

# Telephone and Telegraph Engineers' Handbook

## USEFUL TABLES

### WEIGHTS AND MEASURES

#### LINEAR MEASURE

12 inches (in.)	..... = 1 foot	..... ft.
3 feet	..... = 1 yard	..... yd.
5½ yards	..... = 1 rod	..... rd.
40 rods	..... = 1 furlong	..... fur.
8 furlongs	..... = 1 mile	..... mi.

<i>in.</i>	<i>ft.</i>	<i>yd.</i>	<i>rd.</i>	<i>fur.</i>	<i>mi.</i>
36 =	3 =	1			
198 =	16.5 =	5.5 =	1		
7,920 =	660 =	220 =	40 =	1	
63,360 =	5,280 =	1,760 =	320 =	8 =	1

#### SQUARE MEASURE

144 square inches (sq. in.)	.... = 1 square foot	.... sq. ft.			
9 square feet	..... = 1 square yard	.... sq. yd.			
30¼ square yards	..... = 1 square rod	.... sq. rd.			
160 square rods	..... = 1 acre	..... A.			
640 acres	..... = 1 square mile	.... sq. mi.			
<i>sq. mi. A.</i>	<i>sq. rd.</i>	<i>sq. yd.</i>	<i>sq. ft.</i>	<i>sq. in.</i>	
1 =	640 =	102,400 =	3,097,600 =	27,878,400 =	4,014,489,600

## CUBIC MEASURE

1,728 cubic inches (cu. in.)	.... = 1 cubic foot	.....cu. ft.
27 cubic feet	..... = 1 cubic yard	.....cu. yd.
128 cubic feet	..... = 1 cord	.....cd.
24½ cubic feet	..... = 1 perch	.....P.
1 cu. yd. = 27 cu. ft. = 46,656 cu. in.		

## MEASURE OF ANGLES OR ARCS

60 seconds (")	..... = 1 minute	.....'
60 minutes	..... = 1 degree	.....°
90 degrees	..... = 1 rt. angle or quadrant	.....L
360 degrees	..... = 1 circle	.....cir.
1 cir. = 360° = 21,600' = 1,296,000"		

## AVOIRDUPOIS WEIGHT

437.5 grains (gr.)	..... = 1 ounce	.....oz.
16 ounces	..... = 1 pound	.....lb.
100 pounds	..... = 1 hundredweight	.....cwt.
20 cwt., or 2,000 lb.	..... = 1 ton	.....T.
2,240 lb.	..... = 1 long ton	.....L. T.
1 T. = 20 cwt. = 2,000 lb. = 32,000 oz. = 14,000,000 gr.		
The avoirdupois pound contains 7,000 gr.		

## TROY WEIGHT

24 grains (gr.)	..... = 1 pennyweight	.....pwt.
20 pennyweights	..... = 1 ounce	.....oz.
12 ounces	..... = 1 pound	.....lb.
1 lb. = 12 oz. = 240 pwt. = 5,760 gr.		

## DRY MEASURE

2 pints (pt.)	..... = 1 quart	.....qt.
8 quarts	..... = 1 peck	.....pk.
4 pecks	..... = 1 bushel	.....bu.
1 bu. = 4 pk. = 32 qt. = 64 pt.		

The U. S. bushel contains 2,150.42 cu. in. = approximately 1½ cu. ft. The British bushel contains 2,218.19 cu. in.

## LIQUID MEASURE

4 gills (gi.)	.....	= 1 pint	.....	pt.	
2 pints	.....	= 1 quart	.....	qt.	
4 quarts	.....	= 1 gallon	.....	gal.	
31½ gallons	.....	= 1 barrel	.....	bbbl.	
2 barrels, or 63 gallons	.....	= 1 hogshead	.....	hhd.	
1 hhd.	= 2 bbl.	= 63 gal.	= 252 qt.	= 504 pt.	= 2,016 gi.

The U. S. gallon contains 231 cu. in. = .134 cu. ft., nearly, or 1 cu. ft. contains 7.481 gal.

When water is at its maximum density, 1 cu. ft. weighs 62.425 lb. and 1 gallon weighs 8.345 lb.

For approximations, 1 cu. ft. of water is considered equal to 7½ gal., and 1 gal. as weighing 8½ lb.

## THE METRIC SYSTEM

The metric system is based on the meter, which, according to the U. S. Coast and Geodetic Survey Report of 1884, is equal to 39.370432 in. The value commonly used is 39.37 in. and is authorized by the U. S. government.

There are three principal units—the *meter*, the *liter* (pronounced "lee-ter"), and the *gram*, the units of length, capacity, and weight, respectively. Multiples of these units are obtained by prefixing to the names of the principal units the Greek words *deca* (10), *hecto* (100), and *kilo* (1,000); the submultiples, or divisions, are obtained by prefixing the Latin words *deci* ( $\frac{1}{10}$ ), *centi* ( $\frac{1}{100}$ ), and *milli* ( $\frac{1}{1000}$ ). These prefixes form the key to the entire system. The abbreviations of the principal units of these submultiples begin with a small letter, while those of the multiples begin with a capital letter.

## MEASURES OF LENGTH

10 millimeters (mm.)	.....	= 1 centimeter	.....	cm.
10 centimeters	.....	= 1 decimeter	.....	dm.
10 decimeters	.....	= 1 meter	.....	m.
10 meters	.....	= 1 decameter	.....	Dm.
10 decameters	.....	= 1 hectometer	.....	Hm.
10 hectometers	.....	= 1 kilometer	.....	Km.

## MEASURES OF SURFACE (NOT LAND)

100 square millimeters

(sq. mm.)..... = 1 square centimeter....sq. cm.

100 square centimeters... = 1 square decimeter....sq. dm.

100 square decimeters.... = 1 square meter.....sq. m.

## MEASURES OF VOLUME

1,000 cubic millimeters

(cu. mm.)..... = 1 cubic centimeter....cu. cm.

1,000 cubic centimeters... = 1 cubic decimeter....cu. dm.

1,000 cubic decimeters... = 1 cubic meter.....cu. m.

## MEASURES OF CAPACITY

10 milliliters (ml.)..... = 1 centiliter.....cl.

10 centiliters..... = 1 deciliter.....dl.

10 deciliters..... = 1 liter.....l.

10 liters..... = 1 decaliter.....Dl.

10 decaliters..... = 1 hectoliter.....Hl.

10 hectoliters..... = 1 kiloliter.....Kl.

The liter is equal to the volume occupied by 1 cu. dm.

## MEASURES OF WEIGHT

10 milligrams (mg.)..... = 1 centigram.....cg.

10 centigrams..... = 1 decigram.....dg.

10 decigrams..... = 1 gram.....g.

10 grams..... = 1 decagram.....Dg.

10 decagrams..... = 1 hectogram.....Hg.

10 hectograms..... = 1 kilogram.....Kg.

1,000 kilograms..... = 1 ton.....T.

The gram is the weight of 1 cu. cm. of pure distilled water at a temperature of 39.2° F.; the kilogram is the weight of 1 liter of water; the ton is the weight of 1 cu. m. of water.

## METRIC CONVERSION FACTORS

In order to use the following factors for converting from English to metric units, it is necessary to transform the



equations; for example, 1,000 Km.  $\times$  .621 = 621 mi., but  
1,000 mi.  $\div$  .621 = 1,610 Km.

Km.  $\times$  .621 = mi.

Km.  $\div$  1.609 = mi.

Km.  $\times$  3,281 = ft.

m.  $\times$  39.37 = in.

m.  $\times$  3.281 = ft.

m.  $\times$  1.094 = yd.

cm.  $\times$  .3937 = in.

cm.  $\div$  2.54 = in.

mm.  $\times$  .03937 = in.

mm.  $\div$  25.4 = in.

sq. Km.  $\times$  247.1 = A.

sq. m.  $\times$  10.764 = sq. ft.

sq. cm.  $\times$  .155 = sq. in.

sq. cm.  $\div$  6.451 = sq. in.

sq. mm.  $\times$  .00155 = sq. in.

sq. mm.  $\div$  645.1 = sq. in.

cu. m.  $\times$  35.315 = cu. ft.

cu. m.  $\times$  1.308 = cu. yd.

cu. m.  $\times$  264.2 = gal. (U. S.)

cu. cm.  $\div$  16.383 = cu. in.

l.  $\times$  61.022 = cu. in.

l.  $\times$  .2642 = gal. (U. S.)

l.  $\div$  3.78 = gal. (U. S.)

l.  $\div$  28.316 = cu. ft.

g.  $\times$  15.432 = gr.

g.  $\times$  981 = dynes

g.  $\div$  28.35 = oz. (avoir.)

grams per sq. cm.  $\times$  14.22

= lb. per sq. in.

Kg.  $\times$  2.205 = lb.

Kg.  $\times$  35.3 = oz. (avoir.)

Kg.  $\times$  1,102.3 = tons  
(2,000 lb.)

Kg. per sq. cm.  $\times$  14,223

= lb. per sq. in.

Kg.-m.  $\times$  7.233 = ft.-lb.

kilowatts (k. w.)  $\times$  1.34

= H. P.

watts  $\div$  746 = H. P.

watts  $\times$  .7373 = ft.-lb. per

sec.

Joules  $\times$  .7373 = ft.-lb.

Calorie (kilogram-degree)  $\times$

3.968 = B. T. U.

Calorie (kilogram-degree)  $\div$

.252 = B. T. U.

Joules  $\times$  .24 = gram-calories

gram-calories  $\times$  4.19 =

Joules

gravity (Paris) = 981 cm.

per sec. per sec.

(Degrees centigrade  $\times$  1.8)

+ 32° = degrees F.

## WEIGHT AND SPECIFIC GRAVITY OF VARIOUS SUBSTANCES

The specific gravity of a substance is the ratio of the weight of any volume of the substance to the weight of an equal volume of some standard substance (water, in the case of solids and liquids; and air, in the case of gases).

Metals	Weight per Cu. In. Pound	Specific Gravity
Aluminum.....	.096	2.660
Antimony.....	.242	6.712
Bismuth.....	.352	9.746
Brass, common.....	.307	8.500
Copper, cast.....	.314	8.700
Copper, rolled.....	.321	8.878
Gold, pure cast.....	.696	19.258
Iron, cast.....	.260	7.207
Iron, wrought.....	.281	7.780
Lead, pure.....	.409	11.330
Mercury, at 60° F.....	.491	13.580
Silver, pure.....	.378	10.474
Steel, hard.....	.286	7.919
Steel, soft.....	.283	7.833
Tin.....	.256	7.351
Zinc.....	.260	7.101

Stones and Earth	Weight per Cu. In. Pound	Specific Gravity
Asbestos.....	.1110	3 to 3.2
Brick.....	.0723	2.000
Chalk.....	.1006	2.784
Clay.....	.0686	1.900
Coal, anthracite.....	{ .0592	1.640
	{ .0519	1.436
Coal, bituminous.....	.0488	1.350
Earth, loose.....	.0491	1.360
Emery.....	.1450	4.000
Glass, flint.....	.1260	3.500
Granite, Quincy.....	.0958	2.652
Gypsum, opaque.....	.0783	2.168
Limestone.....	.0980	2.700
Marble, common.....	.0970	2.686
Mica.....	.1012	2.800
Quartz.....	.0961	2.660
Salt, common.....	.0769	2.130
Sand.....	.0957	2.650
Slate.....	.1012	2.800
Soil, common.....	.0717	1.984
Stone, common.....	.0910	2.520
Sulphur, native.....	.0734	2.033

Dry Woods	Weight per Cu. In. Pound	Specific Gravity
Ash.....	.0305	.845
Beech.....	.0308	.852
Cedar, American.....	.0203	.561
Cork.....	.0090	.250
Ebony, American.....	.0441	1.220
Elm.....	.0202	.560
Lignum vitæ.....	.0481	1.330
Mahogany, Honduras.....	.0202	.560
Maple.....	.0285	.790
Oak.....	.0343	.950
Pine, Southern.....	.0260	.720
Pine, White.....	.0144	.400
Poplar.....	.0138	.383
Spruce.....	.0181	.500

Liquids	Weight per Cu. In. Pound	Specific Gravity
Acid, nitric.....	.0440	1.217
Acid, sulphuric.....	.0665	1.841
Acid, muriatic, or hydrochloric.....	.0434	1.200
Alcohol, commercial.....	.0301	.833
Alcohol, pure.....	.0286	.792
Oil, linseed.....	.0340	.940
Oil, turpentine.....	.0314	.870
Water, distilled (62.425 lb. per cu. ft.)	.0361	1.000

Gases and Vapors	Weight per Cu. Ft. Grains	Specific Gravity
At 32° and a tension of 1 atmosphere		
Atmospheric air.....	565.11	1.0000
Ammonia gas.....	333.1	.5894
Carbonic acid.....	859.0	1.5201
Carbonic oxide.....	546.6	.9673
Hydrogen.....	39.1	.0692
Oxygen.....	624.8	1.1056
Sulphureted hydrogen.....	663.8	1.1747
Nitrogen.....	548.9	.9713
Steam at 212° F.....	275.8	.4880

The weight of a cubic foot of any solid or liquid is found by multiplying its specific gravity by 62.425 lb. avoird. The weight of a cubic foot of any gas at atmospheric pressure and at 32° F. is found by multiplying its specific gravity by .08073 lb. avoird.

---

## CHEMISTRY AND ELECTROCHEMISTRY

**Divisions of Matter.**—Science assumes three divisions of matter—*masses*, *molecules*, and *atoms*. A mass is any portion of matter appreciable by the senses. A molecule is the smallest particle of matter into which a body can be divided; it is the smallest particle that is capable of separate existence. An atom is the still smaller particle produced by the division of a molecule by chemical means, and is regarded by chemists as the unit quantity of chemical combination. A molecule is a group of two or more atoms that are united by their affinity, or mutual attraction. *Elemental* molecules are formed of like atoms, *compound* molecules are formed of unlike atoms. Matter composed of elemental molecules is called *simple*, or *elementary matter*; matter composed of compound molecules is called *compound matter*.

The **atomic weight** of an element is the relative proportion, by weight, with which it enters into combinations with other elements. Hydrogen combines with other elements in the smallest proportion, by weight, of any of the elements. The weight of oxygen entering into a combination is 15.88 times the corresponding weight of hydrogen; i. e., if the atomic weight of hydrogen is 1, that of oxygen is 15.88, and if the atomic weight of oxygen is 16, that of hydrogen is about 1.008.

**Valence.**—Atoms unite in molecules always in certain fixed proportions. For example, 2 atoms of hydrogen, *H*, unite with 1 atom of oxygen, *O*, to form 1 molecule of water, *H<sub>2</sub>O*; 1 atom of hydrogen, *H*, unites with 1 atom of chlorine, *Cl*, to form 1 molecule of hydrochloric acid, *HCl*. The valence of an element is the measure of its power to hold other elements in combination, and is stated on the basis that the valence of hydrogen is I. An element is mono-, di-, tri-, tetra-, etc.

**SYMBOLS, ATOMIC WEIGHTS, ETC. FOR A NUMBER  
OF THE MORE COMMON ELEMENTS**

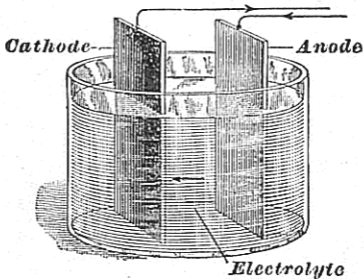
Element and Symbol	Atomic Weight	Common Valence	Chemical Equivalent
Aluminum, <i>Al</i> ...	27.1	III	9.03
Antimony, <i>Sb</i> ...	120.2	III-V	40.067 — 24.04
Arsenic, <i>As</i> ....	75.0	III-V	25. — 15.
Barium, <i>Ba</i> .....	137.4	II	68.7
Bismuth, <i>Bi</i> .....	208.5	III-V	69.5 — 41.7
Boron, <i>B</i> .....	11.0	III	3.67
Bromine <i>Br</i> .....	79.96	I	79.96
Cadmium, <i>Cd</i> ...	112.4	II	56.2
Calcium, <i>Ca</i> .....	40.1	II	20.05
Carbon, <i>C</i> .....	12.0	IV	3.
Chlorine, <i>Cl</i> .....	35.45	I	35.45
Chromium, <i>Cr</i> ...	52.1	II-VI	26.05 — 8.68
Cobalt, <i>Co</i> .....	59.0	II-III	29.5 — 19.67
Copper, <i>Cu</i> .....	63.6	I-II	63.6 — 31.8
Fluorine, <i>F</i> ....	19.0	I	19.
Gold, <i>Au</i> .....	197.2	III	65.73
Hydrogen, <i>H</i> ....	1.008	I	1.008
Iodine, <i>I</i> .....	126.85	I	126.85
Iron, <i>Fe</i> .....	55.9	II-III	27.95 — 18.63
Lead, <i>Pb</i> .....	206.9	II-IV	103.45 — 51.73
Lithium, <i>Li</i> .....	7.03	I	7.03
Magnesium, <i>Mg</i> .	24.36	II	12.18
Manganese, <i>Mn</i> .	55.0	II-VII	27.5 — 7.86
Mercury, <i>Hg</i> ....	200.0	I-II	200.0 — 100.0
Nickel, <i>Ni</i> .....	58.7	II-III	29.35 — 19.57
Nitrogen, <i>N</i> ....	14.04	III-V	4.68 — 2.81
Oxygen, <i>O</i> .....	16.0	II	8.0
Palladium, <i>Pd</i> ..	106.5	IV	26.63
Phosphorus, <i>P</i> ...	31.0	III-V	10.33 — 6.2
Platinum, <i>Pt</i> ...	194.8	IV	48.7
Potassium, <i>K</i> ..	39.15	I	39.15
Selenium <i>Se</i> ....	79.2	II	39.6
Silicon, <i>Si</i> .....	28.4	IV	7.1
Silver, <i>Ag</i> .....	107.93	I	107.93
Sodium, <i>Na</i> .....	23.05	I	23.05
Strontium, <i>Sr</i> ...	87.6	II	43.8
Sulphur, <i>S</i> .....	32.06	II	16.03
Tellurium, <i>Te</i> ..	127.6	II	63.8
Thallium, <i>Tl</i> ....	204.1	I-III	204.1 — 68.03
Thorium, <i>Th</i> ....	232.5	IV	58.13
Tin, <i>Su</i> .....	119.0	II-IV	59.5 — 29.75
Tungsten, <i>W</i> ....	184.0	IV-VI	46.0 — 30.67
Uranium, <i>U</i> .....	239.5	IV-VI	59.88 — 39.92
Vanadium, <i>V</i> ..	51.2	III-V	17.07 — 10.24
Zinc, <i>Zn</i> .....	65.4	II	32.7

The names of non-metallic elements in the above table are printed in *italics*. The atomic weights given are based on oxygen, *O* = 16.

valent according to whether its atoms hold the atoms of other elements in combination in the proportion of one, two, three, four, etc. Hydrogen is monovalent and oxygen bivalent because 1 atom of oxygen holds 2 atoms of hydrogen, as represented by the symbol  $H_2O$ . Some elements, for instance, copper, have two or more different valencies because they unite in different proportions with certain other elements to form different compounds. Thus there is cuprous chloride,  $CuCl$ , and cupric chloride,  $CuCl_2$ .

### ELECTROLYTIC ACTION

A current of electricity in passing through an electrolyte decomposes it; e. g., an electrolyte consisting of zinc chloride (usually dissolved in water) is broken up into chlorine gas and metallic zinc. An electrolytic cell consists of a vessel



ELECTROLYTIC CELL

containing the electrolyte and the electrodes—the anode and the cathode; these are usually metal or carbon plates. The two parts into which the electrolyte is decomposed are called ions; those ions that appear at the anode are called *anions* and those at the cathode are called *cations*. In decomposing zinc chloride, zinc appears at the cathode and is thus a cation, and chlorine gas appears at the anode as an anion.

# CHEMICAL AND ELECTROCHEMICAL EQUIVALENTS

BASED ON ATOMIC WEIGHT OF OXYGEN = 16 AND ELECTROCHEMICAL EQUIVALENT OF SILVER = 0.01118. THE NAMES OF NON-METALLIC ELEMENTS ARE PRINTED IN ITALICS.

Name of Element and Symbol	Common Valence	Electrochemical Equivalent Grams per Coulomb	Name of Element and Symbol	Common Valence	Electrochemical Equivalent Grams per Coulomb
Aluminum, <i>Al</i> ...	III	.00009354	Mercury, <i>Hg</i> ...	I-II	.00207172
Antimony, <i>Sb</i> ...	III-V	.00041504	Nickel, <i>Ni</i> ...	II-III	.00030402
Arsenic, <i>As</i> ...	III-V	.00025997	Nitrogen, <i>N</i> ...	III-V	.00004848
Barium, <i>Ba</i> ...	II	.00071164	Oxygen, <i>O</i> ...	II	.00008287
Bismuth, <i>Bi</i> ...	III-V	.00071992	Palladium, <i>Pd</i> ...	IV	.00027585
Boron, <i>B</i> ...	III	.00003802	Phosphorus, <i>P</i> ...	III-V	.00010700
Bromine, <i>Br</i> ...	I	.00082827	Platinum, <i>Pt</i> ...	IV	.00050446
Cadmium, <i>Cd</i> ...	II	.00058216	Potassium, <i>K</i> ...	I	.00040554
Calcium, <i>Ca</i> ...	II	.00020768	Selenium, <i>Se</i> ...	II	.00041020
Carbon, <i>C</i> ...	IV	.00003108	Silicon, <i>Si</i> ...	IV	.00075346
Chlorine, <i>Cl</i> ...	I	.00036721	Silver, <i>Ag</i> ...	I	.00111800
Chromium, <i>Cr</i> ...	II-VI	.00026984	Sodium, <i>Na</i> ...	I	.00023877
Cobalt, <i>Co</i> ...	II-III	.00030558	Strontium, <i>Sr</i> ...	II	.00045371
Copper, <i>Cu</i> ...	I-II	.00065881	Sulphur, <i>S</i> ...	II	.00016606
Fluorine, <i>F</i> ...	I	.00019681	Tellurium, <i>Te</i> ...	II	.00066088
Gold, <i>Au</i> ...	III	.00068087	Thallium, <i>Tl</i> ...	I-III	.00211419
Hydrogen, <i>H</i> ...	I	.00001044	Thorium, <i>Th</i> ...	IV	.00060215
Iodine, <i>I</i> ...	I	.00131399	Tin, <i>Sn</i> ...	II-IV	.00061634
Iron, <i>Fe</i> ...	II-III	.00028952	Tungsten, <i>W</i> ...	IV-VI	.00031769
Lead, <i>Pb</i> ...	II-IV	.00107160	Uranium, <i>U</i> ...	IV-VI	.00062027
Lithium, <i>Li</i> ...	I	.00007282	Vanadium, <i>V</i> ...	III-V	.00017682
Magnesium, <i>Mg</i> ...	II	.00012617	Zinc, <i>Zn</i> ...	II	.00033873
Manganese, <i>Mn</i> ...	II-VII	.00028486			

The chemical equivalent of an element is the quotient of the atomic weight divided by the valence. The electrochemical equivalent of an element is the weight in grams liberated electrolytically by 1 coulomb (1 ampere-second) of electricity. The electrochemical equivalent is proportional to the chemical equivalent. The electrochemical equivalent of silver has been accurately determined by experiment as .001118 gram, and that of each of the other elements can be calculated from this. For example, the electrochemical equivalent of aluminum is  $\frac{9.03}{107.93} \times .001118 = .00009354$  gram.

