833
109	2.0374265	4.69134788

NOTE.—The authorities for Table IV. are as follows:—Columns 2, 3, and 4 (Mercury excepted), Everett's experiments (Phil. Trans., 1867); g is here taken = 981.4. The densities in these cases are those of the specimens employed. Cols. 5 and 7, Rankine. Col. 6, Watt's Dict. of Chemistry. Col. 8, Dulong and Petit. Col. 10, Wertheim. Col. 11, Matthiessen.

Table V. is abridged from Loomis's Astronomy.

The values in Table III. are Angström's.

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BURCKHARDT'S FACTOR TABLES.

FOR ALL NUMBERS FROM 1 TO 99000.

EXPLANATION.—The tables give the least divisor of every number from 1 up to 99000: but numbers divisible by 2, 3, or 5 are not printed. All the digits of the number whose divisor is sought, excepting the units and tens, will be found in one of the three rows of larger figures. The two remaining digits will be found in the left-hand column. The least divisor will then be found in the column of the first named digits, and in the row of the units and tens.

If the number be prime, a cipher is printed in the place of its least divisor.

The numbers in the first left-hand column are not consecutive. Those are omitted which have 2, 3, or 5 for a divisor. Since $2^2 \cdot 3 \cdot 5^2 = 300$, it follows that this column of numbers will re-appear in the same order after each multiple of 300 is reached.

MODE OF USING THE TABLES.—If the number whose prime factors are required is divisible by 2 or 5, the fact is evident upon inspection, and the division must be effected. The quotient then becomes the number whose factors are required. If this number, being within the range of the tables, is yet not given, *it is divisible by 3*. Dividing by 3, we refer to the tables again for the new quotient and its least factor, and so on.

EXAMPLES.—Required the prime factors of 310155.

Dividing by 5, the quotient is 62031. This number is within the range of the tables. But it is not found printed. Therefore 3 is a divisor of it. Dividing by 3, the quotient is 20677. The table gives 23 for the least factor of 20677. Dividing by 23, the quotient is 899.

The table gives 29 for the least factor of 899. Dividing by 29, the quotient is 31, a prime number. Therefore $310155 = 3 \cdot 5 \cdot 23 \cdot 29 \cdot 31$.

Again, required the divisors of 92881. The table gives 293 for the least divisor. Dividing by it, the quotient is 317. Referring to the tables for 317, a cipher is found in the place of the least divisor, and this signifies that 317 is a prime number.

Therefore $92881 = 293 \times 317$, the product of two primes.

It may be remarked that, to have resolved 92881 into these factors without the aid of the tables by the method of Art. 360, would have involved fifty-nine fruitless trial divisions by prime numbers.

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01	00	03	06	09	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87			
07	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00		
13	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00		
17	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00		
19	00	11	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00		
23	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
29	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
31	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
37	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
41	00	11	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
43	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
47	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
49	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
53	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
59	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
61	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
67	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
71	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
73	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
77	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
79	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
83	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
89	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
91	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
97	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
01	01	04	07	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79	82	85	88			
03	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
07	00	13	19	17	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
09	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
13	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
19	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
21	11	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
27	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
31	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
33	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
37	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
39	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
43	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
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67	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
73	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
79	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
85	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
91	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
97	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