## HEAT

### SPECIFIC HEATS OF METALS

The specific heat of a substance is the number of heat units required to raise a unit mass of the substance one degree in temperature. The specific heat of water is very nearly constant for all temperatures, but that at its temperature of maximum density (4° C. or 39.1° F.) is considered unity. The specific heats of most substances increase with increasing temperatures.

Substance	Specific Heat at		
	0° C. or 32° F.	50° C. or 122° F.	100° C. or 212° F.
Aluminum.....	.2070	.2185	.2300
Copper.....	.0901	.0923	.0966
German silver.....	.0941	.0947	.0952
Iron.....	.1060	.1130	.1200
Lead.....	.0300	.0315	.0331
Platinum.....	.0320	.0326	.0333
Platinum silver.....	.0473	.0487	.0581
Silver.....	.0547	.0569	.0591
Tin.....	.0523	.0568	.0595
Zinc.....	.0901	.0938	.0976



## TEMPERATURE OF FUSION

Substance	Fusing Point, Degrees	
	F.	C.
Aluminum.....	1,160	627
Carbon.....	Infusible	Infusible
Copper.....	1,931	1,054
Gold.....	1,913	1,045
Iridium.....	3,542	1,950
Iron, cast.....	2,192	1,200
Iron, wrought.....	2,912	1,600
Lead.....	617	325
Mercury.....	-37.8	-38.8
Nickel.....	2,642	1,450
Osmium.....	3,900	2,200*
Platinum.....	3,225	1,774
Silver, pure.....	1,749	954
Steel.....	2,520	1,382
Sulphur.....	235	114.5
Tantalum.....	3,865	2,150*
Tin.....	551	233
Tungsten.....	{ above 3,420	above 1,900*

\*J. Swinburne, F. R. S., Proc. British Institution of Electrical Engineers, Jan. 10, 1907.

## HEAT UNITS

One *British thermal unit* (B. T. U.) is the quantity of heat required to raise the temperature of 1 lb. of pure water 1° F. at or near its maximum density, 39.1° F.

One *calorie* is the quantity of heat required to raise the temperature of 1 Kg. of water 1° C. at or near 4° C.

$$1 \text{ B. T. U.} = .252 \text{ calorie and } 1 \text{ calorie} = 3.968 \text{ B. T. U.}$$

One *small, or gram, calorie* (a heat unit also in some use) is the quantity of heat required to raise the temperature of 1 gram of water 1° C. at or near 4° C.

## COEFFICIENTS OF LINEAR EXPANSION

The coefficient of expansion of a body is its expansion per degree rise of temperature. The coefficient of surface expansion is double, and that of cubical expansion three times, the coefficient of linear expansion.

Substance	Coefficient of Linear Expansion in Inches per Degree F.
Aluminum.....	.00001140
Brass.....	.00001040
Brick.....	.00000306
Cement and Concrete.....	{ from .00000550
	to .00000780
Copper.....	.00000961
Glass.....	{ from .00000399
	to .00000521
Gold.....	.00000841
Granite.....	.00000460
Iron, cast.....	.00000587
Iron, wrought.....	.00000677
Lead.....	.00001580
Marble.....	.00000400
Masonry.....	{ from .00000206
	to .00000490
Mercury.....	.00003334
Platinum.....	.00000494
Porcelain.....	.00000200
Sandstone.....	{ from .00000400
	to .00000670
Steel, untempered.....	.00000599
Steel, tempered.....	.00000702
Tin.....	.00001160
Wood (pine).....	.00000276
Zinc.....	.00001634

For example, a 60-ft. steel rail in warming from 20° F. below zero to 100° F. will expand  $120 \times .00000599 \times 60 \times 12 = .5175$  in.

## THE MECHANICAL EQUIVALENT OF HEAT

1 B. T. U. = 778 ft.-lb.

1 ft.-lb. =  $\frac{1}{778} = .001285$  B. T. U.

1 H. P. = 33,000 ft.-lb. per min. = 42.416 B. T. U. per min.

## CENTIGRADE AND FAHRENHEIT DEGREES

Deg. C.	Deg. F.	Deg. C.	Deg. F.	Deg. C.	Deg. F.	Deg. C.	Deg. F.
0	32.0	26	78.8	51	123.8	76	168.8
1	33.8	27	80.6	52	125.6	77	170.6
2	35.6	28	82.4	53	127.4	78	172.4
3	37.4	29	84.2	54	129.2	79	174.2
4	39.2	30	86.0	55	131.0	80	176.0
5	41.0	31	87.8	56	132.8	81	177.8
6	42.8	32	89.6	57	134.6	82	179.6
7	44.6	33	91.4	58	136.4	83	181.4
8	46.4	34	93.2	59	138.2	84	183.2
9	48.2	35	95.0	60	140.0	85	185.0
10	50.0	36	96.8	61	141.8	86	186.8
11	51.8	37	98.6	62	143.6	87	188.6
12	53.6	38	100.4	63	145.4	88	190.4
13	55.4	39	102.2	64	147.2	89	192.2
14	57.2	40	104.0	65	149.0	90	194.0
15	59.0	41	105.8	66	150.8	91	195.8
16	60.8	42	107.6	67	152.6	92	197.6
17	62.6	43	109.4	68	154.4	93	199.4
18	64.4	44	111.2	69	156.2	94	201.2
19	66.2	45	113.0	70	158.0	95	203.0
20	68.0	46	114.8	71	159.8	96	204.8
21	69.8	47	116.6	72	161.6	97	206.6
22	71.6	48	118.4	73	163.4	98	208.4
23	73.4	49	120.2	74	165.2	99	210.2
24	75.2	50	122.0	75	167.0	100	212.0
25	77.0						

## TEMPERATURE

The temperature of a body is its degree of sensible heat. For the measurement of temperatures there are three kinds of thermometers: the Fahrenheit, abbreviated F. or Fahr., commonly used in America; the Centigrade, abbreviated C. or Cent., used in France and by scientists everywhere; and the Réaumur, abbreviated R. or Réau., used in Germany.

<i>Standard Points</i>	<i>Degrees F.</i>	<i>Degrees C.</i>	<i>Degrees R.</i>
Boiling point of water at sea level; i. e., pressure = 1 atmosphere.....	212	100	80
Melting point of ice.....	32	0	0
Absolute zero, i. e., the total absence of heat; theoretical only.....	-460	-273	-219
Between boiling point and freezing point = 180° F. = 100° C. = 80° R.			

$$\text{Temp. F.} = \frac{9}{5}(\text{Temp. C.} + 32^\circ) = \frac{9}{4}\text{Temp. R.} + 32^\circ.$$

$$\text{Temp. C.} = \frac{5}{9}(\text{Temp. F.} - 32^\circ) = \frac{5}{4}\text{Temp. R.}$$

$$\text{Temp. R.} = \frac{4}{9}(\text{Temp. F.} - 32^\circ) = \frac{4}{5}\text{Temp. C.}$$

## MATHEMATICAL TABLES

CIRCUMFERENCES AND AREAS OF CIRCLES FROM  
1-64 TO 100

Diam.	Circum.	Area	Diam.	Circum.	Area
$\frac{1}{2}$	.0491	.0002	4	12.5664	12.5664
$\frac{3}{4}$	.0982	.0008	$4\frac{1}{4}$	12.9591	13.3641
$1\frac{1}{4}$	.1963	.0031	$4\frac{1}{2}$	13.3518	14.1863
$1\frac{3}{4}$	.3927	.0123	$4\frac{3}{4}$	13.7445	15.0330
$2\frac{1}{4}$	.5890	.0276	$4\frac{1}{2}$	14.1372	15.9043
$2\frac{3}{4}$	.7854	.0491	$4\frac{3}{4}$	14.5299	16.8002
$3\frac{1}{4}$	.9817	.0767	$4\frac{1}{2}$	14.9226	17.7206
$3\frac{3}{4}$	1.1781	.1104	$4\frac{3}{4}$	15.3153	18.6555
$4\frac{1}{4}$	1.3744	.1503	5	15.7080	19.6350
$4\frac{3}{4}$	1.5708	.1963	$5\frac{1}{4}$	16.1007	20.6290
$5\frac{1}{4}$	1.7671	.2485	$5\frac{1}{2}$	16.4934	21.6476
$5\frac{3}{4}$	1.9635	.3068	$5\frac{3}{4}$	16.8861	22.6907
$6\frac{1}{4}$	2.1598	.3712	$5\frac{1}{2}$	17.2788	23.7583
$6\frac{3}{4}$	2.3562	.4418	$5\frac{3}{4}$	17.6715	24.8505
$7\frac{1}{4}$	2.5525	.5185	$5\frac{1}{2}$	18.0642	25.9673
$7\frac{3}{4}$	2.7489	.6013	$5\frac{3}{4}$	18.4569	27.1086
8	2.9452	.6903	6	18.8496	28.2744
$8\frac{1}{4}$	3.1416	.7854	$6\frac{1}{4}$	19.2423	29.4648
$8\frac{3}{4}$	3.5343	.9940	$6\frac{1}{2}$	19.6350	30.6797
9	3.9270	1.2272	$6\frac{3}{4}$	20.0277	31.9191
$9\frac{1}{4}$	4.3197	1.4849	$6\frac{1}{2}$	20.4204	33.1831
$9\frac{3}{4}$	4.7124	1.7671	$6\frac{3}{4}$	20.8131	34.4717
10	5.1051	2.0739	$6\frac{1}{2}$	21.2058	35.7848
$10\frac{1}{4}$	5.4978	2.4053	$6\frac{3}{4}$	21.5985	37.1224
$10\frac{3}{4}$	5.8905	2.7612	7	21.9912	38.4846
11	6.2832	3.1416	$7\frac{1}{4}$	22.3839	39.8713
$11\frac{1}{4}$	6.6759	3.5466	$7\frac{1}{2}$	22.7766	41.2826
$11\frac{3}{4}$	7.0686	3.9761	$7\frac{3}{4}$	23.1693	42.7184
12	7.4613	4.4301	$7\frac{1}{2}$	23.5620	44.1787
$12\frac{1}{4}$	7.8540	4.9087	$7\frac{3}{4}$	23.9547	45.6636
$12\frac{3}{4}$	8.2467	5.4119	$7\frac{1}{2}$	24.3474	47.1731
13	8.6394	5.9396	$7\frac{3}{4}$	24.7401	48.7071
$13\frac{1}{4}$	9.0321	6.4918	8	25.1328	50.2656
$13\frac{3}{4}$	9.4248	7.0686	$8\frac{1}{4}$	25.5255	51.8487
14	9.8175	7.6699	$8\frac{1}{2}$	25.9182	53.4563
$14\frac{1}{4}$	10.2102	8.2958	$8\frac{3}{4}$	26.3109	55.0884
$14\frac{3}{4}$	10.6029	8.9462	$8\frac{1}{2}$	26.7036	56.7451
15	10.9956	9.6211	$8\frac{3}{4}$	27.0963	58.4264
$15\frac{1}{4}$	11.3883	10.3206	$8\frac{1}{2}$	27.4890	60.1322
$15\frac{3}{4}$	11.7810	11.0447	8	27.8817	61.8625
16	12.1737	11.7933	9	28.2744	63.6174

TABLE—(Continued)

Diam.	Circum.	Area	Diam.	Circum.	Area
9 $\frac{1}{8}$	28.6671	65.3968	19 $\frac{1}{2}$	61.2612	298.648
9 $\frac{1}{4}$	29.0598	67.2008	19 $\frac{3}{4}$	62.0466	306.355
9 $\frac{3}{8}$	29.4525	69.0293	20	62.8320	314.160
9 $\frac{1}{2}$	29.8452	70.8823	20 $\frac{1}{4}$	63.6174	322.063
9 $\frac{5}{8}$	30.2379	72.7599	20 $\frac{1}{2}$	64.4028	330.064
9 $\frac{3}{4}$	30.6306	74.6621	20 $\frac{3}{4}$	65.1882	338.164
9 $\frac{7}{8}$	31.0233	76.589	21	65.9736	346.361
10	31.4160	78.540	21 $\frac{1}{4}$	66.7590	354.657
10 $\frac{1}{4}$	32.2014	82.516	21 $\frac{1}{2}$	67.5444	363.051
10 $\frac{1}{2}$	32.9868	86.590	21 $\frac{3}{4}$	68.3298	371.543
10 $\frac{3}{4}$	33.7722	90.763	22	69.1152	380.134
11	34.5576	95.033	22 $\frac{1}{4}$	69.9006	388.822
11 $\frac{1}{4}$	35.3430	99.402	22 $\frac{1}{2}$	70.6860	397.609
11 $\frac{1}{2}$	36.1284	103.869	22 $\frac{3}{4}$	71.4714	406.494
11 $\frac{3}{4}$	36.9138	108.434	23	72.2568	415.477
12	37.6992	113.098	23 $\frac{1}{4}$	73.0422	424.558
12 $\frac{1}{4}$	38.4846	117.859	23 $\frac{1}{2}$	73.8276	433.737
12 $\frac{1}{2}$	39.2700	122.719	23 $\frac{3}{4}$	74.6130	443.015
12 $\frac{3}{4}$	40.0554	127.677	24	75.3984	452.390
13	40.8408	132.733	24 $\frac{1}{4}$	76.1838	461.864
13 $\frac{1}{4}$	41.6262	137.887	24 $\frac{1}{2}$	76.9692	471.436
13 $\frac{1}{2}$	42.4116	143.139	24 $\frac{3}{4}$	77.7546	481.107
13 $\frac{3}{4}$	43.1970	148.490	25	78.5400	490.875
14	43.9824	153.938	25 $\frac{1}{4}$	79.3254	500.742
14 $\frac{1}{4}$	44.7678	159.485	25 $\frac{1}{2}$	80.1108	510.706
14 $\frac{1}{2}$	45.5532	165.130	25 $\frac{3}{4}$	80.8962	520.769
14 $\frac{3}{4}$	46.3386	170.874	26	81.6816	530.930
15	47.1240	176.715	26 $\frac{1}{4}$	82.4670	541.190
15 $\frac{1}{4}$	47.9094	182.655	26 $\frac{1}{2}$	83.2524	551.547
15 $\frac{1}{2}$	48.6948	188.692	26 $\frac{3}{4}$	84.0378	562.003
15 $\frac{3}{4}$	49.4802	194.828	27	84.8232	572.557
16	50.2656	201.062	27 $\frac{1}{4}$	85.6086	583.209
16 $\frac{1}{4}$	51.0510	207.395	27 $\frac{1}{2}$	86.3940	593.959
16 $\frac{1}{2}$	51.8364	213.825	27 $\frac{3}{4}$	87.1794	604.807
16 $\frac{3}{4}$	52.6218	220.354	28	87.9648	615.754
17	53.4072	226.981	28 $\frac{1}{4}$	88.7502	626.798
17 $\frac{1}{4}$	54.1926	233.706	28 $\frac{1}{2}$	89.5356	637.941
17 $\frac{1}{2}$	54.9780	240.529	28 $\frac{3}{4}$	90.3210	649.182
17 $\frac{3}{4}$	55.7634	247.450	29	91.1064	660.521
18	56.5488	254.470	29 $\frac{1}{4}$	91.8918	671.959
18 $\frac{1}{4}$	57.3342	261.587	29 $\frac{1}{2}$	92.6772	683.494
18 $\frac{1}{2}$	58.1196	268.803	29 $\frac{3}{4}$	93.4626	695.128
18 $\frac{3}{4}$	58.9050	276.117	30	94.2480	706.860
19	59.6904	283.529	30 $\frac{1}{4}$	95.0334	718.690
19 $\frac{1}{4}$	60.4758	291.040	30 $\frac{1}{2}$	95.8188	730.618

TABLE—(Continued)

Diam.	Circum.	Area	Diam.	Circum.	Area
30 $\frac{3}{4}$	96.6042	742.645	42	131.947	1,385.450
31	97.3896	754.769	42 $\frac{1}{4}$	132.733	1,401.990
31 $\frac{1}{4}$	98.1750	766.992	42 $\frac{1}{2}$	133.518	1,418.630
31 $\frac{1}{2}$	98.9604	779.313	42 $\frac{3}{4}$	134.303	1,435.370
31 $\frac{3}{4}$	99.7458	791.732	43	135.089	1,452.200
32	100.5312	804.250	43 $\frac{1}{4}$	135.874	1,469.140
32 $\frac{1}{4}$	101.3166	816.865	43 $\frac{1}{2}$	136.660	1,486.170
32 $\frac{1}{2}$	102.1020	829.579	43 $\frac{3}{4}$	137.445	1,503.300
32 $\frac{3}{4}$	102.8874	842.391	44	138.230	1,520.530
33	103.673	855.301	44 $\frac{1}{4}$	139.016	1,537.860
33 $\frac{1}{4}$	104.458	868.309	44 $\frac{1}{2}$	139.801	1,555.29
33 $\frac{1}{2}$	105.244	881.415	44 $\frac{3}{4}$	140.587	1,572.81
33 $\frac{3}{4}$	106.029	894.620	45	141.372	1,590.43
34	106.814	907.922	45 $\frac{1}{4}$	142.157	1,608.16
34 $\frac{1}{4}$	107.600	921.323	45 $\frac{1}{2}$	142.943	1,625.97
34 $\frac{1}{2}$	108.385	934.822	45 $\frac{3}{4}$	143.728	1,643.89
34 $\frac{3}{4}$	109.171	948.420	46	144.514	1,661.91
35	109.956	962.115	46 $\frac{1}{4}$	145.299	1,680.02
35 $\frac{1}{4}$	110.741	975.909	46 $\frac{1}{2}$	146.084	1,698.23
35 $\frac{1}{2}$	111.527	989.800	46 $\frac{3}{4}$	146.870	1,716.54
35 $\frac{3}{4}$	112.312	1,003.790	47	147.655	1,734.95
36	113.098	1,017.878	47 $\frac{1}{4}$	148.441	1,753.45
36 $\frac{1}{4}$	113.883	1,032.065	47 $\frac{1}{2}$	149.226	1,772.06
36 $\frac{1}{2}$	114.668	1,046.349	47 $\frac{3}{4}$	150.011	1,790.76
36 $\frac{3}{4}$	115.454	1,060.732	48	150.797	1,809.56
37	116.239	1,075.213	48 $\frac{1}{4}$	151.582	1,828.46
37 $\frac{1}{4}$	117.025	1,089.792	48 $\frac{1}{2}$	152.368	1,847.46
37 $\frac{1}{2}$	117.810	1,104.469	48 $\frac{3}{4}$	153.153	1,866.55
37 $\frac{3}{4}$	118.595	1,119.244	49	153.938	1,885.75
38	119.381	1,134.118	49 $\frac{1}{4}$	154.724	1,905.04
38 $\frac{1}{4}$	120.166	1,149.089	49 $\frac{1}{2}$	155.509	1,924.43
38 $\frac{1}{2}$	120.952	1,164.159	49 $\frac{3}{4}$	156.295	1,943.91
38 $\frac{3}{4}$	121.737	1,179.327	50	157.080	1,963.50
39	122.522	1,194.593	50 $\frac{1}{4}$	157.865	2,002.97
39 $\frac{1}{4}$	123.308	1,209.958	51	160.222	2,042.83
39 $\frac{1}{2}$	124.093	1,225.420	51 $\frac{1}{4}$	161.792	2,083.08
39 $\frac{1}{2}$	124.879	1,240.981	52	163.363	2,123.72
40	125.664	1,256.640	52 $\frac{1}{4}$	164.934	2,164.76
40 $\frac{1}{4}$	126.449	1,272.400	53	166.505	2,206.19
40 $\frac{1}{2}$	127.235	1,288.250	53 $\frac{1}{4}$	168.076	2,248.01
40 $\frac{3}{4}$	128.020	1,304.210	54	169.646	2,290.23
41	128.806	1,320.260	54 $\frac{1}{4}$	171.217	2,332.83
41 $\frac{1}{4}$	129.591	1,336.410	55	172.788	2,375.83
41 $\frac{1}{2}$	130.376	1,352.660	55 $\frac{1}{4}$	174.359	2,419.23
41 $\frac{3}{4}$	131.162	1,369.000	56	175.930	2,463.01

TABLE—(Continued)

Diam.	Circum.	Area	Diam.	Circum.	Area
56½	177.500	2,507.19	78½	246.616	4,839.83
57	179.071	2,551.76	79	248.186	4,901.68
57½	180.642	2,596.73	79½	249.757	4,963.92
58	182.213	2,642.09	80	251.328	5,026.56
58½	183.784	2,687.84	80½	252.899	5,089.59
59	185.354	2,733.98	81	254.470	5,153.01
59½	186.925	2,780.51	81½	256.040	5,216.82
60	188.496	2,827.44	82	257.611	5,281.03
60½	190.067	2,874.76	82½	259.182	5,345.63
61	191.638	2,922.47	83	260.753	5,410.62
61½	193.208	2,970.58	83½	262.324	5,476.01
62	194.779	3,019.08	84	263.894	5,541.78
62½	196.350	3,067.97	84½	265.465	5,607.95
63	197.921	3,117.25	85	267.036	5,674.51
63½	199.492	3,166.93	85½	268.607	5,741.47
64	201.062	3,217.00	86	270.178	5,808.82
64½	202.633	3,267.46	86½	271.748	5,876.56
65	204.204	3,318.31	87	273.319	5,944.69
65½	205.775	3,369.56	87½	274.890	6,013.22
66	207.346	3,421.20	88	276.461	6,082.14
66½	208.916	3,473.24	88½	278.032	6,151.45
67	210.487	3,525.66	89	279.602	6,221.15
67½	212.058	3,578.48	89½	281.173	6,291.25
68	213.629	3,631.69	90	282.744	6,361.74
68½	215.200	3,685.29	90½	284.315	6,432.62
69	216.770	3,739.29	91	285.886	6,503.90
69½	218.341	3,793.68	91½	287.456	6,575.56
70	219.912	3,848.46	92	289.027	6,647.63
70½	221.483	3,903.63	92½	290.598	6,720.08
71	223.054	3,959.20	93	292.169	6,792.92
71½	224.624	4,015.16	93½	293.740	6,866.16
72	226.195	4,071.51	94	295.310	6,939.79
72½	227.766	4,128.26	94½	296.881	7,013.82
73	229.337	4,185.40	95	298.452	7,088.24
73½	230.908	4,242.93	95½	300.023	7,163.04
74	232.478	4,300.85	96	301.594	7,238.25
74½	234.049	4,359.17	96½	303.164	7,313.84
75	235.620	4,417.87	97	304.735	7,389.83
75½	237.191	4,476.98	97½	306.306	7,466.21
76	238.762	4,536.47	98	307.877	7,542.98
76½	240.332	4,596.36	98½	309.448	7,620.15
77	241.903	4,656.64	99	311.018	7,697.71
77½	243.474	4,717.31	99½	312.589	7,775.66
78	245.045	4,778.37	100	314.160	7,854.00



## DECIMAL EQUIVALENTS OF PARTS OF ONE INCH

1-64	.015625	17-64	.265625	33-64	.515625	49-64	.765625
1-32	.031250	9-32	.281250	17-32	.531250	25-32	.781250
3-64	.046875	19-64	.296875	35-64	.546875	51-64	.796875
1-16	.062500	5-16	.312500	9-16	.562500	13-16	.812500
5-64	.078125	21-64	.328125	37-64	.578125	53-64	.828125
3-32	.093750	11-32	.343750	19-32	.593750	27-32	.843750
7-64	.109375	23-64	.359375	39-64	.609375	55-64	.859375
1-8	.125000	3-8	.375000	5-8	.625000	7-8	.875000
9-64	.140625	25-64	.390625	41-64	.640625	57-64	.890625
5-32	.156250	13-32	.406250	21-32	.656250	29-32	.906250
11-64	.171875	27-64	.421875	43-64	.671875	59-64	.921875
3-16	.187500	7-16	.437500	11-16	.687500	15-16	.937500
13-64	.203125	29-64	.453125	45-64	.703125	61-64	.953125
7-32	.218750	15-32	.468750	23-32	.718750	31-32	.968750
15-64	.234375	31-64	.484375	47-64	.734375	63-64	.984375
1-4	.250000	1-2	.500000	3-4	.750000	1	1

## TRIGONOMETRIC FUNCTIONS

The table given on pages 23-27 contains the natural sines, cosines, tangents, and cotangents of angles from  $0^\circ$  to  $90^\circ$ . Angles less than  $45^\circ$  are given in the first column at the left-hand side of the page, and the names of the functions are given at the top of the page; angles greater than  $45^\circ$  appear at the right-hand side of the page, and the names of the functions are given at the bottom. Thus, the second column contains the sines of angles less than  $45^\circ$  and the cosines of angles greater than  $45^\circ$ ; the sixth column contains the cotangents of angles less than  $45^\circ$  and the tangents of angles greater than  $45^\circ$ . To find the function of an angle less than  $45^\circ$ , look in the column of angles at the left of the page for the angle, and at the top of the page for the name of the function; to find a function of an angle greater than  $45^\circ$ , look in the column at the right of the page for the angle and at the bottom of the page for the name of the function. The successive angles differ by an interval of  $10'$ ; they increase downwards in the left-hand column and upwards in the right-hand column. Thus, for angles less than  $45^\circ$  read down from top of page, and for angles greater than  $45^\circ$  read up from bottom of page.

The third, fifth, seventh, and ninth columns, headed *d*, contain the differences between the successive functions; for

example, the sine of  $32^{\circ} 10'$  is .5324 and the sine of  $32^{\circ} 20'$  is .5348, as given in the second column, page 26; the difference is  $.5348 - .5324 = .0024$ , and the 24 is written in the third column, just opposite the space between .5324 and .5348. In like manner, the differences between the successive tabular values of the tangents are given in the fifth column, those between the cotangents in the seventh column, and those for the cosines in the ninth column. These differences in the functions correspond to a difference of  $10'$  in the angle; thus, when the angle  $32^{\circ} 10'$  is increased by  $10'$ , that is, to  $32^{\circ} 20'$ , the increase of the sine is .0024, or, as given in the table, 24. In the tabular difference, no attention is paid to the decimal point, it being understood that the difference is merely the number obtained by subtracting the last two or three figures of the smaller function from those of the larger. These differences are used to obtain the sines, cosines, etc. of angles not given in the table; for example, to find the tangent of  $27^{\circ} 34'$  find in the table the tangent of  $27^{\circ} 30'$ , .5206, and (in column 5) the difference for  $10'$ , 37. Difference for  $1'$  is  $37 \div 10 = 3.7$ , and difference for  $4'$  is  $3.7 \times 4 = 14.8$ . Adding this difference to the value of the  $\tan 27^{\circ} 30'$ , gives

$$\begin{array}{r} \tan 27^{\circ} 30' = .5206 \\ \text{difference for } 4' = \quad 14.8 \\ \hline \end{array}$$

$\tan 27^{\circ} 34' = .52208$ , or .5221, to four places.

Since only four decimal places are retained, the 8 in the fifth place is dropped and the figure in the fourth place is increased by 1, because 8 is greater than 5.

To avoid multiplication, the column of proportional parts, headed P. P., at the extreme right of the page, is used. At the head of each table in this column is the difference for  $10'$ , and below are the differences for any intermediate number of minutes from  $1'$  to  $9'$ . In the above example, the difference at  $27^{\circ} 30'$  for  $10'$  was 37; looking in the table with 37 at the head, the difference opposite 4 is 14.8; that opposite 7 is 25.9; and so on. For want of space, the differences for the cotangents for angles less than  $45^{\circ}$  (or the tangents of angles greater than  $45^{\circ}$ ) have been omitted from the tables of proportional parts. The use of these functions should be

°	'	Sin.	d.	Tan.	d.	Cot.	d.	Cos.	d.	P. P.		
0	0	0.0000		0.0000		infinit.		1.0000		0	0 90	
	10	0.0029	29	0.0029	29	343.7737		1.0000		0	50	
	20	0.0058	29	0.0058	29	171.8854		1.0000		0	40	30
	30	0.0087	29	0.0087	29	114.5887		1.0000		1	30	1 3.0
	40	0.0116	29	0.0116	29	85.9398		0.9999		0	20	2 6.0
	50	0.0145	29	0.0145	29	68.7501		0.9999		0	10	3 9.0
			30		30					1		4 12.0
1	0	0.0175		0.0175		57.2900		0.9998		0	0 89	5 15.0
	10	0.0204	29	0.0204	29	49.1039	81861	0.9998		0	50	6 18.0
	20	0.0233	29	0.0233	29	42.9641	61398	0.9997		1	40	7 21.0
	30	0.0262	29	0.0262	29	38.1885	47756	0.9997		0	30	8 24.0
	40	0.0291	29	0.0291	29	34.3678	38207	0.9996		1	20	9 27.0
	50	0.0320	29	0.0320	29	31.2416	31262	0.9995		1	10	
			29		29		26053			1		
2	0	0.0349		0.0349		28.6363		0.9994		1	0 88	
	10	0.0378	29	0.0378	29	26.4316	22047	0.9993		1	50	
	20	0.0407	29	0.0407	30	24.5418	18898	0.9992		1	40	1 2.9
	30	0.0436	29	0.0437	29	22.9038	16380	0.9990		2	30	2 5.8
	40	0.0465	29	0.0466	29	21.4704	14334	0.9989		1	20	3 8.7
	50	0.0494	29	0.0495	29	20.2056	12648	0.9988		1	10	4 11.6
			29		29		11245			2		5 14.5
3	0	0.0523		0.0524		19.0811		0.9986		1	0 87	6 17.4
	10	0.0552	29	0.0553	29	18.0750	10061	0.9985		1	50	7 20.3
	20	0.0581	29	0.0582	30	17.1693	9057	0.9983		2	40	8 23.2
	30	0.0610	29	0.0612	29	16.3499	8194	0.9981		2	30	9 26.1
	40	0.0640	29	0.0641	29	15.6048	7451	0.9980		1	20	
	50	0.0669	29	0.0670	29	14.9244	6804	0.9978		2	10	
			29		29		6237			2		28
4	0	0.0698		0.0699		14.3007		0.9976		2	0 86	1 2.8
	10	0.0727	29	0.0729	29	13.7267	5740	0.9974		2	50	2 5.6
	20	0.0756	29	0.0758	29	13.1969	5298	0.9971		3	40	3 8.4
	30	0.0785	29	0.0787	29	12.7062	4907	0.9969		2	30	4 11.2
	40	0.0814	29	0.0816	30	12.2505	4557	0.9967		3	20	5 14.0
	50	0.0843	29	0.0846	29	11.8262	4243	0.9964		3	10	6 16.8
			29		29		3961			2		7 19.6
5	0	0.0872		0.0875		11.4301		0.9962		2	0 85	8 22.4
	10	0.0901	28	0.0904	29	11.0594	3707	0.9959		3	50	9 25.2
	20	0.0929	29	0.0934	30	10.7119	3475	0.9957		2	40	
	30	0.0958	29	0.0963	29	10.3854	3265	0.9954		3	30	
	40	0.0987	29	0.0992	29	10.0780	3074	0.9951		3	20	5
	50	0.1016	29	0.1022	30	9.7882	2898	0.9948		3	10	1 0.5
			29		29		2738			3		2 1.0
6	0	0.1045		0.1051		9.5144		0.9945		3	0 84	3 1.5
	10	0.1074	29	0.1080	29	9.2553	2591	0.9942		3	50	4 2.0
	20	0.1103	29	0.1110	30	9.0098	2455	0.9939		3	40	5 2.5
	30	0.1132	29	0.1139	30	8.7769	2329	0.9936		3	30	6 3.0
	40	0.1161	29	0.1169	29	8.5555	2214	0.9932		4	20	7 3.5
	50	0.1190	29	0.1198	29	8.3450	2105	0.9929		3	10	8 4.0
			29		30		2007			4		9 4.5
7	0	0.1219		0.1228		8.1443		0.9925		3	0 83	
	10	0.1248	29	0.1257	29	7.9530	1913	0.9922		4	50	
	20	0.1276	29	0.1287	30	7.7704	1826	0.9918		4	40	4
	30	0.1305	29	0.1317	29	7.5958	1746	0.9914		4	30	1 0.4
	40	0.1334	29	0.1346	29	7.4287	1671	0.9911		3	20	2 0.8
	50	0.1363	29	0.1376	30	7.2687	1600	0.9907		4	10	3 1.2
			29		29		1533			4		4 1.6
8	0	0.1392		0.1405		7.1154		0.9903		4	0 82	5 2.0
	10	0.1421	28	0.1435	30	6.9682	1472	0.9899		4	50	6 2.4
	20	0.1449	29	0.1465	30	6.8269	1413	0.9894		5	40	7 2.8
	30	0.1478	29	0.1495	29	6.6912	1357	0.9890		4	30	8 3.2
	40	0.1507	29	0.1524	30	6.5606	1306	0.9886		4	20	9 3.6
	50	0.1536	29	0.1554	30	6.4348	1258	0.9881		5	10	
			28		30		1210			4		
9	0	0.1564		0.1584		6.3138		0.9877		4	0 81	
		Cos.	d.	Cot.	d.	Tan.	d.	Sin.	d.	°		P. P.

										P. P.			
°	'	Sin.	d.	Tan.	d.	Cot.	d.	Cos.	d.				
9	0	0.1564	29	0.1584	30	6.3138	1168	0.9877	5	0	81		
	10	0.1593	29	0.1614	30	6.1970	1126	0.9872	4	50			
	20	0.1622	28	0.1644	29	6.0844	1086	0.9868	5	40			
	30	0.1650	28	0.1673	30	5.9758	1050	0.9863	5	30			
	40	0.1679	29	0.1703	30	5.8708	1014	0.9858	5	20			
	50	0.1708	29	0.1733	30	5.7694	981	0.9853	5	10			
10	0	0.1736	28	0.1763	30	5.6713	949	0.9848	6	0	80		
	10	0.1765	29	0.1793	30	5.5764	919	0.9843	5	50			
	20	0.1794	28	0.1823	30	5.4845	890	0.9838	5	40			
	30	0.1822	29	0.1853	30	5.3955	862	0.9833	6	30			
	40	0.1851	29	0.1883	31	5.3093	836	0.9827	5	20			
	50	0.1880	28	0.1914	30	5.2257	811	0.9822	6	10			
11	0	0.1908	29	0.1944	30	5.1446	788	0.9816	5	0	79		
	10	0.1937	28	0.1974	30	5.0658	764	0.9811	6	50			
	20	0.1965	29	0.2004	31	4.9894	742	0.9805	6	40			
	30	0.1994	28	0.2033	30	4.9152	722	0.9799	6	30			
	40	0.2022	29	0.2065	30	4.8430	701	0.9793	6	20			
	50	0.2051	28	0.2095	31	4.7729	683	0.9787	6	10			
12	0	0.2079	29	0.2126	30	4.7046	664	0.9781	6	0	78		
	10	0.2108	28	0.2166	30	4.6382	646	0.9775	6	50			
	20	0.2136	29	0.2186	31	4.5736	629	0.9769	6	40			
	30	0.2164	29	0.2217	30	4.5107	613	0.9763	6	30			
	40	0.2193	28	0.2247	31	4.4494	597	0.9757	7	20			
	50	0.2221	29	0.2278	31	4.3897	582	0.9750	6	10			
13	0	0.2250	28	0.2309	30	4.3315	568	0.9744	6	0	77		
	10	0.2278	29	0.2339	31	4.2747	554	0.9737	7	50			
	20	0.2306	28	0.2370	31	4.2193	540	0.9730	6	40			
	30	0.2334	29	0.2401	31	4.1653	527	0.9724	6	30			
	40	0.2363	28	0.2432	30	4.1126	515	0.9717	7	20			
	50	0.2391	28	0.2462	31	4.0611	503	0.9710	7	10			
14	0	0.2419	29	0.2493	31	4.0108	491	0.9703	7	0	76		
	10	0.2447	28	0.2524	31	3.9617	481	0.9696	7	50			
	20	0.2476	29	0.2555	31	3.9136	469	0.9689	8	40			
	30	0.2504	28	0.2586	31	3.8667	459	0.9681	8	30			
	40	0.2532	28	0.2617	31	3.8208	448	0.9674	7	20			
	50	0.2560	28	0.2648	31	3.7760	439	0.9667	7	10			
15	0	0.2588	29	0.2679	32	3.7321	430	0.9659	8	0	75		
	10	0.2616	28	0.2711	31	3.6891	421	0.9652	7	50			
	20	0.2644	28	0.2742	31	3.6470	411	0.9644	8	40			
	30	0.2672	28	0.2773	32	3.6059	403	0.9636	8	30			
	40	0.2700	28	0.2805	31	3.5656	395	0.9628	8	20			
	50	0.2728	28	0.2836	31	3.5261	387	0.9621	8	10			
16	0	0.2756	29	0.2867	32	3.4874	379	0.9613	8	0	74		
	10	0.2784	28	0.2899	32	3.4495	371	0.9605	9	50			
	20	0.2812	28	0.2931	31	3.4124	365	0.9596	8	40			
	30	0.2840	28	0.2962	32	3.3759	357	0.9588	8	30			
	40	0.2868	28	0.2994	32	3.3402	350	0.9580	8	20			
	50	0.2896	28	0.3026	32	3.3052	343	0.9572	9	10			
17	0	0.2924	29	0.3057	31	3.2709	338	0.9563	8	0	73		
	10	0.2952	27	0.3089	32	3.2371	330	0.9555	9	50			
	20	0.2979	28	0.3121	32	3.2041	325	0.9546	9	40			
	30	0.3007	28	0.3153	32	3.1716	319	0.9537	9	30			
	40	0.3035	27	0.3185	32	3.1397	313	0.9528	8	20			
	50	0.3062	27	0.3217	32	3.1084	307	0.9520	9	10			
18	0	0.3090	28	0.3249	32	3.0777	301	0.9511	9	0	72		
		Cos.	d.	Cot.	d.	Tan.	d.	Sin.	d.	'	°		

P. P.

32 31 30

1	3.2	3.1	3.0
2	6.4	6.2	6.0
3	9.6	9.3	9.0
4	12.8	12.4	12.0
5	16.0	15.5	15.0
6	19.2	18.6	18.0
7	22.4	21.7	21.0
8	25.6	24.8	24.0
9	28.8	27.9	27.0

29 28 27

1	2.9	2.8	2.7
2	5.8	5.6	5.4
3	8.7	8.4	8.1
4	11.6	11.2	10.8
5	14.5	14.0	13.5
6	17.4	16.8	16.2
7	20.3	19.6	18.9
8	23.2	22.4	21.6
9	26.1	25.2	24.3

9 8

1	0.9	0.8
2	1.8	1.6
3	2.7	2.4
4	3.6	3.2
5	4.5	4.0
6	5.4	4.8
7	6.3	5.6
8	7.2	6.4
9	8.1	7.2

7 6

1	0.7	0.6
2	1.4	1.2
3	2.1	1.8
4	2.8	2.4
5	3.5	3.0
6	4.2	3.6
7	4.9	4.2
8	5.6	4.8
9	6.3	5.4

5 4

1	0.5	0.4
2	1.0	0.8
3	1.5	1.2
4	2.0	1.6
5	2.5	2.0
6	3.0	2.4
7	3.5	2.8
8	4.0	3.2
9	4.5	3.6

P. P.

°	'	Sin.	d.	Tan.	d.	Cot.	d.	Cos.	d.		P. P.
18	0	0.3090		0.3249		3.0777		0.9511		0 72	
	10	0.3118	28	0.3281	32	3.0475	302	0.9502	9	50	
	20	0.3145	27	0.3314	33	3.0178	297	0.9492	10	40	37   36   35
	30	0.3173	28	0.3346	32	2.9887	291	0.9483	9	30	1   3.7   3.6   3.5
	40	0.3201	27	0.3378	33	2.9600	287	0.9474	9	20	2   7.4   7.2   7.0
	50	0.3228	27	0.3411	33	2.9319	281	0.9465	9	10	3   11.1   10.8   10.5
			28		32		277		10	0	4   14.8   14.4   14.0
19	0	0.3256		0.3443		2.9042		0.9455		0 71	
	10	0.3283	27	0.3476	33	2.8770	272	0.9446	9	50	5   18.5   18.0   17.5
	20	0.3311	28	0.3508	33	2.8502	268	0.9436	10	40	6   22.2   21.6   21.0
	30	0.3338	27	0.3541	33	2.8239	263	0.9426	10	30	7   25.9   25.2   24.5
	40	0.3365	28	0.3574	33	2.7980	259	0.9417	9	20	8   29.6   28.8   28.0
	50	0.3393	27	0.3607	33	2.7725	255	0.9407	10	10	9   33.3   32.4   31.5
			28		32		250		10	0	
20	0	0.3420		0.3640		2.7475		0.9397		0 70	
	10	0.3448	27	0.3673	33	2.7228	247	0.9387	10	50	34   33   32
	20	0.3475	28	0.3706	33	2.6985	243	0.9377	10	40	1   3.4   3.3   3.2
	30	0.3502	27	0.3739	33	2.6746	239	0.9367	10	30	2   6.8   6.6   6.4
	40	0.3529	28	0.3772	33	2.6511	235	0.9356	11	20	3   10.2   9.9   9.6
	50	0.3557	27	0.3805	34	2.6279	232	0.9346	10	10	4   13.6   13.2   12.8
			28		33		228		10	0	5   17.0   16.5   16.0
21	0	0.3584		0.3839		2.6051		0.9336		0 69	
	10	0.3611	27	0.3872	34	2.5826	225	0.9325	11	50	6   20.4   19.8   19.2
	20	0.3638	28	0.3906	34	2.5605	221	0.9315	10	40	7   23.8   23.1   22.4
	30	0.3665	27	0.3939	34	2.5386	219	0.9304	11	30	8   27.2   26.4   25.6
	40	0.3692	28	0.3973	33	2.5172	214	0.9293	10	20	9   30.6   29.7   28.8
	50	0.3719	27	0.4006	33	2.4960	212	0.9283	10	10	
			28		34		209		11	0	28   27   26
22	0	0.3746		0.4040		2.4751		0.9272		0 68	
	10	0.3773	27	0.4074	34	2.4545	206	0.9261	11	50	1   2.8   2.7   2.6
	20	0.3800	28	0.4108	34	2.4342	203	0.9250	11	40	2   5.6   5.4   5.2
	30	0.3827	27	0.4142	34	2.4142	200	0.9239	11	30	3   8.4   8.1   7.8
	40	0.3854	28	0.4176	34	2.3945	197	0.9228	11	20	4   11.2   10.8   10.4
	50	0.3881	27	0.4210	34	2.3750	195	0.9216	12	10	5   14.0   13.5   13.0
			26		35		191		11	0	6   16.8   16.2   15.6
23	0	0.3907		0.4245		2.3559		0.9205		0 67	
	10	0.3934	27	0.4279	35	2.3369	190	0.9194	12	50	7   19.6   18.9   18.2
	20	0.3961	28	0.4314	34	2.3183	186	0.9182	11	40	8   22.4   21.6   20.8
	30	0.3987	27	0.4348	35	2.2998	181	0.9171	12	30	9   25.2   24.3   23.4
	40	0.4014	28	0.4383	34	2.2817	180	0.9159	12	20	
	50	0.4041	27	0.4417	35	2.2637	177	0.9147	12	10	13   12
			26		35		174		12	0	1   1.3   1.3
24	0	0.4067		0.4452		2.2460		0.9135		0 66	
	10	0.4094	27	0.4487	35	2.2286	173	0.9124	12	50	2   2.6   2.4
	20	0.4120	28	0.4522	35	2.2113	170	0.9112	12	40	3   3.9   3.6
	30	0.4147	27	0.4557	35	2.1943	168	0.9100	12	30	4   5.2   4.8
	40	0.4173	28	0.4592	35	2.1775	166	0.9088	13	20	5   6.5   6.0
	50	0.4200	27	0.4628	36	2.1609	164	0.9075	13	10	6   7.8   7.2
			26		35		161		12	0	7   9.1   8.4
25	0	0.4226		0.4663		2.1445		0.9063		0 65	
	10	0.4253	27	0.4699	36	2.1283	162	0.9051	13	50	8   10.4   9.6
	20	0.4279	28	0.4734	36	2.1123	160	0.9038	13	40	9   11.7   10.8
	30	0.4305	27	0.4770	36	2.0965	158	0.9026	13	30	
	40	0.4331	28	0.4805	35	2.0809	156	0.9013	13	20	11   1.1   1.0   0.9
	50	0.4358	27	0.4841	35	2.0655	154	0.9001	12	10	2   2.2   2.0   1.8
			26		36		152		13	0	3   3.3   3.0   2.7
26	0	0.4384		0.4877		2.0503		0.8988		0 64	
	10	0.4410	27	0.4913	36	2.0353	150	0.8975	13	50	4   4.4   4.0   3.6
	20	0.4436	28	0.4949	36	2.0204	149	0.8962	13	40	5   5.5   5.0   4.5
	30	0.4462	27	0.4986	36	2.0057	147	0.8949	13	30	6   6.6   6.0   5.4
	40	0.4488	28	0.5022	37	1.9912	145	0.8936	13	20	7   7.7   7.0   6.3
	50	0.4514	27	0.5059	37	1.9768	144	0.8923	13	10	8   8.8   8.0   7.2
			26		36		142		13	0	9   9.9   9.0   8.1
27	0	0.4540		0.5095		1.9626		0.8910		0 63	
		Cos.	d.	Cot.	d.	Tan.	d.	Sin.	d.	'	P. P.

°	'	Sin.	d.	Tan.	d.	Cot.	d.	Cos.	d.	°	P. P.			
											1	2	3	
27	0	0.4540	26	0.5095	37	1.9626	140	0.8910	13	0	63	44	43	42
	10	0.4566	26	0.5132	37	1.9486	139	0.8897	13	50		4.4	4.3	4.2
	20	0.4592	25	0.5169	37	1.9347	137	0.8884	14	40		8.8	8.6	8.4
	30	0.4617	26	0.5206	37	1.9210	136	0.8870	13	30		13.2	12.9	12.6
	40	0.4643	26	0.5243	37	1.9074	134	0.8857	14	20		17.6	17.2	16.8
	50	0.4669	26	0.5280	37	1.8940	133	0.8843	14	10		22.0	21.5	21.0
28	0	0.4695	26	0.5317	37	1.8807	131	0.8829	14	0	62	26.4	25.8	25.2
	10	0.4720	26	0.5354	38	1.8676	130	0.8816	14	50		30.8	30.1	29.4
	20	0.4746	26	0.5392	38	1.8546	128	0.8802	14	40		35.2	34.4	33.6
	30	0.4772	25	0.5430	37	1.8418	127	0.8788	14	30		39.6	38.7	37.8
	40	0.4797	26	0.5467	38	1.8291	126	0.8774	14	20		41	40	39
	50	0.4823	25	0.5505	38	1.8165	125	0.8760	14	10		4.1	4.0	3.9
29	0	0.4848	26	0.5543	38	1.8040	123	0.8746	14	0	61	8.2	8.0	7.8
	10	0.4874	25	0.5581	38	1.7917	121	0.8732	14	50		12.3	12.0	11.7
	20	0.4899	25	0.5619	39	1.7796	121	0.8718	14	40		16.4	16.0	15.6
	30	0.4924	26	0.5658	38	1.7675	119	0.8704	15	30		20.5	20.0	19.5
	40	0.4950	25	0.5696	39	1.7556	119	0.8689	14	20		24.6	24.0	23.4
	50	0.4975	25	0.5735	39	1.7437	116	0.8675	15	10		28.7	28.0	27.3
30	0	0.5000	25	0.5774	39	1.7321	116	0.8660	14	0	60	32.8	32.0	31.2
	10	0.5025	25	0.5812	39	1.7205	115	0.8646	15	50		36.9	36.0	35.1
	20	0.5050	25	0.5851	39	1.7090	113	0.8631	15	40		38	37	
	30	0.5075	25	0.5890	40	1.6977	113	0.8616	15	30		3.8	3.7	
	40	0.5100	25	0.5930	40	1.6864	111	0.8601	14	20		7.6	7.4	
	50	0.5125	25	0.5969	40	1.6753	110	0.8587	15	10		11.4	11.1	
31	0	0.5150	25	0.6009	39	1.6643	109	0.8572	15	0	59	15.2	14.8	
	10	0.5175	25	0.6048	40	1.6534	108	0.8557	15	50		19.0	18.5	
	20	0.5200	25	0.6088	40	1.6426	107	0.8542	16	40		22.8	22.2	
	30	0.5225	25	0.6128	40	1.6319	107	0.8526	15	30		26.6	25.9	
	40	0.5250	25	0.6168	40	1.6212	105	0.8511	15	20		30.4	29.6	
	50	0.5275	24	0.6208	41	1.6107	104	0.8496	16	10		34.2	33.3	
32	0	0.5299	25	0.6249	40	1.6003	103	0.8480	15	0	58	26	25	24
	10	0.5324	24	0.6289	41	1.5900	102	0.8465	15	50		2.6	2.5	2.4
	20	0.5348	25	0.6330	41	1.5798	101	0.8450	16	40		5.2	5.0	4.8
	30	0.5373	25	0.6371	41	1.5697	100	0.8434	16	30		7.8	7.5	7.2
	40	0.5398	24	0.6412	41	1.5597	100	0.8418	15	20		10.4	10.0	9.6
	50	0.5422	24	0.6453	41	1.5497	98	0.8403	16	10		13.0	12.5	12.0
33	0	0.5446	25	0.6494	42	1.5399	97	0.8387	16	0	57	15.6	15.0	14.4
	10	0.5471	24	0.6536	41	1.5301	96	0.8371	16	50		18.2	17.5	16.8
	20	0.5495	24	0.6577	42	1.5204	96	0.8355	16	40		20.8	20.0	19.2
	30	0.5519	25	0.6619	42	1.5108	95	0.8339	16	30		23.4	22.5	21.6
	40	0.5544	24	0.6661	42	1.5013	94	0.8323	16	20		23	17	16
	50	0.5568	24	0.6703	42	1.4919	93	0.8307	17	10		2.3	1.7	1.6
34	0	0.5592	24	0.6745	42	1.4826	93	0.8290	16	0	56	4.6	3.4	3.2
	10	0.5616	24	0.6787	43	1.4733	92	0.8274	16	50		6.9	5.1	4.8
	20	0.5640	24	0.6830	43	1.4641	91	0.8258	17	40		9.2	6.8	6.4
	30	0.5664	24	0.6873	43	1.4550	90	0.8241	16	30		11.5	8.5	8.0
	40	0.5688	24	0.6916	43	1.4460	90	0.8225	17	20		13.8	10.2	9.6
	50	0.5712	24	0.6959	43	1.4370	89	0.8208	16	10		16.1	11.9	11.2
35	0	0.5736	24	0.7002	44	1.4281	88	0.8192	17	0	55	18.4	13.6	12.8
	10	0.5760	23	0.7046	43	1.4193	87	0.8175	17	50		20.7	15.3	14.4
	20	0.5783	24	0.7089	44	1.4106	87	0.8158	17	40		15	14	13
	30	0.5807	24	0.7133	44	1.4019	85	0.8141	17	30		1.5	1.4	1.3
	40	0.5831	23	0.7177	44	1.3944	86	0.8124	17	20		3.0	2.8	2.6
	50	0.5854	24	0.7221	44	1.3848	84	0.8107	17	10		4.5	4.2	3.9
36	0	0.5878	24	0.7265	44	1.3764	84	0.8090	17	0	54	6.0	5.6	5.2
		Cos.	d.	Cot.	d.	Tan.	d.	Sin.	d.			7.5	7.0	6.5
												9.0	8.4	7.8
												10.5	9.8	9.1
												12.0	11.2	10.4
												13.5	12.6	11.7

° /	Sin.	d.	Tan.	d.	Cot.	d.	Cos.	d.		P. P.				
36 0	0.5878		0.7265		1.3764		0.8090		0 54	58	57	56	55	
10	0.5901	23	0.7310	45	1.3680	84	0.8073	17	50	1	5.8	5.7	5.6	5.5
20	0.5925	24	0.7355	45	1.3597	83	0.8056	17	40	2	11.6	11.4	11.2	11.0
30	0.5948	24	0.7400	45	1.3514	82	0.8039	17	30	3	17.4	17.1	16.8	16.5
40	0.5972	23	0.7445	45	1.3432	81	0.8021	17	20	4	23.2	22.8	22.4	22.0
50	0.5995	23	0.7490	46	1.3351	81	0.8004	17	10	5	29.0	28.5	28.0	27.5
37 0	0.6018		0.7536		1.3270		0.7986		0 53	6	34.8	34.2	33.6	33.0
10	0.6041	23	0.7581	45	1.3190	80	0.7969	17	50	7	40.6	39.9	39.2	38.5
20	0.6065	24	0.7627	46	1.3111	79	0.7951	17	40	8	46.4	45.6	44.8	44.0
30	0.6088	23	0.7673	47	1.3032	78	0.7934	18	30	9	52.2	51.3	50.4	49.5
40	0.6111	23	0.7720	46	1.2954	78	0.7916	18	20		54	53	52	51
50	0.6134	23	0.7766	47	1.2876	77	0.7898	18	10	1	5.4	5.3	5.2	5.1
38 0	0.6157		0.7813		1.2799		0.7880		0 52	2	10.8	10.6	10.4	10.2
10	0.6180	23	0.7860	47	1.2723	76	0.7862	18	50	3	16.2	15.9	15.6	15.3
20	0.6202	22	0.7907	47	1.2647	75	0.7844	18	40	4	21.6	21.2	20.8	20.4
30	0.6225	23	0.7954	48	1.2572	75	0.7826	18	30	5	27.0	26.5	26.0	25.5
40	0.6248	23	0.8002	48	1.2497	74	0.7808	18	20	6	32.4	31.8	31.2	30.6
50	0.6271	22	0.8050	48	1.2423	74	0.7790	18	10	7	37.8	37.1	36.4	35.7
39 0	0.6293		0.8098		1.2349		0.7771		0 51	8	43.2	42.4	41.6	40.8
10	0.6316	23	0.8146	49	1.2276	73	0.7753	18	50	9	48.6	47.7	46.8	45.9
20	0.6338	23	0.8195	48	1.2203	73	0.7735	18	40		50	49	48	
30	0.6361	22	0.8243	49	1.2131	72	0.7716	18	30	1	5.0	4.9	4.8	
40	0.6383	23	0.8292	50	1.2059	71	0.7698	19	20	2	10.0	9.8	9.6	
50	0.6406	22	0.8342	49	1.1988	70	0.7679	19	10	3	15.0	14.7	14.4	
40 0	0.6428		0.8391		1.1918		0.7660		0 50	4	20.0	19.6	19.2	
10	0.6450	22	0.8441	50	1.1847	69	0.7642	19	50	5	25.0	24.5	24.0	
20	0.6472	23	0.8491	50	1.1778	69	0.7623	19	40	6	30.0	29.4	28.8	
30	0.6494	22	0.8541	50	1.1708	68	0.7604	19	30	7	35.0	34.3	33.6	
40	0.6517	22	0.8591	51	1.1640	69	0.7585	19	20	8	40.0	39.2	38.4	
50	0.6539	22	0.8642	51	1.1571	67	0.7566	19	10	9	45.0	44.1	43.2	
41 0	0.6561		0.8693		1.1504		0.7547		0 49		47	46	45	
10	0.6583	21	0.8744	52	1.1436	68	0.7528	19	50	1	4.7	4.6	4.5	
20	0.6604	22	0.8796	51	1.1369	67	0.7509	19	40	2	9.4	9.2	9.0	
30	0.6626	22	0.8847	52	1.1303	66	0.7490	20	30	3	14.1	13.8	13.5	
40	0.6648	22	0.8899	53	1.1237	66	0.7470	20	20	4	18.8	18.4	18.0	
50	0.6670	21	0.8952	52	1.1171	65	0.7451	20	10	5	23.5	23.0	22.5	
42 0	0.6691		0.9004		1.1106		0.7431		0 48	6	28.2	27.6	27.0	
10	0.6713	22	0.9057	53	1.1041	65	0.7412	20	50	7	32.9	32.2	31.5	
20	0.6734	22	0.9110	53	1.0977	64	0.7392	20	40	8	37.6	36.8	36.0	
30	0.6756	21	0.9163	54	1.0913	63	0.7373	20	30	9	42.3	41.4	40.5	
40	0.6777	22	0.9217	54	1.0850	64	0.7353	20	20		24	23	22	21
50	0.6799	21	0.9271	54	1.0786	62	0.7333	20	10	1	2.4	2.3	2.2	2.1
43 0	0.6820		0.9325		1.0724		0.7314		0 47	2	4.8	4.6	4.4	4.2
10	0.6841	21	0.9380	55	1.0661	63	0.7294	20	50	3	7.2	6.9	6.6	6.3
20	0.6862	22	0.9435	55	1.0599	61	0.7274	20	40	4	9.6	9.2	8.8	8.4
30	0.6884	21	0.9490	55	1.0538	61	0.7254	20	30	5	12.0	11.5	11.0	10.5
40	0.6905	21	0.9545	56	1.0477	61	0.7234	20	20	6	14.4	13.8	13.2	12.6
50	0.6926	21	0.9601	56	1.0416	61	0.7214	20	10	7	16.8	16.1	15.4	14.7
44 0	0.6947		0.9657		1.0355		0.7193		0 46	8	19.2	18.4	17.6	16.8
10	0.6967	20	0.9713	57	1.0295	60	0.7173	20	50	9	21.6	20.7	19.8	18.9
20	0.6988	21	0.9770	57	1.0235	59	0.7153	20	40		20	19	18	17
30	0.7009	21	0.9827	57	1.0176	59	0.7133	21	30	1	2.0	1.9	1.8	1.7
40	0.7030	20	0.9884	58	1.0117	59	0.7112	20	20	2	4.0	3.8	3.6	3.4
50	0.7050	21	0.9942	58	1.0058	58	0.7092	21	10	3	6.0	5.7	5.4	5.1
45 0	0.7071		1.0000		1.0000		0.7071		0 45	4	8.0	7.6	7.2	6.8
										5	10.0	9.5	9.0	8.5
										6	12.0	11.4	10.8	10.2
										7	14.0	13.3	12.6	11.9
										8	16.0	15.2	14.4	13.6
										9	18.0	17.1	16.2	15.3
											P. P.			

avoided, if possible, since the differences change very rapidly, and the computation is therefore likely to be inexact.

In finding the functions of an angle, note carefully whether the difference obtained from the table of proportional parts is to be added or subtracted, by observing whether the function is increasing or decreasing as the angle increases. For example, the sine of  $21^\circ$  is .3584, and the following sines, reading downwards, are .3611, .3638, etc. The sine of  $21^\circ 6'$  is greater than that of  $21^\circ$ , and the difference for  $6'$  must be added. On the other hand, the cosine of  $21^\circ$  is .9336, and the following cosines, reading downwards, are .9325, .9315, etc.; that is, as the angle grows larger the cosine decreases, and the difference obtained for any angle between  $21^\circ$  and  $21^\circ 10'$ , say  $21^\circ 6'$ , must be subtracted from the cosine of  $21^\circ$ .

Suppose the function, i. e., the sine, cosine, tangent, or cotangent is given and the corresponding angle is to be found; for example, find the angle whose sine is .4943. First find in the second column the sine next *smaller* than .4943, which is .4924, and the difference for  $10'$  is 26. The angle corresponding to .4924 is  $29^\circ 30'$ . Subtracting the .4924 from .4943, the first remainder is 19; in the table of proportional parts under 26, the part next lower than this difference, is 18.2, opposite which is  $7'$ . Subtracting 18.2 from 19 leaves .8 as the second remainder. In the table under 26 is found 7.8, which with its decimal point moved one place to the left is nearest to the second remainder, and opposite 7.8 is 3, which indicates  $.3'$  or  $18''$ . Hence, the angle is  $29^\circ 30' + 7' + 18'' = 29^\circ 37' 18''$ .

### INVOLUTION AND EVOLUTION

By means of the following table, the square, cube, square root, cube root, and reciprocal of any number may be obtained correct always to five significant figures, and in the majority of cases correct to six significant figures.

In any number, the figures beginning with the first digit\* at the left and ending with the last digit at the right, are

---

\*Ciphers (used merely to locate the decimal point) are not digits.



called the *significant figures* of the number. Thus, the number 405,800 has the four significant figures 4, 0, 5, 8; and the *significant part* of the number is 4058. The number .000090067 has five significant figures, 9, 0, 0, 6, 7, and the significant part is 90067. *All numbers that differ only in the position of the decimal point have the same significant figures and the same significant part.* For example, .002103, 21.03, 21,030, and 210,300 have the same significant figures 2, 1, 0, and 3, and the same significant part 2103.

The *integral part* of a number is the part to the left of the decimal point.

**Square and Cube Roots.**—If the given number contains less than four significant figures, the required root can be found in the table, the square root under  $\sqrt{n}$ , or  $\sqrt{10n}$ , and the cube root under  $\sqrt[3]{n}$ ,  $\sqrt[3]{10n}$ , or  $\sqrt[3]{100n}$ , according to the number of significant figures in the integral part of the number. Thus,  $\sqrt{3.14} = 1.772$ ;  $\sqrt{31.4} = \sqrt{10 \times 3.14} = 5.60357$ ;  $\sqrt[3]{3.14} = 1.46434$ ;  $\sqrt[3]{31.4} = \sqrt[3]{10 \times 3.14} = 3.15484$ ;  $\sqrt[3]{314} = \sqrt[3]{100 \times 3.14} = 6.79688$ .

In order to locate the decimal point, the given number must be pointed off into periods of two figures each for square root and three figures each for cube root, beginning always at the decimal point. Thus, for square root: 12703, 1'27'03; 12.703, 12.70'30; 220000, 22'00'00; .000442, .00'04'42; and for cube root: 3141.6, 3'141.6; 67296428, 67'296'428; .0000000217, .000'000'021'700, etc.

*There are as many figures in the root preceding the decimal point as there are periods preceding the decimal point in the given number; if the number is entirely decimal, the root is entirely decimal, and there are as many ciphers following the decimal point in the root as there are cipher periods following the decimal point in the given number.*

Applying this rule,  $\sqrt{220000} = 469.04$ ,  $\sqrt{.000442} = .021024$ ,  $\sqrt[3]{518000} = 80.3113$ , and  $\sqrt[3]{.000073} = .0418$ .

If the number has more than three significant figures, point off the number into periods, place a decimal point between the first and second periods of the significant part of the number, and proceed as in the following examples:

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt[10]{n}$	$\sqrt[3]{n}$	$\sqrt[10]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
1.01	1.0201	1.03030	1.00499	3.17805	1.00332	2.16159	4.65701	.990099
1.02	1.0404	1.06121	1.00995	3.19374	1.00662	2.16870	4.67233	.980392
1.03	1.0609	1.09273	1.01489	3.20936	1.00990	2.17577	4.68755	.970874
1.04	1.0816	1.12486	1.01980	3.22490	1.01316	2.18278	4.70267	.961539
1.05	1.1025	1.15763	1.02470	3.24037	1.01640	2.18976	4.71769	.952381
1.06	1.1236	1.19102	1.02956	3.25576	1.01961	2.19669	4.73262	.943396
1.07	1.1449	1.22504	1.03441	3.27109	1.02281	2.20358	4.74746	.934579
1.08	1.1664	1.25971	1.03923	3.28634	1.02599	2.21042	4.76220	.925926
1.09	1.1881	1.29503	1.04403	3.30151	1.02914	2.21722	4.77686	.917431
1.10	1.2100	1.33100	1.04881	3.31662	1.03228	2.22398	4.79142	.909091
1.11	1.2321	1.36763	1.05357	3.33167	1.03540	2.23070	4.80590	.900901
1.12	1.2544	1.40493	1.05830	3.34664	1.03850	2.23738	4.82028	.892857
1.13	1.2769	1.44290	1.06301	3.36155	1.04158	2.24402	4.83459	.884956
1.14	1.2996	1.48154	1.06771	3.37639	1.04464	2.25062	4.84881	.877193
1.15	1.3225	1.52088	1.07238	3.39116	1.04769	2.25718	4.86294	.869565
1.16	1.3456	1.56090	1.07703	3.40588	1.05072	2.26370	4.87700	.862069
1.17	1.3689	1.60161	1.08167	3.42053	1.05373	2.27019	4.89097	.854701
1.18	1.3924	1.64303	1.08628	3.43511	1.05672	2.27664	4.90487	.847458
1.19	1.4161	1.68516	1.09087	3.44964	1.05970	2.28305	4.91868	.840336
1.20	1.4400	1.72800	1.09545	3.46410	1.06266	2.28943	4.93242	.833333
1.21	1.4641	1.77156	1.10000	3.47851	1.06560	2.29577	4.94609	.826446
1.22	1.4884	1.81585	1.10454	3.49285	1.06853	2.30208	4.95968	.819672
1.23	1.5129	1.86087	1.10905	3.50714	1.07144	2.30835	4.97319	.813008
1.24	1.5376	1.90662	1.11355	3.52136	1.07434	2.31459	4.98663	.806452
1.25	1.5625	1.95313	1.11803	3.53553	1.07722	2.32080	5.00000	.800000
1.26	1.5876	2.00038	1.12250	3.54965	1.08008	2.32697	5.01330	.793651
1.27	1.6129	2.04838	1.12694	3.56371	1.08293	2.33310	5.02653	.787402
1.28	1.6384	2.09715	1.13137	3.57771	1.08577	2.33921	5.03968	.781250
1.29	1.6641	2.14669	1.13578	3.59166	1.08859	2.34529	5.05277	.775194
1.30	1.6900	2.19700	1.14018	3.60555	1.09139	2.35134	5.06580	.769231
1.31	1.7161	2.24809	1.14455	3.61939	1.09418	2.35735	5.07875	.763359
1.32	1.7424	2.29997	1.14891	3.63318	1.09696	2.36333	5.09164	.757576
1.33	1.7689	2.35264	1.15326	3.64692	1.09972	2.36928	5.10447	.751880
1.34	1.7956	2.40610	1.15758	3.66060	1.10247	2.37521	5.11723	.746269
1.35	1.8225	2.46038	1.16190	3.67423	1.10521	2.38110	5.12993	.740741
1.36	1.8496	2.51546	1.16619	3.68782	1.10793	2.38696	5.14256	.735294
1.37	1.8769	2.57135	1.17047	3.70135	1.11064	2.39280	5.15514	.729927
1.38	1.9044	2.62807	1.17473	3.71484	1.11334	2.39861	5.16765	.724638
1.39	1.9321	2.68562	1.17898	3.72827	1.11602	2.40439	5.18010	.719425
1.40	1.9600	2.74400	1.18322	3.74166	1.11869	2.41014	5.19249	.714286
1.41	1.9881	2.80322	1.18743	3.75500	1.12135	2.41587	5.20483	.709220
1.42	2.0164	2.86329	1.19164	3.76829	1.12399	2.42156	5.21710	.704225
1.43	2.0449	2.92421	1.19583	3.78153	1.12662	2.42724	5.22932	.699301
1.44	2.0736	2.98598	1.20000	3.79473	1.12924	2.43288	5.24148	.694444
1.45	2.1025	3.04863	1.20416	3.80789	1.13185	2.43850	5.25359	.689655
1.46	2.1316	3.11214	1.20830	3.82099	1.13445	2.44409	5.26564	.684932
1.47	2.1609	3.17652	1.21244	3.83406	1.13703	2.44966	5.27763	.680272
1.48	2.1904	3.24179	1.21655	3.84708	1.13960	2.45520	5.28957	.675676
1.49	2.2201	3.30795	1.22066	3.86005	1.14216	2.46072	5.30146	.671141
1.50	2.2500	3.37500	1.22474	3.87298	1.14471	2.46621	5.31329	.666667

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
1.51	2.2801	3.44295	1.22882	3.88587	1.14725	2.47168	5.32507	.662252
1.52	2.3104	3.51181	1.23288	3.89872	1.14978	2.47713	5.33680	.657895
1.53	2.3409	3.58158	1.23693	3.91152	1.15230	2.48255	5.34848	.653595
1.54	2.3716	3.65226	1.24097	3.92428	1.15480	2.48794	5.36011	.649351
1.55	2.4025	3.72388	1.24499	3.93700	1.15729	2.49332	5.37169	.645161
1.56	2.4336	3.79642	1.24900	3.94968	1.15978	2.49866	5.38321	.641026
1.57	2.4649	3.86989	1.25300	3.96232	1.16225	2.50399	5.39469	.636943
1.58	2.4964	3.94431	1.25698	3.97492	1.16471	2.50930	5.40612	.632911
1.59	2.5281	4.01968	1.26095	3.98748	1.16717	2.51458	5.41750	.628931
1.60	2.5600	4.09600	1.26491	4.00000	1.16961	2.51984	5.42884	.625000
1.61	2.5921	4.17328	1.26886	4.01248	1.17204	2.52508	5.44012	.621118
1.62	2.6244	4.25153	1.27279	4.02492	1.17446	2.53030	5.45136	.617284
1.63	2.6569	4.33075	1.27671	4.03733	1.17687	2.53549	5.46256	.613497
1.64	2.6896	4.41094	1.28062	4.04969	1.17927	2.54067	5.47370	.609756
1.65	2.7225	4.49213	1.28452	4.06202	1.18167	2.54582	5.48481	.606061
1.66	2.7556	4.57430	1.28841	4.07431	1.18405	2.55095	5.49586	.602410
1.67	2.7889	4.65746	1.29228	4.08656	1.18642	2.55607	5.50688	.598802
1.68	2.8224	4.74163	1.29615	4.09878	1.18878	2.56116	5.51785	.595238
1.69	2.8561	4.82681	1.30000	4.11096	1.19114	2.56623	5.52877	.591716
1.70	2.8900	4.91300	1.30384	4.12311	1.19348	2.57128	5.53966	.588235
1.71	2.9241	5.00021	1.30767	4.13521	1.19582	2.57631	5.55050	.584795
1.72	2.9584	5.08845	1.31149	4.14729	1.19815	2.58133	5.56130	.581395
1.73	2.9929	5.17772	1.31529	4.15933	1.20046	2.58632	5.57205	.578035
1.74	3.0276	5.26802	1.31909	4.17133	1.20277	2.59129	5.58277	.574713
1.75	3.0625	5.35938	1.32288	4.18330	1.20507	2.59625	5.59344	.571429
1.76	3.0976	5.45178	1.32665	4.19524	1.20736	2.60118	5.60408	.568182
1.77	3.1329	5.54523	1.33041	4.20714	1.20964	2.60610	5.61467	.564972
1.78	3.1684	5.63975	1.33417	4.21900	1.21192	2.61100	5.62523	.561798
1.79	3.2041	5.73534	1.33791	4.23084	1.21418	2.61588	5.63574	.558659
1.80	3.2400	5.83200	1.34164	4.24264	1.21644	2.62074	5.64622	.555556
1.81	3.2761	5.92974	1.34536	4.25441	1.21869	2.62558	5.65665	.552486
1.82	3.3124	6.02857	1.34907	4.26615	1.22093	2.63041	5.66705	.549451
1.83	3.3489	6.12849	1.35277	4.27785	1.22316	2.63522	5.67741	.546448
1.84	3.3856	6.22950	1.35647	4.28952	1.22539	2.64001	5.68773	.543475
1.85	3.4225	6.33163	1.36015	4.30116	1.22760	2.64479	5.69802	.540541
1.86	3.4596	6.43486	1.36382	4.31277	1.22981	2.64954	5.70827	.537634
1.87	3.4969	6.53920	1.36748	4.32435	1.23201	2.65428	5.71848	.534759
1.88	3.5344	6.64467	1.37113	4.33590	1.23420	2.65900	5.72865	.531915
1.89	3.5721	6.75127	1.37477	4.34741	1.23639	2.66371	5.73879	.529101
1.90	3.6100	6.85900	1.37840	4.35890	1.23856	2.66840	5.74890	.526316
1.91	3.6481	6.96787	1.38203	4.37035	1.24073	2.67307	5.75897	.523560
1.92	3.6864	7.07789	1.38564	4.38178	1.24289	2.67773	5.76900	.520833
1.93	3.7249	7.18906	1.38924	4.39318	1.24505	2.68237	5.77900	.518135
1.94	3.7636	7.30138	1.39284	4.40454	1.24719	2.68700	5.78896	.515464
1.95	3.8025	7.41488	1.39642	4.41588	1.24933	2.69161	5.79889	.512821
1.96	3.8416	7.52954	1.40000	4.42719	1.25146	2.69620	5.80879	.510204
1.97	3.8809	7.64537	1.40357	4.43847	1.25359	2.70078	5.81865	.507614
1.98	3.9204	7.76239	1.40712	4.44972	1.25571	2.70534	5.82848	.505051
1.99	3.9601	7.88060	1.41067	4.46094	1.25782	2.70989	5.83827	.502513
2.00	4.0000	8.00000	1.41421	4.47214	1.25992	2.71442	5.84804	.500000

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
2.01	4.0401	8.12060	1.41774	4.48330	1.26202	2.71893	5.85777	.497512
2.02	4.0804	8.24241	1.42127	4.49444	1.26411	2.72343	5.86746	.495050
2.03	4.1209	8.36543	1.42478	4.50555	1.26619	2.72792	5.87713	.492611
2.04	4.1616	8.48966	1.42829	4.51664	1.26827	2.73239	5.88677	.490196
2.05	4.2025	8.61519	1.43178	4.52769	1.27033	2.73685	5.89637	.487805
2.06	4.2436	8.74182	1.43527	4.53872	1.27240	2.74129	5.90594	.485437
2.07	4.2849	8.86974	1.43875	4.54973	1.27445	2.74572	5.91548	.483092
2.08	4.3264	8.99891	1.44222	4.56070	1.27650	2.75014	5.92499	.480769
2.09	4.3681	9.12933	1.44568	4.57165	1.27854	2.75454	5.93447	.478469
2.10	4.4100	9.26100	1.44914	4.58258	1.28058	2.75893	5.94392	.476191
2.11	4.4521	9.39393	1.45258	4.59347	1.28261	2.76330	5.95334	.473934
2.12	4.4944	9.52813	1.45602	4.60435	1.28463	2.76766	5.96273	.471698
2.13	4.5369	9.66360	1.45945	4.61519	1.28665	2.77200	5.97209	.469484
2.14	4.5796	9.80034	1.46287	4.62601	1.28866	2.77633	5.98142	.467290
2.15	4.6225	9.93838	1.46629	4.63681	1.29066	2.78065	5.99073	.465116
2.16	4.6656	10.0777	1.46969	4.64758	1.29266	2.78495	6.00000	.462963
2.17	4.7089	10.2183	1.47309	4.65833	1.29465	2.78924	6.00925	.460830
2.18	4.7524	10.3602	1.47648	4.66905	1.29664	2.79352	6.01846	.458716
2.19	4.7961	10.5035	1.47986	4.67974	1.29862	2.79779	6.02765	.456621
2.20	4.8400	10.6480	1.48324	4.69042	1.30059	2.80204	6.03681	.454546
2.21	4.8841	10.7939	1.48661	4.70106	1.30256	2.80628	6.04594	.452489
2.22	4.9284	10.9410	1.48997	4.71169	1.30452	2.81051	6.05505	.450451
2.23	4.9729	11.0896	1.49332	4.72229	1.30648	2.81472	6.06413	.448431
2.24	5.0176	11.2394	1.49666	4.73286	1.30843	2.81892	6.07318	.446429
2.25	5.0625	11.3906	1.50000	4.74342	1.31037	2.82311	6.08220	.444444
2.26	5.1076	11.5432	1.50333	4.75395	1.31231	2.82728	6.09120	.442478
2.27	5.1529	11.6971	1.50665	4.76445	1.31424	2.83145	6.10017	.440529
2.28	5.1984	11.8524	1.50997	4.77493	1.31617	2.83560	6.10911	.438597
2.29	5.2441	12.0090	1.51327	4.78539	1.31809	2.83974	6.11803	.436681
2.30	5.2900	12.1670	1.51658	4.79583	1.32001	2.84387	6.12693	.434783
2.31	5.3361	12.3264	1.51987	4.80625	1.32192	2.84798	6.13579	.432900
2.32	5.3824	12.4872	1.52315	4.81664	1.32382	2.85209	6.14463	.431035
2.33	5.4289	12.6493	1.52643	4.82701	1.32572	2.85618	6.15345	.429185
2.34	5.4756	12.8129	1.52971	4.83735	1.32761	2.86026	6.16224	.427350
2.35	5.5225	12.9779	1.53297	4.84768	1.32950	2.86433	6.17101	.425532
2.36	5.5696	13.1443	1.53623	4.85798	1.33139	2.86838	6.17975	.423729
2.37	5.6169	13.3121	1.53948	4.86826	1.33326	2.87243	6.18846	.421941
2.38	5.6644	13.4813	1.54272	4.87852	1.33514	2.87646	6.19715	.420168
2.39	5.7121	13.6519	1.54596	4.88876	1.33700	2.88049	6.20582	.418410
2.40	5.7600	13.8240	1.54919	4.89898	1.33887	2.88451	6.21447	.416667
2.41	5.8081	13.9975	1.55242	4.90918	1.34072	2.88850	6.22308	.414938
2.42	5.8564	14.1725	1.55563	4.91935	1.34257	2.89249	6.23168	.413223
2.43	5.9049	14.3489	1.55885	4.92950	1.34442	2.89647	6.24025	.411523
2.44	5.9536	14.5268	1.56205	4.93964	1.34626	2.90044	6.24880	.409836
2.45	6.0025	14.7061	1.56525	4.94975	1.34810	2.90439	6.25732	.408163
2.46	6.0516	14.8869	1.56844	4.95984	1.34993	2.90834	6.26583	.406504
2.47	6.1009	15.0692	1.57162	4.96991	1.35176	2.91227	6.27431	.404858
2.48	6.1504	15.2530	1.57480	4.97996	1.35358	2.91620	6.28276	.403226
2.49	6.2001	15.4382	1.57797	4.98999	1.35540	2.92011	6.29119	.401606
2.50	6.2500	15.6250	1.58114	5.00000	1.35721	2.92402	6.29961	.400000

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
2.51	6.3001	15.8133	1.58430	5.00999	1.35902	2.92791	6.30799	.393406
2.52	6.3504	16.0030	1.58745	5.01996	1.36082	2.93179	6.31636	.396825
2.53	6.4009	16.1943	1.59060	5.02991	1.36262	2.93567	6.32470	.399257
2.54	6.4516	16.3871	1.59374	5.03984	1.36441	2.93953	6.33303	.393701
2.55	6.5025	16.5814	1.59687	5.04975	1.36620	2.94338	6.34133	.392157
2.56	6.5536	16.7772	1.60000	5.05964	1.36798	2.94723	6.34960	.390625
2.57	6.6049	16.9746	1.60312	5.06952	1.36976	2.95106	6.35786	.389105
2.58	6.6564	17.1735	1.60624	5.07937	1.37153	2.95488	6.36610	.387597
2.59	6.7081	17.3740	1.60935	5.08920	1.37330	2.95869	6.37431	.386100
2.60	6.7600	17.5760	1.61245	5.09902	1.37507	2.96250	6.38250	.384615
2.61	6.8121	17.7796	1.61555	5.10882	1.37683	2.96629	6.39068	.383142
2.62	6.8644	17.9847	1.61864	5.11859	1.37859	2.97007	6.39883	.381679
2.63	6.9169	18.1914	1.62173	5.12835	1.38034	2.97385	6.40696	.380223
2.64	6.9696	18.3997	1.62481	5.13809	1.38208	2.97761	6.41507	.378783
2.65	7.0225	18.6096	1.62788	5.14782	1.38383	2.98137	6.42316	.377359
2.66	7.0756	18.8211	1.63095	5.15752	1.38557	2.98511	6.43123	.375940
2.67	7.1289	19.0342	1.63401	5.16720	1.38730	2.98885	6.43928	.374532
2.68	7.1824	19.2488	1.63707	5.17687	1.38903	2.99257	6.44731	.373134
2.69	7.2361	19.4651	1.64012	5.18652	1.39076	2.99629	6.45531	.371747
2.70	7.2900	19.6830	1.64317	5.19615	1.39248	3.00000	6.46330	.370370
2.71	7.3441	19.9025	1.64621	5.20577	1.39419	3.00370	6.47127	.369004
2.72	7.3984	20.1236	1.64924	5.21536	1.39591	3.00739	6.47922	.367647
2.73	7.4529	20.3464	1.65227	5.22494	1.39761	3.01107	6.48715	.366300
2.74	7.5076	20.5708	1.65529	5.23450	1.39932	3.01474	6.49507	.364964
2.75	7.5625	20.7969	1.65831	5.24404	1.40102	3.01841	6.50296	.363636
2.76	7.6176	21.0246	1.66132	5.25357	1.40272	3.02206	6.51083	.362319
2.77	7.6729	21.2539	1.66433	5.26308	1.40441	3.02571	6.51868	.361011
2.78	7.7284	21.4850	1.66733	5.27257	1.40610	3.02934	6.52652	.359712
2.79	7.7841	21.7176	1.67033	5.28205	1.40778	3.03297	6.53434	.358423
2.80	7.8400	21.9520	1.67332	5.29150	1.40946	3.03659	6.54213	.357142
2.81	7.8961	22.1880	1.67631	5.30094	1.41114	3.04020	6.54991	.355872
2.82	7.9524	22.4258	1.67929	5.31037	1.41281	3.04380	6.55767	.354610
2.83	8.0089	22.6652	1.68226	5.31977	1.41448	3.04740	6.56541	.353357
2.84	8.0656	22.9063	1.68523	5.32917	1.41614	3.05098	6.57314	.352113
2.85	8.1225	23.1491	1.68819	5.33854	1.41780	3.05456	6.58084	.350877
2.86	8.1796	23.3937	1.69115	5.34790	1.41946	3.05813	6.58853	.349650
2.87	8.2369	23.6399	1.69411	5.35724	1.42111	3.06169	6.59620	.348432
2.88	8.2944	23.8879	1.69706	5.36656	1.42276	3.06524	6.60385	.347222
2.89	8.3521	24.1376	1.70000	5.37587	1.42440	3.06878	6.61149	.346021
2.90	8.4100	24.3890	1.70294	5.38516	1.42604	3.07232	6.61911	.344823
2.91	8.4681	24.6422	1.70587	5.39444	1.42768	3.07585	6.62671	.343643
2.92	8.5264	24.8971	1.70880	5.40370	1.42931	3.07936	6.63429	.342466
2.93	8.5849	25.1538	1.71172	5.41295	1.43094	3.08287	6.64185	.341297
2.94	8.6436	25.4122	1.71464	5.42218	1.43257	3.08638	6.64940	.340136
2.95	8.7025	25.6724	1.71756	5.43139	1.43419	3.08987	6.65693	.338983
2.96	8.7616	25.9343	1.72047	5.44059	1.43581	3.09336	6.66444	.337838
2.97	8.8209	26.1981	1.72337	5.44977	1.43743	3.09684	6.67194	.336700
2.98	8.8804	26.4636	1.72627	5.45894	1.43904	3.10031	6.67942	.335571
2.99	8.9401	26.7309	1.72916	5.46809	1.44065	3.10378	6.68688	.334448
3.00	9.0000	27.0000	1.73205	5.47723	1.44225	3.10723	6.69433	.333333

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
3.01	9.0601	27.2709	1.73494	5.48635	1.44385	3.11068	6.70176	.332226
3.02	9.1204	27.5436	1.73781	5.49545	1.44545	3.11412	6.70917	.331126
3.03	9.1809	27.8181	1.74069	5.50454	1.44704	3.11755	6.71657	.330033
3.04	9.2416	28.0945	1.74356	5.51362	1.44863	3.12098	6.72395	.328947
3.05	9.3025	28.3726	1.74642	5.52268	1.45022	3.12440	6.73132	.327869
3.06	9.3636	28.6526	1.74929	5.53173	1.45180	3.12781	6.73866	.326797
3.07	9.4249	28.9344	1.75214	5.54076	1.45338	3.13121	6.74600	.325733
3.08	9.4864	29.2181	1.75499	5.54977	1.45496	3.13461	6.75331	.324675
3.09	9.5481	29.5036	1.75784	5.55878	1.45653	3.13800	6.76061	.323625
3.10	9.6100	29.7910	1.76068	5.56776	1.45810	3.14138	6.76790	.322581
3.11	9.6721	30.0802	1.76352	5.57674	1.45967	3.14475	6.77517	.321543
3.12	9.7344	30.3713	1.76635	5.58570	1.46123	3.14812	6.78242	.320513
3.13	9.7969	30.6643	1.76918	5.59464	1.46279	3.15148	6.78966	.319489
3.14	9.8596	30.9591	1.77200	5.60357	1.46434	3.15484	6.79688	.318471
3.15	9.9225	31.2559	1.77482	5.61249	1.46590	3.15818	6.80409	.317460
3.16	9.9856	31.5545	1.77764	5.62139	1.46745	3.16152	6.81128	.316456
3.17	10.0489	31.8550	1.78045	5.63028	1.46899	3.16485	6.81846	.315457
3.18	10.1124	32.1574	1.78326	5.63915	1.47054	3.16817	6.82562	.314465
3.19	10.1761	32.4618	1.78606	5.64801	1.47208	3.17149	6.83277	.313480
3.20	10.2400	32.7680	1.78885	5.65685	1.47361	3.17480	6.83990	.312500
3.21	10.3041	33.0762	1.79165	5.66569	1.47515	3.17811	6.84702	.311527
3.22	10.3684	33.3862	1.79444	5.67450	1.47668	3.18140	6.85412	.310559
3.23	10.4329	33.6983	1.79722	5.68331	1.47820	3.18469	6.86121	.309598
3.24	10.4976	34.0122	1.80000	5.69210	1.47973	3.18798	6.86829	.308642
3.25	10.5625	34.3281	1.80278	5.70088	1.48125	3.19125	6.87534	.307692
3.26	10.6276	34.6460	1.80555	5.70964	1.48277	3.19452	6.88239	.306749
3.27	10.6929	34.9658	1.80831	5.71839	1.48428	3.19779	6.88942	.305810
3.28	10.7584	35.2876	1.81108	5.72713	1.48579	3.20104	6.89643	.304878
3.29	10.8241	35.6129	1.81384	5.73585	1.48730	3.20429	6.90344	.303951
3.30	10.8900	35.9370	1.81659	5.74456	1.48881	3.20753	6.91042	.303030
3.31	10.9561	36.2647	1.81934	5.75326	1.49031	3.21077	6.91740	.302115
3.32	11.0224	36.5944	1.82209	5.76194	1.49181	3.21400	6.92436	.301205
3.33	11.0889	36.9260	1.82483	5.77062	1.49330	3.21723	6.93130	.300300
3.34	11.1556	37.2597	1.82757	5.77927	1.49480	3.22044	6.93823	.299401
3.35	11.2225	37.5954	1.83030	5.78792	1.49629	3.22365	6.94515	.298508
3.36	11.2896	37.9331	1.83303	5.79655	1.49777	3.22686	6.95205	.297619
3.37	11.3569	38.2728	1.83576	5.80517	1.49926	3.23005	6.95894	.296736
3.38	11.4244	38.6145	1.83848	5.81378	1.50074	3.23325	6.96582	.295858
3.39	11.4921	38.9582	1.84120	5.82237	1.50222	3.23643	6.97268	.294985
3.40	11.5600	39.3040	1.84391	5.83095	1.50369	3.23961	6.97953	.294118
3.41	11.6281	39.6518	1.84662	5.83952	1.50517	3.24278	6.98637	.293255
3.42	11.6964	40.0017	1.84932	5.84808	1.50664	3.24595	6.99319	.292398
3.43	11.7649	40.3536	1.85203	5.85662	1.50810	3.24911	7.00000	.291545
3.44	11.8336	40.7076	1.85472	5.86515	1.50957	3.25227	7.00680	.290698
3.45	11.9025	41.0636	1.85742	5.87367	1.51103	3.25542	7.01358	.289855
3.46	11.9716	41.4217	1.86011	5.88218	1.51249	3.25856	7.02035	.289017
3.47	12.0409	41.7819	1.86279	5.89067	1.51394	3.26169	7.02711	.288184
3.48	12.1104	42.1442	1.86548	5.89915	1.51540	3.26482	7.03385	.287356
3.49	12.1801	42.5085	1.86815	5.90762	1.51685	3.26795	7.04058	.286533
3.50	12.2500	42.8750	1.87083	5.91608	1.51829	3.27107	7.04730	.285714

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
3.51	12.3201	43.2436	1.87350	5.92453	1.51974	3.27418	7.05400	.284900
3.52	12.3904	43.6142	1.87617	5.93296	1.52118	3.27729	7.06070	.284091
3.53	12.4609	43.9870	1.87883	5.94138	1.52262	3.28039	7.06738	.283286
3.54	12.5316	44.3619	1.88149	5.94979	1.52406	3.28348	7.07404	.282486
3.55	12.6025	44.7389	1.88414	5.95819	1.52549	3.28657	7.08070	.281690
3.56	12.6736	45.1180	1.88680	5.96657	1.52692	3.28965	7.08734	.280899
3.57	12.7449	45.4993	1.88944	5.97495	1.52835	3.29273	7.09397	.280112
3.58	12.8164	45.8827	1.89209	5.98331	1.52978	3.29580	7.10059	.279330
3.59	12.8881	46.2683	1.89473	5.99166	1.53120	3.29887	7.10719	.278552
3.60	12.9600	46.6560	1.89737	6.00000	1.53262	3.30193	7.11379	.277778
3.61	13.0321	47.0459	1.90000	6.00833	1.53404	3.30498	7.12037	.277008
3.62	13.1044	47.4379	1.90263	6.01664	1.53545	3.30803	7.12694	.276243
3.63	13.1769	47.8321	1.90526	6.02495	1.53686	3.31107	7.13349	.275482
3.64	13.2496	48.2285	1.90788	6.03324	1.53827	3.31411	7.14004	.274725
3.65	13.3225	48.6271	1.91050	6.04152	1.53968	3.31714	7.14657	.273973
3.66	13.3956	49.0279	1.91311	6.04979	1.54109	3.32017	7.15309	.273224
3.67	13.4689	49.4309	1.91572	6.05805	1.54249	3.32319	7.15960	.272480
3.68	13.5424	49.8360	1.91833	6.06630	1.54389	3.32621	7.16610	.271739
3.69	13.6161	50.2434	1.92094	6.07454	1.54529	3.32922	7.17258	.271003
3.70	13.6900	50.6530	1.92354	6.08276	1.54668	3.33222	7.17905	.270270
3.71	13.7641	51.0648	1.92614	6.09098	1.54807	3.33522	7.18552	.269542
3.72	13.8384	51.4788	1.92873	6.09918	1.54946	3.33822	7.19197	.268817
3.73	13.9129	51.8951	1.93132	6.10737	1.55085	3.34120	7.19841	.268097
3.74	13.9876	52.3136	1.93391	6.11555	1.55223	3.34419	7.20483	.267380
3.75	14.0625	52.7344	1.93649	6.12372	1.55362	3.34716	7.21125	.266667
3.76	14.1376	53.1574	1.93907	6.13188	1.55500	3.35014	7.21765	.265957
3.77	14.2129	53.5826	1.94165	6.14003	1.55637	3.35310	7.22405	.265252
3.78	14.2884	54.0102	1.94422	6.14817	1.55775	3.35607	7.23043	.264550
3.79	14.3641	54.4399	1.94679	6.15630	1.55912	3.35902	7.23680	.263852
3.80	14.4400	54.8720	1.94936	6.16441	1.56049	3.36198	7.24316	.263158
3.81	14.5161	55.3063	1.95192	6.17252	1.56186	3.36492	7.24950	.262467
3.82	14.5924	55.7430	1.95448	6.18061	1.56322	3.36786	7.25584	.261780
3.83	14.6689	56.1819	1.95704	6.18870	1.56459	3.37080	7.26217	.261097
3.84	14.7456	56.6231	1.95959	6.19677	1.56595	3.37373	7.26848	.260417
3.85	14.8225	57.0666	1.96214	6.20484	1.56731	3.37666	7.27479	.259740
3.86	14.8996	57.5125	1.96469	6.21289	1.56866	3.37958	7.28108	.259067
3.87	14.9769	57.9606	1.96723	6.22093	1.57001	3.38249	7.28736	.258398
3.88	15.0544	58.4111	1.96977	6.22896	1.57137	3.38540	7.29363	.257732
3.89	15.1321	58.8639	1.97231	6.23699	1.57271	3.38831	7.29989	.257069
3.90	15.2100	59.3190	1.97484	6.24500	1.57406	3.39121	7.30614	.256410
3.91	15.2881	59.7765	1.97737	6.25300	1.57541	3.39411	7.31238	.255755
3.92	15.3664	60.2363	1.97990	6.26099	1.57675	3.39700	7.31861	.255102
3.93	15.4449	60.6985	1.98242	6.26897	1.57809	3.39988	7.32483	.254453
3.94	15.5236	61.1630	1.98494	6.27694	1.57942	3.40277	7.33104	.253807
3.95	15.6025	61.6299	1.98746	6.28490	1.58076	3.40564	7.33723	.253165
3.96	15.6816	62.0991	1.98997	6.29285	1.58209	3.40851	7.34342	.252525
3.97	15.7609	62.5708	1.99249	6.30079	1.58342	3.41138	7.34960	.251889
3.98	15.8404	63.0448	1.99499	6.30872	1.58475	3.41424	7.35576	.251256
3.99	15.9201	63.5212	1.99750	6.31664	1.58608	3.41710	7.36192	.250627
4.00	16.0000	64.0000	2.00000	6.32456	1.58740	3.41995	7.36806	.250000

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
4.01	16.0801	64.4812	2.00250	6.33246	1.58872	3.42280	7.37420	.249377
4.02	16.1604	64.9648	2.00499	6.34035	1.59004	3.42564	7.38032	.248756
4.03	16.2409	65.4508	2.00749	6.34823	1.59136	3.42848	7.38644	.248139
4.04	16.3216	65.9393	2.00998	6.35610	1.59267	3.43131	7.39254	.247525
4.05	16.4025	66.4301	2.01246	6.36396	1.59399	3.43414	7.39864	.246914
4.06	16.4836	66.9234	2.01494	6.37181	1.59530	3.43697	7.40472	.246305
4.07	16.5649	67.4191	2.01742	6.37966	1.59661	3.43979	7.41080	.245700
4.08	16.6464	67.9173	2.01990	6.38749	1.59791	3.44260	7.41686	.245098
4.09	16.7281	68.4179	2.02237	6.39531	1.59922	3.44541	7.42291	.244499
4.10	16.8100	68.9210	2.02485	6.40312	1.60052	3.44822	7.42896	.243902
4.11	16.8921	69.4265	2.02731	6.41093	1.60182	3.45102	7.43499	.243309
4.12	16.9744	69.9345	2.02978	6.41872	1.60312	3.45382	7.44102	.242718
4.13	17.0569	70.4450	2.03224	6.42651	1.60441	3.45661	7.44703	.242131
4.14	17.1396	70.9579	2.03470	6.43428	1.60571	3.45939	7.45304	.241546
4.15	17.2225	71.4734	2.03715	6.44205	1.60700	3.46218	7.45904	.240964
4.16	17.3056	71.9913	2.03961	6.44981	1.60829	3.46496	7.46502	.240385
4.17	17.3889	72.5117	2.04206	6.45755	1.60958	3.46773	7.47100	.239808
4.18	17.4724	73.0346	2.04450	6.46529	1.61086	3.47050	7.47697	.239234
4.19	17.5561	73.5601	2.04695	6.47302	1.61215	3.47327	7.48292	.238664
4.20	17.6400	74.0880	2.04939	6.48074	1.61343	3.47603	7.48887	.238095
4.21	17.7241	74.6185	2.05183	6.48845	1.61471	3.47878	7.49481	.237530
4.22	17.8084	75.1514	2.05426	6.49615	1.61599	3.48154	7.50074	.236967
4.23	17.8929	75.6870	2.05670	6.50385	1.61726	3.48428	7.50666	.236407
4.24	17.9776	76.2250	2.05913	6.51153	1.61853	3.48703	7.51257	.235849
4.25	18.0625	76.7656	2.06155	6.51920	1.61981	3.48977	7.51847	.235294
4.26	18.1476	77.3088	2.06398	6.52687	1.62108	3.49250	7.52437	.234742
4.27	18.2329	77.8545	2.06640	6.53452	1.62234	3.49523	7.53025	.234192
4.28	18.3184	78.4028	2.06882	6.54217	1.62361	3.49796	7.53612	.233645
4.29	18.4041	78.9536	2.07123	6.54981	1.62487	3.50068	7.54199	.233100
4.30	18.4900	79.5070	2.07364	6.55744	1.62613	3.50340	7.54784	.232558
4.31	18.5761	80.0630	2.07605	6.56506	1.62739	3.50611	7.55369	.232019
4.32	18.6624	80.6216	2.07846	6.57267	1.62865	3.50882	7.55953	.231482
4.33	18.7489	81.1827	2.08087	6.58027	1.62991	3.51153	7.56535	.230947
4.34	18.8356	81.7465	2.08327	6.58787	1.63116	3.51423	7.57117	.230415
4.35	18.9225	82.3129	2.08567	6.59545	1.63241	3.51692	7.57698	.229885
4.36	19.0096	82.8819	2.08806	6.60303	1.63366	3.51962	7.58279	.229358
4.37	19.0969	83.4535	2.09045	6.61060	1.63491	3.52231	7.58858	.228833
4.38	19.1844	84.0277	2.09284	6.61816	1.63616	3.52499	7.59436	.228311
4.39	19.2721	84.6045	2.09523	6.62571	1.63740	3.52767	7.60014	.227790
4.40	19.3600	85.1840	2.09762	6.63325	1.63864	3.53035	7.60590	.227273
4.41	19.4481	85.7661	2.10000	6.64078	1.63988	3.53302	7.61166	.226757
4.42	19.5364	86.3509	2.10238	6.64831	1.64112	3.53569	7.61741	.226244
4.43	19.6249	86.9383	2.10476	6.65582	1.64236	3.53835	7.62315	.225734
4.44	19.7136	87.5284	2.10713	6.66333	1.64359	3.54101	7.62888	.225225
4.45	19.8025	88.1211	2.10950	6.67083	1.64483	3.54367	7.63461	.224719
4.46	19.8916	88.7165	2.11187	6.67832	1.64606	3.54632	7.64032	.224215
4.47	19.9809	89.3146	2.11424	6.68581	1.64729	3.54897	7.64603	.223714
4.48	20.0704	89.9154	2.11660	6.69328	1.64851	3.55162	7.65172	.223214
4.49	20.1601	90.5188	2.11896	6.70075	1.64974	3.55426	7.65741	.222717
4.50	20.2500	91.1250	2.12132	6.70820	1.65096	3.55689	7.66309	.222222



$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
4.51	20.3401	91.7339	2.12368	6.71565	1.65219	3.55953	7.66877	.221730
4.52	20.4304	92.3454	2.12603	6.72309	1.65341	3.56215	7.67443	.221239
4.53	20.5209	92.9597	2.12838	6.73053	1.65462	3.56478	7.68009	.220751
4.54	20.6116	93.5767	2.13073	6.73795	1.65584	3.56740	7.68573	.220264
4.55	20.7025	94.1964	2.13307	6.74537	1.65706	3.57002	7.69137	.219780
4.56	20.7936	94.8188	2.13542	6.75278	1.65827	3.57263	7.69700	.219298
4.57	20.8849	95.4440	2.13776	6.76018	1.65948	3.57524	7.70262	.218818
4.58	20.9764	96.0719	2.14009	6.76757	1.66069	3.57785	7.70824	.218341
4.59	21.0681	96.7026	2.14243	6.77495	1.66190	3.58045	7.71384	.217865
4.60	21.1600	97.3360	2.14476	6.78233	1.66310	3.58305	7.71944	.217391
4.61	21.2521	97.9722	2.14709	6.78970	1.66431	3.58564	7.72503	.216920
4.62	21.3444	98.6111	2.14942	6.79706	1.66551	3.58823	7.73061	.216450
4.63	21.4369	99.2528	2.15174	6.80441	1.66671	3.59082	7.73619	.215983
4.64	21.5296	99.8973	2.15407	6.81175	1.66791	3.59340	7.74175	.215517
4.65	21.6225	100.545	2.15639	6.81909	1.66911	3.59598	7.74731	.215054
4.66	21.7156	101.195	2.15870	6.82642	1.67030	3.59856	7.75286	.214592
4.67	21.8089	101.848	2.16102	6.83374	1.67150	3.60113	7.75840	.214133
4.68	21.9024	102.503	2.16333	6.84105	1.67269	3.60370	7.76394	.213675
4.69	21.9961	103.162	2.16564	6.84836	1.67388	3.60626	7.76946	.213220
4.70	22.0900	103.823	2.16795	6.85565	1.67507	3.60883	7.77498	.212766
4.71	22.1841	104.487	2.17025	6.86294	1.67626	3.61138	7.78049	.212314
4.72	22.2784	105.154	2.17256	6.87023	1.67744	3.61394	7.78599	.211864
4.73	22.3729	105.824	2.17486	6.87750	1.67863	3.61649	7.79149	.211417
4.74	22.4676	106.496	2.17715	6.88477	1.67981	3.61904	7.79697	.210971
4.75	22.5625	107.172	2.17945	6.89202	1.68099	3.62158	7.80245	.210526
4.76	22.6576	107.850	2.18174	6.89928	1.68217	3.62412	7.80793	.210084
4.77	22.7529	108.531	2.18403	6.90652	1.68334	3.62665	7.81339	.209644
4.78	22.8484	109.215	2.18632	6.91375	1.68452	3.62919	7.81885	.209205
4.79	22.9441	109.902	2.18861	6.92098	1.68569	3.63171	7.82429	.208768
4.80	23.0400	110.592	2.19089	6.92820	1.68687	3.63424	7.82974	.208333
4.81	23.1361	111.285	2.19317	6.93542	1.68804	3.63676	7.83517	.207900
4.82	23.2324	111.980	2.19545	6.94262	1.68920	3.63928	7.84059	.207469
4.83	23.3289	112.679	2.19773	6.94982	1.69037	3.64180	7.84601	.207039
4.84	23.4256	113.380	2.20000	6.95701	1.69154	3.64431	7.85142	.206612
4.85	23.5225	114.084	2.20227	6.96419	1.69270	3.64682	7.85683	.206186
4.86	23.6196	114.791	2.20454	6.97137	1.69386	3.64932	7.86222	.205761
4.87	23.7169	115.501	2.20681	6.97854	1.69503	3.65182	7.86761	.205339
4.88	23.8144	116.214	2.20907	6.98570	1.69619	3.65432	7.87299	.204918
4.89	23.9121	116.930	2.21133	6.99285	1.69734	3.65682	7.87837	.204499
4.90	24.0100	117.649	2.21359	7.00000	1.69850	3.65931	7.88374	.204082
4.91	24.1081	118.371	2.21585	7.00714	1.69965	3.66179	7.88909	.203666
4.92	24.2064	119.095	2.21811	7.01427	1.70081	3.66428	7.89445	.203252
4.93	24.3049	119.823	2.22036	7.02140	1.70196	3.66676	7.89979	.202840
4.94	24.4036	120.554	2.22261	7.02851	1.70311	3.66924	7.90513	.202429
4.95	24.5025	121.287	2.22486	7.03562	1.70426	3.67171	7.91046	.202020
4.96	24.6016	122.024	2.22711	7.04273	1.70540	3.67418	7.91578	.201613
4.97	24.7009	122.763	2.22935	7.04982	1.70655	3.67665	7.92110	.201207
4.98	24.8004	123.506	2.23159	7.05691	1.70769	3.67911	7.92641	.200803
4.99	24.9001	124.251	2.23383	7.06399	1.70884	3.68157	7.93171	.200401
5.00	25.0000	125.000	2.23607	7.07107	1.70998	3.68403	7.93701	.200000

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
5.01	25.1001	125.752	2.23830	7.07814	1.71112	3.68649	7.94229	.199601
5.02	25.2004	126.506	2.24054	7.08520	1.71225	3.68894	7.94757	.199203
5.03	25.3009	127.264	2.24277	7.09225	1.71339	3.69138	7.95285	.198807
5.04	25.4016	128.024	2.24499	7.09930	1.71452	3.69383	7.95811	.198413
5.05	25.5025	128.788	2.24722	7.10634	1.71566	3.69627	7.96337	.198020
5.06	25.6036	129.554	2.24944	7.11337	1.71679	3.69871	7.96868	.197629
5.07	25.7049	130.324	2.25167	7.12039	1.71792	3.70114	7.97387	.197239
5.08	25.8064	131.097	2.25389	7.12741	1.71905	3.70358	7.97911	.196850
5.09	25.9081	131.872	2.25610	7.13442	1.72017	3.70600	7.98434	.196464
5.10	26.0100	132.651	2.25832	7.14143	1.72130	3.70843	7.98957	.196078
5.11	26.1121	133.433	2.26053	7.14843	1.72242	3.71085	7.99479	.195695
5.12	26.2144	134.218	2.26274	7.15542	1.72355	3.71327	8.00000	.195313
5.13	26.3169	135.006	2.26495	7.16240	1.72467	3.71566	8.00520	.194932
5.14	26.4196	135.797	2.26716	7.16938	1.72579	3.71811	8.01040	.194553
5.15	26.5225	136.591	2.26936	7.17635	1.72691	3.72051	8.01559	.194175
5.16	26.6256	137.388	2.27156	7.18331	1.72802	3.72292	8.02078	.193793
5.17	26.7289	138.188	2.27376	7.19027	1.72914	3.72532	8.02596	.193424
5.18	26.8324	138.992	2.27596	7.19722	1.73025	3.72772	8.03113	.193050
5.19	26.9361	139.798	2.27816	7.20417	1.73137	3.73012	8.03629	.192678
5.20	27.0400	140.608	2.28035	7.21110	1.73248	3.73251	8.04145	.192308
5.21	27.1441	141.421	2.28254	7.21803	1.73359	3.73490	8.04660	.191939
5.22	27.2484	142.237	2.28473	7.22496	1.73470	3.73729	8.05175	.191571
5.23	27.3529	143.056	2.28692	7.23187	1.73580	3.73968	8.05689	.191205
5.24	27.4576	143.878	2.28910	7.23878	1.73691	3.74206	8.06202	.190840
5.25	27.5625	144.703	2.29129	7.24569	1.73801	3.74443	8.06714	.190476
5.26	27.6676	145.532	2.29347	7.25259	1.73912	3.74681	8.07226	.190114
5.27	27.7729	146.363	2.29565	7.25948	1.74022	3.74918	8.07737	.189753
5.28	27.8784	147.198	2.29783	7.26636	1.74132	3.75158	8.08248	.189394
5.29	27.9841	148.036	2.30000	7.27324	1.74242	3.75399	8.08758	.189036
5.30	28.0900	148.877	2.30217	7.28011	1.74351	3.75629	8.09267	.188679
5.31	28.1961	149.721	2.30434	7.28697	1.74461	3.75865	8.09776	.188324
5.32	28.3024	150.569	2.30651	7.29383	1.74570	3.76100	8.10284	.187970
5.33	28.4089	151.419	2.30868	7.30068	1.74680	3.76336	8.10791	.187617
5.34	28.5156	152.273	2.31084	7.30753	1.74789	3.76571	8.11298	.187266
5.35	28.6225	153.130	2.31301	7.31437	1.74898	3.76806	8.11804	.186916
5.36	28.7296	153.991	2.31517	7.32120	1.75007	3.77041	8.12310	.186567
5.37	28.8369	154.854	2.31733	7.32803	1.75116	3.77275	8.12814	.186220
5.38	28.9444	155.721	2.31948	7.33485	1.75224	3.77509	8.13319	.185874
5.39	29.0521	156.591	2.32164	7.34166	1.75333	3.77744	8.13822	.185529
5.40	29.1600	157.464	2.32379	7.34847	1.75441	3.77976	8.14325	.185185
5.41	29.2681	158.340	2.32594	7.35527	1.75549	3.78210	8.14828	.184843
5.42	29.3764	159.220	2.32809	7.36206	1.75657	3.78442	8.15329	.184502
5.43	29.4849	160.103	2.33024	7.36885	1.75765	3.78675	8.15831	.184162
5.44	29.5936	160.989	2.33238	7.37564	1.75873	3.78907	8.16331	.183824
5.45	29.7025	161.879	2.33452	7.38241	1.75981	3.79139	8.16831	.183486
5.46	29.8116	162.771	2.33666	7.38918	1.76088	3.79371	8.17330	.183150
5.47	29.9209	163.667	2.33880	7.39594	1.76196	3.79603	8.17829	.182815
5.48	30.0304	164.567	2.34094	7.40270	1.76303	3.79834	8.18327	.182482
5.49	30.1401	165.469	2.34307	7.40945	1.76410	3.80065	8.18824	.182149
5.50	30.2500	166.375	2.34521	7.41620	1.76517	3.80295	8.19321	.181818

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
5.51	30.3601	167.284	2.34734	7.42294	1.76624	3.80526	8.19818	.181488
5.52	30.4704	168.197	2.34947	7.42967	1.76731	3.80756	8.20313	.181159
5.53	30.5809	169.112	2.35160	7.43640	1.76838	3.80986	8.20808	.180832
5.54	30.6916	170.031	2.35372	7.44312	1.76944	3.80115	8.21303	.180505
5.55	30.8025	170.954	2.35584	7.44983	1.77051	3.81444	8.21797	.180180
5.56	30.9136	171.880	2.35797	7.45654	1.77157	3.81673	8.22290	.179856
5.57	31.0249	172.809	2.36008	7.46324	1.77263	3.81902	8.22783	.179533
5.58	31.1364	173.741	2.36220	7.46994	1.77369	3.82130	8.23275	.179212
5.59	31.2481	174.677	2.36432	7.47663	1.77475	3.82358	8.23766	.178891
5.60	31.3600	175.616	2.36643	7.48331	1.77581	3.82586	8.24257	.178571
5.61	31.4721	176.558	2.36854	7.48999	1.77686	3.82814	8.24747	.178253
5.62	31.5844	177.504	2.37065	7.49667	1.77792	3.83041	8.25237	.177936
5.63	31.6969	178.454	2.37276	7.50333	1.77897	3.83268	8.25726	.177620
5.64	31.8096	179.406	2.37487	7.50999	1.78003	3.83495	8.26215	.177305
5.65	31.9225	180.362	2.37697	7.51665	1.78108	3.83721	8.26703	.176991
5.66	32.0356	181.321	2.37908	7.52330	1.78213	3.83948	8.27190	.176678
5.67	32.1489	182.284	2.38118	7.52994	1.78318	3.84174	8.27677	.176367
5.68	32.2624	183.250	2.38328	7.53658	1.78422	3.84400	8.28164	.176056
5.69	32.3761	184.220	2.38537	7.54321	1.78527	3.84625	8.28649	.175747
5.70	32.4900	185.193	2.38747	7.54983	1.78632	3.84850	8.29134	.175439
5.71	32.6041	186.169	2.38956	7.55645	1.78736	3.85075	8.29619	.175131
5.72	32.7184	187.149	2.39165	7.56307	1.78840	3.85300	8.30103	.174825
5.73	32.8329	188.133	2.39374	7.56968	1.78944	3.85524	8.30587	.174520
5.74	32.9476	189.119	2.39583	7.57628	1.79048	3.85748	8.31069	.174216
5.75	33.0625	190.109	2.39792	7.58288	1.79152	3.85972	8.31552	.173913
5.76	33.1776	191.103	2.40000	7.58947	1.79256	3.86196	8.32034	.173611
5.77	33.2929	192.100	2.40208	7.59605	1.79360	3.86419	8.32515	.173310
5.78	33.4084	193.101	2.40416	7.60263	1.79463	3.86642	8.32995	.173010
5.79	33.5241	194.105	2.40624	7.60920	1.79567	3.86865	8.33476	.172712
5.80	33.6400	195.112	2.40832	7.61577	1.79670	3.87088	8.33955	.172414
5.81	33.7561	196.123	2.41039	7.62234	1.79773	3.87310	8.34434	.172117
5.82	33.8724	197.137	2.41247	7.62889	1.79876	3.87532	8.34913	.171821
5.83	33.9889	198.155	2.41454	7.63544	1.79979	3.87754	8.35390	.171527
5.84	34.1056	199.177	2.41661	7.64199	1.80082	3.87975	8.35868	.171233
5.85	34.2225	200.202	2.41868	7.64853	1.80185	3.88197	8.36345	.170940
5.86	34.3396	201.230	2.42074	7.65506	1.80288	3.88418	8.36821	.170649
5.87	34.4569	202.262	2.42281	7.66159	1.80390	3.88639	8.37297	.170358
5.88	34.5744	203.297	2.42487	7.66812	1.80492	3.88859	8.37772	.170068
5.89	34.6921	204.336	2.42693	7.67463	1.80595	3.89082	8.38247	.169779
5.90	34.8100	205.379	2.42899	7.68115	1.80697	3.89300	8.38721	.169492
5.91	34.9281	206.425	2.43105	7.68765	1.80799	3.89520	8.39194	.169205
5.92	35.0464	207.475	2.43311	7.69415	1.80901	3.89739	8.39667	.168919
5.93	35.1649	208.528	2.43516	7.70065	1.81003	3.89958	8.40140	.168634
5.94	35.2836	209.585	2.43721	7.70714	1.81104	3.90177	8.40612	.168350
5.95	35.4025	210.645	2.43926	7.71362	1.81206	3.90396	8.41083	.168067
5.96	35.5216	211.709	2.44131	7.72010	1.81307	3.90615	8.41554	.167785
5.97	35.6409	212.776	2.44336	7.72658	1.81409	3.90833	8.42025	.167504
5.98	35.7604	213.847	2.44540	7.73305	1.81510	3.91051	8.42494	.167224
5.99	35.8801	214.922	2.44745	7.73951	1.81611	3.91269	8.42964	.166945
6.00	36.0000	216.000	2.44949	7.74597	1.81712	3.91487	8.43433	.166667

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
6.01	36.1201	217.082	2.45153	7.75242	1.81813	3.91704	8.43901	.166369
6.02	36.2404	218.167	2.45357	7.75887	1.81914	3.91921	8.44369	.166113
6.03	36.3609	219.256	2.45561	7.76531	1.82014	3.92138	8.44836	.165838
6.04	36.4816	220.349	2.45764	7.77174	1.82115	3.92355	8.45303	.165563
6.05	36.6025	221.445	2.45967	7.77817	1.82215	3.92571	8.45769	.165289
6.06	36.7236	222.545	2.46171	7.78460	1.82316	3.92787	8.46235	.165017
6.07	36.8449	223.649	2.46374	7.79102	1.82416	3.93003	8.46700	.164745
6.08	36.9664	224.756	2.46577	7.79744	1.82516	3.93219	8.47165	.164474
6.09	37.0881	225.867	2.46779	7.80385	1.82616	3.93434	8.47629	.164204
6.10	37.2100	226.981	2.46982	7.81025	1.82716	3.93650	8.48093	.163934
6.11	37.3321	228.099	2.47184	7.81665	1.82816	3.93865	8.48556	.163666
6.12	37.4544	229.221	2.47386	7.82304	1.82915	3.94079	8.49018	.163399
6.13	37.5769	230.346	2.47588	7.82943	1.83015	3.94294	8.49481	.163132
6.14	37.6996	231.476	2.47790	7.83582	1.83115	3.94508	8.49942	.162866
6.15	37.8225	232.608	2.47992	7.84219	1.83214	3.94722	8.50404	.162602
6.16	37.9456	233.745	2.48193	7.84857	1.83313	3.94936	8.50864	.162338
6.17	38.0689	234.885	2.48395	7.85493	1.83412	3.95150	8.51324	.162076
6.18	38.1924	236.029	2.48596	7.86130	1.83511	3.95363	8.51784	.161812
6.19	38.3161	237.177	2.48797	7.86766	1.83610	3.95576	8.52243	.161551
6.20	38.4400	238.328	2.48998	7.87401	1.83709	3.95789	8.52702	.161290
6.21	38.5641	239.483	2.49199	7.88036	1.83808	3.96002	8.53160	.161031
6.22	38.6884	240.642	2.49399	7.88670	1.83906	3.96214	8.53618	.160772
6.23	38.8129	241.804	2.49600	7.89303	1.84005	3.96426	8.54075	.160514
6.24	38.9376	242.971	2.49800	7.89937	1.84103	3.96639	8.54532	.160256
6.25	39.0625	244.141	2.50000	7.90569	1.84202	3.96850	8.54988	.160000
6.26	39.1876	245.314	2.50200	7.91202	1.84300	3.97062	8.55444	.159744
6.27	39.3129	246.492	2.50400	7.91833	1.84398	3.97273	8.55899	.159490
6.28	39.4384	247.673	2.50599	7.92465	1.84496	3.97484	8.56354	.159236
6.29	39.5641	248.858	2.50799	7.93095	1.84594	3.97695	8.56808	.158983
6.30	39.6900	250.047	2.50998	7.93725	1.84691	3.97906	8.57262	.158730
6.31	39.8161	251.240	2.51197	7.94355	1.84789	3.98116	8.57715	.158479
6.32	39.9424	252.436	2.51396	7.94984	1.84887	3.98326	8.58168	.158228
6.33	40.0689	253.636	2.51595	7.95613	1.84984	3.98536	8.58620	.157978
6.34	40.1956	254.840	2.51794	7.96241	1.85082	3.98746	8.59072	.157729
6.35	40.3225	256.048	2.51992	7.96869	1.85179	3.98956	8.59524	.157480
6.36	40.4496	257.259	2.52190	7.97496	1.85276	3.99165	8.59975	.157233
6.37	40.5769	258.475	2.52389	7.98123	1.85373	3.99374	8.60425	.156986
6.38	40.7044	259.694	2.52587	7.98749	1.85470	3.99583	8.60875	.156740
6.39	40.8321	260.917	2.52784	7.99375	1.85567	3.99792	8.61325	.156495
6.40	40.9600	262.144	2.52982	8.00000	1.85664	4.00000	8.61774	.156250
6.41	41.0881	263.375	2.53180	8.00625	1.85760	4.00208	8.62222	.156006
6.42	41.2164	264.609	2.53377	8.01249	1.85857	4.00416	8.62671	.155763
6.43	41.3449	265.848	2.53574	8.01873	1.85953	4.00624	8.63118	.155521
6.44	41.4736	267.090	2.53772	8.02496	1.86050	4.00832	8.63566	.155280
6.45	41.6025	268.336	2.53969	8.03119	1.86146	4.01039	8.64012	.155039
6.46	41.7316	269.586	2.54165	8.03741	1.86242	4.01246	8.64459	.154799
6.47	41.8609	270.840	2.54362	8.04363	1.86338	4.01453	8.64904	.154560
6.48	41.9904	272.098	2.54558	8.04984	1.86434	4.01660	8.65350	.154321
6.49	42.1201	273.359	2.54755	8.05605	1.86530	4.01866	8.65795	.154083
6.50	42.2500	274.625	2.54951	8.06226	1.86626	4.02073	8.66239	.153846

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
6.51	42.3801	275.894	2.55147	8.06846	1.86721	4.02279	8.66683	.153610
6.52	42.5104	277.168	2.55343	8.07465	1.86817	4.02485	8.67127	.153374
6.53	42.6409	278.445	2.55539	8.08084	1.86912	4.02690	8.67570	.153139
6.54	42.7716	279.726	2.55734	8.08703	1.87008	4.02896	8.68012	.152905
6.55	42.9025	281.011	2.55930	8.09321	1.87103	4.03101	8.68455	.152672
6.56	43.0336	282.300	2.56125	8.09938	1.87198	4.03306	8.68896	.152439
6.57	43.1649	283.593	2.56320	8.10555	1.87293	4.03511	8.69338	.152207
6.58	43.2964	284.890	2.56515	8.11172	1.87388	4.03715	8.69778	.151976
6.59	43.4281	286.191	2.56710	8.11788	1.87483	4.03920	8.70219	.151745
6.60	43.5600	287.496	2.56905	8.12404	1.87578	4.04124	8.70659	.151515
6.61	43.6921	288.805	2.57099	8.13019	1.87672	4.04328	8.71098	.151286
6.62	43.8244	290.118	2.57294	8.13634	1.87767	4.04532	8.71537	.151057
6.63	43.9569	291.434	2.57488	8.14248	1.87862	4.04735	8.71976	.150830
6.64	44.0896	292.755	2.57682	8.14862	1.87956	4.04939	8.72414	.150602
6.65	44.2225	294.080	2.57876	8.15475	1.88050	4.05142	8.72852	.150376
6.66	44.3556	295.408	2.58070	8.16088	1.88144	4.05345	8.73289	.150150
6.67	44.4889	296.741	2.58263	8.16701	1.88239	4.05548	8.73726	.149925
6.68	44.6224	298.078	2.58457	8.17313	1.88333	4.05750	8.74162	.149701
6.69	44.7561	299.418	2.58650	8.17924	1.88427	4.05953	8.74598	.149477
6.70	44.8900	300.763	2.58844	8.18535	1.88520	4.06155	8.75034	.149254
6.71	45.0241	302.112	2.59037	8.19146	1.88614	4.06357	8.75469	.149031
6.72	45.1584	303.464	2.59230	8.19756	1.88708	4.06558	8.75904	.148810
6.73	45.2929	304.821	2.59422	8.20366	1.88801	4.06760	8.76338	.148588
6.74	45.4276	306.182	2.59615	8.20975	1.88895	4.06961	8.76772	.148363
6.75	45.5625	307.547	2.59808	8.21584	1.88988	4.07163	8.77205	.148143
6.76	45.6976	308.916	2.60000	8.22192	1.89081	4.07364	8.77638	.147929
6.77	45.8329	310.289	2.60192	8.22800	1.89175	4.07564	8.78071	.147711
6.78	45.9684	311.666	2.60384	8.23408	1.89268	4.07765	8.78503	.147493
6.79	46.1041	313.047	2.60576	8.24015	1.89361	4.07965	8.78935	.147275
6.80	46.2400	314.432	2.60768	8.24621	1.89454	4.08166	8.79366	.147059
6.81	46.3761	315.821	2.60960	8.25227	1.89546	4.08365	8.79797	.146843
6.82	46.5124	317.215	2.61151	8.25833	1.89639	4.08565	8.80227	.146623
6.83	46.6489	318.612	2.61343	8.26438	1.89732	4.08765	8.80657	.146413
6.84	46.7856	320.014	2.61534	8.27043	1.89824	4.08964	8.81087	.146199
6.85	46.9225	321.419	2.61725	8.27647	1.89917	4.09164	8.81516	.145985
6.86	47.0596	322.829	2.61916	8.28251	1.90009	4.09362	8.81945	.145773
6.87	47.1969	324.243	2.62107	8.28855	1.90102	4.09561	8.82373	.145560
6.88	47.3344	325.661	2.62298	8.29458	1.90194	4.09760	8.82801	.145349
6.89	47.4721	327.083	2.62488	8.30060	1.90286	4.09958	8.83229	.145138
6.90	47.6100	328.509	2.62679	8.30662	1.90378	4.10157	8.83656	.144923
6.91	47.7481	329.939	2.62869	8.31264	1.90470	4.10355	8.84082	.144718
6.92	47.8864	331.374	2.63059	8.31865	1.90562	4.10552	8.84509	.144509
6.93	48.0249	332.813	2.63249	8.32466	1.90653	4.10750	8.84934	.144300
6.94	48.1636	334.255	2.63439	8.33067	1.90745	4.10948	8.85360	.144092
6.95	48.3025	335.702	2.63629	8.33667	1.90837	4.11145	8.85785	.143885
6.96	48.4416	337.154	2.63818	8.34266	1.90928	4.11342	8.86210	.143678
6.97	48.5809	338.609	2.64008	8.34865	1.91019	4.11539	8.86634	.143472
6.98	48.7204	340.068	2.64197	8.35464	1.91111	4.11736	8.87058	.143267
6.99	48.8601	341.532	2.64386	8.36062	1.91202	4.11932	8.87481	.143062
7.00	49.0000	343.000	2.64575	8.36660	1.91293	4.12129	8.87904	.142857

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
7.01	49.1401	344.472	2.64764	8.37257	1.91384	4.12325	8.88327	.142653
7.02	49.2804	345.948	2.64959	8.37854	1.91475	4.12521	8.88749	.142450
7.03	49.4209	347.429	2.65141	8.38451	1.91566	4.12716	8.89171	.142248
7.04	49.5616	348.914	2.65330	8.39047	1.91657	4.12912	8.89592	.142046
7.05	49.7025	350.403	2.65518	8.39643	1.91747	4.13107	8.90013	.141844
7.06	49.8436	351.896	2.65707	8.40238	1.91838	4.13303	8.90434	.141643
7.07	49.9849	353.393	2.65895	8.40833	1.91929	4.13498	8.90854	.141443
7.08	50.1264	354.895	2.66083	8.41427	1.92019	4.13695	8.91274	.141243
7.09	50.2681	356.401	2.66271	8.42021	1.92109	4.13897	8.91693	.141044
7.10	50.4100	357.911	2.66458	8.42615	1.92200	4.14082	8.92112	.140845
7.11	50.5521	359.425	2.66646	8.43208	1.92290	4.14276	8.92531	.140647
7.12	50.6944	360.944	2.66833	8.43801	1.92380	4.14470	8.92949	.140449
7.13	50.8369	362.467	2.67021	8.44393	1.92470	4.14664	8.93367	.140253
7.14	50.9796	363.994	2.67208	8.44985	1.92560	4.14858	8.93784	.140056
7.15	51.1225	365.526	2.67395	8.45577	1.92650	4.15051	8.94201	.139860
7.16	51.2656	367.062	2.67582	8.46168	1.92740	4.15245	8.94618	.139665
7.17	51.4089	368.602	2.67769	8.46759	1.92829	4.15438	8.95034	.139470
7.18	51.5524	370.146	2.67955	8.47349	1.92919	4.15631	8.95450	.139276
7.19	51.6961	371.695	2.68142	8.47939	1.93008	4.15824	8.95866	.139082
7.20	51.8400	373.248	2.68328	8.48528	1.93098	4.16017	8.96281	.138889
7.21	51.9841	374.805	2.68514	8.49117	1.93187	4.16209	8.96696	.138696
7.22	52.1284	376.367	2.68701	8.49706	1.93277	4.16402	8.97110	.138504
7.23	52.2729	377.933	2.68887	8.50294	1.93366	4.16594	8.97524	.138313
7.24	52.4176	379.503	2.69072	8.50882	1.93455	4.16786	8.97938	.138122
7.25	52.5625	381.078	2.69258	8.51469	1.93544	4.16978	8.98351	.137931
7.26	52.7076	382.657	2.69444	8.52056	1.93633	4.17169	8.98764	.137741
7.27	52.8529	384.241	2.69629	8.52643	1.93722	4.17361	8.99176	.137552
7.28	52.9984	385.828	2.69815	8.53229	1.93810	4.17552	8.99588	.137363
7.29	53.1441	387.420	2.70000	8.53815	1.93899	4.17743	9.00000	.137174
7.30	53.2900	389.017	2.70185	8.54400	1.93988	4.17934	9.00411	.136986
7.31	53.4361	390.618	2.70370	8.54985	1.94076	4.18125	9.00822	.136799
7.32	53.5824	392.223	2.70555	8.55570	1.94165	4.18315	9.01233	.136612
7.33	53.7289	393.833	2.70740	8.56154	1.94253	4.18506	9.01643	.136426
7.34	53.8756	395.447	2.70924	8.56738	1.94341	4.18696	9.02053	.136240
7.35	54.0225	397.065	2.71109	8.57321	1.94430	4.18886	9.02462	.136054
7.36	54.1696	398.688	2.71293	8.57904	1.94518	4.19076	9.02871	.135867
7.37	54.3169	400.316	2.71477	8.58487	1.94606	4.19266	9.03280	.135685
7.38	54.4644	401.947	2.71662	8.59069	1.94694	4.19455	9.03689	.135501
7.39	54.6121	403.583	2.71846	8.59651	1.94782	4.19644	9.04097	.135318
7.40	54.7600	405.224	2.72029	8.60233	1.94870	4.19834	9.04504	.135135
7.41	54.9081	406.869	2.72213	8.60814	1.94957	4.20023	9.04911	.134953
7.42	55.0564	408.518	2.72397	8.61394	1.95045	4.20212	9.05318	.134771
7.43	55.2049	410.172	2.72580	8.61974	1.95132	4.20400	9.05725	.134590
7.44	55.3536	411.831	2.72764	8.62554	1.95220	4.20589	9.06131	.134409
7.45	55.5025	413.494	2.72947	8.63134	1.95307	4.20777	9.06537	.134228
7.46	55.6516	415.161	2.73130	8.63713	1.95395	4.20965	9.06942	.134048
7.47	55.8009	416.833	2.73313	8.64292	1.95482	4.21153	9.07347	.133869
7.48	55.9504	418.509	2.73496	8.64870	1.95569	4.21341	9.07752	.133690
7.49	56.1001	420.190	2.73679	8.65448	1.95656	4.21529	9.08156	.133511
7.50	56.2500	421.875	2.73861	8.66025	1.95743	4.21716	9.08560	.133333

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
7.51	56.4001	423.505	2.74044	8.66603	1.95830	4.21904	9.08964	.133156
7.52	56.5504	425.259	2.74226	8.67179	1.95917	4.22091	9.09367	.132979
7.53	56.7009	426.958	2.74408	8.67756	1.96004	4.22278	9.09770	.132802
7.54	56.8516	428.661	2.74591	8.68332	1.96091	4.22465	9.10173	.132626
7.55	57.0025	430.369	2.74773	8.68907	1.96177	4.22651	9.10575	.132450
7.56	57.1536	432.081	2.74955	8.69483	1.96264	4.22838	9.10977	.132275
7.57	57.3049	433.798	2.75136	8.70057	1.96350	4.23024	9.11378	.132100
7.58	57.4564	435.520	2.75318	8.70632	1.96437	4.23210	9.11779	.131926
7.59	57.6081	437.246	2.75500	8.71206	1.96523	4.23396	9.12180	.131752
7.60	57.7600	438.976	2.75681	8.71780	1.96610	4.23582	9.12581	.131579
7.61	57.9121	440.711	2.75862	8.72353	1.96696	4.23768	9.12981	.131406
7.62	58.0644	442.451	2.76043	8.72926	1.96782	4.23954	9.13380	.131234
7.63	58.2169	444.195	2.76225	8.73499	1.96868	4.24139	9.13780	.131062
7.64	58.3696	445.944	2.76405	8.74071	1.96954	4.24324	9.14179	.130890
7.65	58.5225	447.697	2.76586	8.74643	1.97040	4.24509	9.14577	.130719
7.66	58.6756	449.455	2.76767	8.75214	1.97126	4.24694	9.14976	.130548
7.67	58.8289	451.218	2.76948	8.75785	1.97211	4.24879	9.15374	.130378
7.68	58.9824	452.985	2.77128	8.76356	1.97297	4.25063	9.15771	.130208
7.69	59.1361	454.757	2.77308	8.76926	1.97383	4.25248	9.16169	.130039
7.70	59.2900	456.533	2.77489	8.77496	1.97468	4.25432	9.16566	.129870
7.71	59.4441	458.314	2.77669	8.78066	1.97554	4.25616	9.16962	.129702
7.72	59.5984	460.100	2.77849	8.78635	1.97639	4.25800	9.17359	.129534
7.73	59.7529	461.890	2.78029	8.79204	1.97724	4.25984	9.17754	.129366
7.74	59.9076	463.685	2.78209	8.79773	1.97809	4.26168	9.18150	.129199
7.75	60.0625	465.484	2.78388	8.80341	1.97895	4.26351	9.18545	.129032
7.76	60.2176	467.289	2.78568	8.80909	1.97980	4.26534	9.18940	.128866
7.77	60.3729	469.097	2.78747	8.81476	1.98065	4.26717	9.19335	.128700
7.78	60.5284	470.911	2.78927	8.82043	1.98150	4.26900	9.19729	.128535
7.79	60.6841	472.729	2.79106	8.82610	1.98234	4.27083	9.20123	.128370
7.80	60.8400	474.552	2.79285	8.83176	1.98319	4.27266	9.20516	.128205
7.81	60.9961	476.380	2.79464	8.83742	1.98404	4.27448	9.20910	.128041
7.82	61.1524	478.212	2.79643	8.84308	1.98489	4.27631	9.21303	.127877
7.83	61.3089	480.049	2.79821	8.84873	1.98573	4.27813	9.21695	.127714
7.84	61.4656	481.890	2.80000	8.85438	1.98658	4.27995	9.22087	.127551
7.85	61.6225	483.737	2.80179	8.86002	1.98742	4.28177	9.22479	.127389
7.86	61.7796	485.588	2.80357	8.86566	1.98826	4.28359	9.22871	.127227
7.87	61.9369	487.443	2.80535	8.87130	1.98911	4.28540	9.23262	.127065
7.88	62.0944	489.304	2.80713	8.87694	1.98995	4.28722	9.23653	.126904
7.89	62.2521	491.169	2.80891	8.88257	1.99079	4.28903	9.24043	.126743
7.90	62.4100	493.039	2.81069	8.88819	1.99163	4.29084	9.24433	.126582
7.91	62.5681	494.914	2.81247	8.89382	1.99247	4.29265	9.24823	.126422
7.92	62.7264	496.793	2.81425	8.89944	1.99331	4.29446	9.25213	.126263
7.93	62.8849	498.677	2.81603	8.90505	1.99415	4.29627	9.25602	.126103
7.94	63.0436	500.566	2.81780	8.91067	1.99499	4.29807	9.25991	.125944
7.95	63.2025	502.460	2.81957	8.91628	1.99582	4.29987	9.26380	.125786
7.96	63.3616	504.358	2.82135	8.92188	1.99666	4.30168	9.26768	.125628
7.97	63.5209	506.262	2.82312	8.92749	1.99750	4.30348	9.27156	.125471
7.98	63.6804	508.170	2.82489	8.93308	1.99833	4.30528	9.27544	.125313
7.99	63.8401	510.082	2.82666	8.93868	1.99917	4.30707	9.27931	.125156
8.00	64.0000	512.000	2.82843	8.94427	2.00000	4.30887	9.28318	.125000

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
8.01	64.1601	513.922	2.83019	8.94986	2.00083	4.31066	9.28704	.124844
8.02	64.3204	515.850	2.83196	8.95545	2.00167	4.31246	9.29091	.124683
8.03	64.4809	517.782	2.83373	8.96103	2.00250	4.31425	9.29477	.124533
8.04	64.6416	519.718	2.83549	8.96660	2.00333	4.31604	9.29862	.124378
8.05	64.8025	521.660	2.83725	8.97218	2.00416	4.31783	9.30248	.124224
8.06	64.9636	523.607	2.83901	8.97775	2.00499	4.31961	9.30633	.124070
8.07	65.1249	525.558	2.84077	8.98332	2.00582	4.32140	9.31018	.123916
8.08	65.2864	527.514	2.84253	8.98888	2.00664	4.32318	9.31402	.123762
8.09	65.4481	529.475	2.84429	8.99444	2.00747	4.32497	9.31786	.123609
8.10	65.6100	531.441	2.84605	9.00000	2.00830	4.32675	9.32170	.123457
8.11	65.7721	533.412	2.84781	9.00555	2.00912	4.32853	9.32553	.123305
8.12	65.9344	535.387	2.84956	9.01110	2.00995	4.33031	9.32936	.123153
8.13	66.0969	537.368	2.85132	9.01665	2.01078	4.33208	9.33319	.123001
8.14	66.2596	539.353	2.85307	9.02219	2.01160	4.33386	9.33702	.122850
8.15	66.4225	541.343	2.85482	9.02774	2.01242	4.33563	9.34084	.122699
8.16	66.5856	543.338	2.85657	9.03327	2.01325	4.33741	9.34466	.122549
8.17	66.7489	545.339	2.85832	9.03881	2.01407	4.33918	9.34847	.122399
8.18	66.9124	547.343	2.86007	9.04434	2.01489	4.34095	9.35229	.122249
8.19	67.0761	549.353	2.86182	9.04986	2.01571	4.34272	9.35610	.122100
8.20	67.2400	551.368	2.86356	9.05539	2.01653	4.34448	9.35990	.121951
8.21	67.4041	553.388	2.86531	9.06091	2.01735	4.34625	9.36370	.121803
8.22	67.5684	555.412	2.86705	9.06642	2.01817	4.34801	9.36751	.121655
8.23	67.7329	557.442	2.86880	9.07193	2.01899	4.34977	9.37130	.121507
8.24	67.8976	559.476	2.87054	9.07744	2.01980	4.35153	9.37510	.121359
8.25	68.0625	561.516	2.87228	9.08295	2.02062	4.35329	9.37889	.121212
8.26	68.2276	563.560	2.87402	9.08845	2.02144	4.35505	9.38268	.121065
8.27	68.3929	565.609	2.87576	9.09395	2.02225	4.35681	9.38646	.120919
8.28	68.5584	567.664	2.87750	9.09945	2.02307	4.35856	9.39024	.120773
8.29	68.7241	569.723	2.87924	9.10494	2.02388	4.36032	9.39402	.120627
8.30	68.8900	571.787	2.88097	9.11043	2.02469	4.36207	9.39780	.120482
8.31	69.0561	573.856	2.88271	9.11592	2.02551	4.36382	9.40157	.120337
8.32	69.2224	575.930	2.88444	9.12140	2.02632	4.36557	9.40534	.120192
8.33	69.3889	578.010	2.88617	9.12688	2.02713	4.36732	9.40911	.120048
8.34	69.5556	580.094	2.88791	9.13236	2.02794	4.36907	9.41287	.119904
8.35	69.7225	582.183	2.88964	9.13783	2.02875	4.37081	9.41663	.119761
8.36	69.8896	584.277	2.89137	9.14330	2.02956	4.37255	9.42039	.119617
8.37	70.0569	586.376	2.89310	9.14877	2.03037	4.37430	9.42414	.119474
8.38	70.2244	588.480	2.89482	9.15423	2.03118	4.37604	9.42789	.119332
8.39	70.3921	590.590	2.89655	9.15969	2.03199	4.37778	9.43164	.119190
8.40	70.5600	592.704	2.89828	9.16515	2.03279	4.37952	9.43539	.119048
8.41	70.7281	594.823	2.90000	9.17061	2.03360	4.38126	9.43913	.118906
8.42	70.8964	596.948	2.90172	9.17606	2.03440	4.38299	9.44287	.118765
8.43	71.0649	599.077	2.90345	9.18150	2.03521	4.38473	9.44661	.118624
8.44	71.2336	601.212	2.90517	9.18695	2.03601	4.38646	9.45034	.118483
8.45	71.4025	603.351	2.90689	9.19239	2.03682	4.38819	9.45407	.118343
8.46	71.5716	605.496	2.90861	9.19783	2.03762	4.38992	9.45780	.118203
8.47	71.7409	607.645	2.91033	9.20326	2.03842	4.39165	9.46152	.118064
8.48	71.9104	609.800	2.91204	9.20869	2.03923	4.39338	9.46525	.117925
8.49	72.0801	611.960	2.91376	9.21412	2.04003	4.39511	9.46897	.117786
8.50	72.2500	614.125	2.91548	9.21954	2.04083	4.39683	9.47268	.117647



$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
8.51	72.4201	616.295	2.91719	9.22497	2.04163	4.39855	9.47640	.117509
8.52	72.5904	618.470	2.91890	9.23038	2.04243	4.40028	9.48011	.117371
8.53	72.7609	620.650	2.92062	9.23580	2.04323	4.40200	9.48381	.117233
8.54	72.9316	622.836	2.92233	9.24121	2.04402	4.40372	9.48752	.117095
8.55	73.1025	625.026	2.92404	9.24662	2.04482	4.40543	9.49122	.116959
8.56	73.2736	627.222	2.92575	9.25203	2.04562	4.40715	9.49492	.116822
8.57	73.4449	629.423	2.92746	9.25743	2.04641	4.40887	9.49861	.116686
8.58	73.6164	631.629	2.92916	9.26283	2.04721	4.41058	9.50231	.116550
8.59	73.7881	633.840	2.93087	9.26823	2.04801	4.41229	9.50600	.116414
8.60	73.9600	636.056	2.93258	9.27362	2.04880	4.41400	9.50969	.116279
8.61	74.1321	638.277	2.93428	9.27901	2.04959	4.41571	9.51337	.116144
8.62	74.3044	640.504	2.93598	9.28440	2.05039	4.41742	9.51705	.116009
8.63	74.4769	642.736	2.93769	9.28978	2.05118	4.41913	9.52073	.115875
8.64	74.6496	644.973	2.93939	9.29516	2.05197	4.42084	9.52441	.115741
8.65	74.8225	647.215	2.94109	9.30054	2.05276	4.42254	9.52808	.115607
8.66	74.9956	649.462	2.94279	9.30591	2.05355	4.42425	9.53175	.115473
8.67	75.1689	651.714	2.94449	9.31128	2.05434	4.42595	9.53542	.115340
8.68	75.3424	653.972	2.94618	9.31665	2.05513	4.42765	9.53908	.115207
8.69	75.5161	656.235	2.94788	9.32202	2.05592	4.42935	9.54274	.115075
8.70	75.6900	658.503	2.94958	9.32738	2.05671	4.43105	9.54640	.114943
8.71	75.8641	660.776	2.95127	9.33274	2.05750	4.43274	9.55006	.114811
8.72	76.0384	663.055	2.95296	9.33809	2.05828	4.43444	9.55371	.114679
8.73	76.2129	665.339	2.95466	9.34345	2.05907	4.43614	9.55736	.114548
8.74	76.3876	667.628	2.95635	9.34880	2.05986	4.43783	9.56101	.114417
8.75	76.5625	669.922	2.95804	9.35414	2.06064	4.43952	9.56466	.114286
8.76	76.7376	672.221	2.95973	9.35949	2.06143	4.44121	9.56830	.114155
8.77	76.9129	674.526	2.96142	9.36483	2.06221	4.44290	9.57194	.114025
8.78	77.0884	676.836	2.96311	9.37017	2.06299	4.44459	9.57557	.113895
8.79	77.2641	679.151	2.96479	9.37550	2.06378	4.44627	9.57921	.113766
8.80	77.4400	681.472	2.96648	9.38083	2.06456	4.44796	9.58284	.113636
8.81	77.6161	683.798	2.96816	9.38616	2.06534	4.44964	9.58647	.113507
8.82	77.7924	686.129	2.96985	9.39149	2.06612	4.45133	9.59009	.113379
8.83	77.9689	688.465	2.97153	9.39681	2.06690	4.45301	9.59372	.113250
8.84	78.1456	690.807	2.97321	9.40213	2.06768	4.45469	9.59734	.113122
8.85	78.3225	693.154	2.97489	9.40744	2.06846	4.45637	9.60095	.112994
8.86	78.4996	695.506	2.97658	9.41276	2.06924	4.45805	9.60457	.112867
8.87	78.6769	697.864	2.97825	9.41807	2.07002	4.45972	9.60818	.112740
8.88	78.8544	700.227	2.97993	9.42338	2.07080	4.46140	9.61179	.112613
8.89	79.0321	702.595	2.98161	9.42868	2.07157	4.46307	9.61540	.112486
8.90	79.2100	704.969	2.98329	9.43398	2.07235	4.46474	9.61900	.112360
8.91	79.3881	707.348	2.98496	9.43928	2.07313	4.46642	9.62260	.112233
8.92	79.5664	709.732	2.98664	9.44458	2.07390	4.46809	9.62620	.112108
8.93	79.7449	712.122	2.98831	9.44987	2.07468	4.46976	9.62980	.111982
8.94	79.9236	714.517	2.98998	9.45516	2.07545	4.47142	9.63339	.111857
8.95	80.1025	716.917	2.99166	9.46044	2.07622	4.47309	9.63698	.111732
8.96	80.2816	719.323	2.99333	9.46573	2.07700	4.47476	9.64057	.111607
8.97	80.4609	721.734	2.99500	9.47101	2.07777	4.47642	9.64415	.111483
8.98	80.6404	724.151	2.99666	9.47629	2.07854	4.47808	9.64774	.111359
8.99	80.8201	726.573	2.99833	9.48156	2.07931	4.47974	9.65132	.111235
9.00	81.0000	729.000	3.00000	9.48683	2.08008	4.48140	9.65489	.111111

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10n}$	$\sqrt[3]{n}$	$\sqrt[3]{10n}$	$\sqrt[3]{100n}$	$\frac{1}{n}$
9.01	81.1801	731.433	3.00167	9.49210	2.08085	4.48306	9.65847	.110933
9.02	81.3604	733.871	3.00333	9.49737	2.08162	4.48472	9.66204	.110865
9.03	81.5409	736.314	3.00500	9.50263	2.08239	4.48638	9.66561	.110742
9.04	81.7216	738.763	3.00666	9.50789	2.08316	4.48803	9.66918	.110620
9.05	81.9025	741.218	3.00832	9.51315	2.08393	4.48968	9.67274	.110497
9.06	82.0836	743.677	3.00998	9.51840	2.08470	4.49134	9.67630	.110375
9.07	82.2649	746.143	3.01164	9.52365	2.08546	4.49299	9.67986	.110254
9.08	82.4464	748.613	3.01330	9.52890	2.08623	4.49464	9.68342	.110132
9.09	82.6281	751.089	3.01496	9.53415	2.08699	4.49629	9.68697	.110011
9.10	82.8100	753.571	3.01662	9.53939	2.08776	4.49794	9.69052	.109890
9.11	82.9921	756.058	3.01828	9.54463	2.08852	4.49959	9.69407	.109770
9.12	83.1744	758.551	3.01993	9.54987	2.08929	4.50123	9.69762	.109649
9.13	83.3569	761.048	3.02159	9.55510	2.09005	4.50288	9.70116	.109529
9.14	83.5396	763.552	3.02324	9.56033	2.09081	4.50452	9.70470	.109409
9.15	83.7225	766.061	3.02490	9.56556	2.09158	4.50616	9.70824	.109290
9.16	83.9056	768.575	3.02655	9.57079	2.09234	4.50780	9.71177	.109170
9.17	84.0889	771.095	3.02820	9.57601	2.09310	4.50945	9.71531	.109051
9.18	84.2724	773.621	3.02985	9.58123	2.09386	4.51108	9.71884	.108933
9.19	84.4561	776.152	3.03150	9.58645	2.09462	4.51272	9.72236	.108814
9.20	84.6400	778.688	3.03315	9.59166	2.09538	4.51436	9.72589	.108695
9.21	84.8241	781.230	3.03480	9.59687	2.09614	4.51599	9.72941	.108578
9.22	85.0084	783.777	3.03645	9.60208	2.09690	4.51763	9.73293	.108460
9.23	85.1929	786.330	3.03809	9.60729	2.09765	4.51926	9.73645	.108342
9.24	85.3776	788.889	3.03974	9.61249	2.09841	4.52089	9.73996	.108225
9.25	85.5625	791.453	3.04138	9.61769	2.09917	4.52252	9.74348	.108103
9.26	85.7476	794.023	3.04302	9.62289	2.09992	4.52415	9.74699	.107991
9.27	85.9329	796.598	3.04467	9.62808	2.10068	4.52578	9.75049	.107875
9.28	86.1184	799.179	3.04631	9.63328	2.10144	4.52740	9.75400	.107759
9.29	86.3041	801.765	3.04795	9.63846	2.10219	4.52903	9.75750	.107643
9.30	86.4900	804.357	3.04959	9.64365	2.10294	4.53065	9.76100	.107527
9.31	86.6761	806.954	3.05123	9.64883	2.10370	4.53228	9.76450	.107411
9.32	86.8624	809.558	3.05287	9.65401	2.10445	4.53390	9.76799	.107296
9.33	87.0489	812.166	3.05450	9.65919	2.10520	4.53552	9.77148	.107181
9.34	87.2356	814.781	3.05614	9.66437	2.10595	4.53714	9.77497	.107066
9.35	87.4225	817.400	3.05778	9.66954	2.10671	4.53876	9.77846	.106952
9.36	87.6096	820.026	3.05941	9.67471	2.10746	4.54038	9.78195	.106833
9.37	87.7969	822.657	3.06105	9.67988	2.10821	4.54199	9.78543	.106724
9.38	87.9844	825.294	3.06268	9.68504	2.10896	4.54361	9.78891	.106610
9.39	88.1721	827.936	3.06431	9.69020	2.10971	4.54522	9.79239	.106496
9.40	88.3600	830.584	3.06594	9.69536	2.11045	4.54684	9.79586	.106383
9.41	88.5481	833.238	3.06757	9.70052	2.11120	4.54845	9.79933	.106270
9.42	88.7364	835.897	3.06920	9.70567	2.11195	4.55006	9.80280	.106157
9.43	88.9249	838.562	3.07083	9.71082	2.11270	4.55167	9.80627	.106045
9.44	89.1136	841.232	3.07246	9.71597	2.11344	4.55328	9.80974	.105932
9.45	89.3025	843.909	3.07409	9.72111	2.11419	4.55488	9.81320	.105820
9.46	89.4916	846.591	3.07571	9.72625	2.11494	4.55649	9.81666	.105703
9.47	89.6809	849.278	3.07734	9.73139	2.11568	4.55809	9.82012	.105597
9.48	89.8704	851.971	3.07896	9.73653	2.11642	4.55970	9.82357	.105485
9.49	90.0601	854.670	3.08058	9.74166	2.11717	4.56130	9.82703	.105374
9.50	90.2500	857.375	3.08221	9.74679	2.11791	4.56290	9.83048	.105263

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt{10 n}$	$\sqrt[3]{n}$	$\sqrt[3]{10 n}$	$\sqrt[3]{100 n}$	$\frac{1}{n}$
9.51	90.4401	860.085	3.08383	9.75192	2.11865	4.56450	9.83392	.105153
9.52	90.6304	862.801	3.08545	9.75705	2.11940	4.56610	9.83737	.105042
9.53	90.8209	865.523	3.08707	9.76217	2.12014	4.56770	9.84081	.104932
9.54	91.0116	868.251	3.08869	9.76729	2.12088	4.56930	9.84425	.104822
9.55	91.2025	870.984	3.09031	9.77241	2.12162	4.57089	9.84769	.104712
9.56	91.3936	873.723	3.09192	9.77753	2.12236	4.57249	9.85113	.104603
9.57	91.5849	876.467	3.09354	9.78264	2.12310	4.57408	9.85456	.104493
9.58	91.7764	879.218	3.09516	9.78775	2.12384	4.57568	9.85799	.104384
9.59	91.9681	881.974	3.09677	9.79285	2.12458	4.57727	9.86142	.104275
9.60	92.1600	884.736	3.09839	9.79796	2.12532	4.57886	9.86485	.104167
9.61	92.3521	887.504	3.10000	9.80306	2.12605	4.58045	9.86827	.104058
9.62	92.5444	890.277	3.10161	9.80816	2.12679	4.58203	9.87169	.103950
9.63	92.7369	893.056	3.10322	9.81326	2.12753	4.58362	9.87511	.103842
9.64	92.9296	895.841	3.10483	9.81835	2.12826	4.58521	9.87853	.103734
9.65	93.1225	898.632	3.10644	9.82344	2.12900	4.58679	9.88195	.103627
9.66	93.3156	901.429	3.10805	9.82853	2.12974	4.58838	9.88536	.103520
9.67	93.5089	904.231	3.10966	9.83362	2.13047	4.58996	9.88877	.103413
9.68	93.7024	907.039	3.11127	9.83870	2.13120	4.59154	9.89217	.103306
9.69	93.8961	909.853	3.11288	9.84378	2.13194	4.59312	9.89558	.103199
9.70	94.0900	912.673	3.11448	9.84886	2.13267	4.59470	9.89898	.103093
9.71	94.2841	915.499	3.11609	9.85393	2.13340	4.59628	9.90238	.102987
9.72	94.4784	918.330	3.11769	9.85901	2.13414	4.59786	9.90578	.102881
9.73	94.6729	921.167	3.11929	9.86408	2.13487	4.59943	9.90918	.102775
9.74	94.8676	924.010	3.12090	9.86914	2.13560	4.60101	9.91257	.102669
9.75	95.0625	926.859	3.12250	9.87421	2.13633	4.60258	9.91596	.102564
9.76	95.2576	929.714	3.12410	9.87927	2.13706	4.60416	9.91935	.102459
9.77	95.4529	932.575	3.12570	9.88433	2.13779	4.60573	9.92274	.102354
9.78	95.6484	935.441	3.12730	9.88939	2.13852	4.60730	9.92612	.102250
9.79	95.8441	938.314	3.12890	9.89444	2.13925	4.60887	9.92950	.102145
9.80	96.0400	941.192	3.13050	9.89949	2.13997	4.61044	9.93288	.102041
9.81	96.2361	944.076	3.13209	9.90454	2.14070	4.61200	9.93626	.101937
9.82	96.4324	946.966	3.13369	9.90959	2.14143	4.61357	9.93964	.101833
9.83	96.6289	949.862	3.13528	9.91464	2.14216	4.61513	9.94301	.101729
9.84	96.8256	952.764	3.13688	9.91968	2.14288	4.61670	9.94638	.101626
9.85	97.0225	955.672	3.13847	9.92472	2.14361	4.61826	9.94975	.101523
9.86	97.2196	958.585	3.14006	9.92975	2.14433	4.61983	9.95311	.101420
9.87	97.4169	961.505	3.14166	9.93479	2.14506	4.62139	9.95648	.101317
9.88	97.6144	964.430	3.14325	9.93982	2.14578	4.62295	9.95984	.101215
9.89	97.8121	967.362	3.14484	9.94485	2.14651	4.62451	9.96320	.101112
9.90	98.0100	970.299	3.14643	9.94987	2.14723	4.62607	9.96655	.101010
9.91	98.2081	973.242	3.14802	9.95490	2.14795	4.62762	9.96991	.100908
9.92	98.4064	976.191	3.14960	9.95992	2.14867	4.62918	9.97326	.100807
9.93	98.6049	979.147	3.15119	9.96494	2.14940	4.63073	9.97661	.100705
9.94	98.8036	982.108	3.15278	9.96995	2.15012	4.63229	9.97996	.100604
9.95	99.0025	985.075	3.15436	9.97497	2.15084	4.63384	9.98331	.100503
9.96	99.2016	988.048	3.15595	9.97998	2.15156	4.63539	9.98665	.100402
9.97	99.4009	991.027	3.15753	9.98499	2.15228	4.63694	9.98999	.100301
9.98	99.6004	994.012	3.15911	9.98999	2.15300	4.63849	9.99333	.100200
9.99	99.8001	997.003	3.16070	9.99500	2.15372	4.64004	9.99667	.100100
10.00	100.000	1000.00	3.16228	10.0000	2.15443	4.64159	10.0000	.100000

*Square Root.*—EXAMPLE.—(a)  $\sqrt{3.1416} = ?$  (b)  $\sqrt{2342.9} = ?$

SOLUTION.—(a) In this case, the decimal point need not be moved. In the table under  $n^2$  find  $3.1329 = 1.77^2$  and  $3.1684 = 1.78^2$ , one of these numbers being a little less and the other a little greater than the given number 3.1416. The first three figures of the required root are 177.  $31,684 - 31,329 = 355$  is the first difference;  $31,416$  (the number itself)  $- 31,329 = 87$  is the second difference.  $87 \div 355 = .245$ , or .25, which gives the fourth and fifth figures of the root. Hence,  $\sqrt{3.1416} = 1.7725$ .

(b) Pointing off and placing the decimal point between the first and second periods, the number appears 23.4290. Under  $n^2$  find  $23.4256 = 4.84^2$  and  $23.5225 = 4.85^2$ . The first three figures of the root are 484. The first difference is  $235,225 - 234,256 = 969$ ; the second difference is  $234,290 - 234,256 = 34$ ;  $34 \div 969 = .035$ , or .04, which gives the fourth and fifth figures of the root. Since the integral part of the number  $23'42.9$  contains two periods, the integral part of the root contains two figures, or  $\sqrt{2342.9} = 48.404$ .

*Cube Root.*—EXAMPLE.—(a)  $\sqrt[3]{.0000062417} = ?$

(b)  $\sqrt[3]{50932676} = ?$

SOLUTION.—(a) Pointed off, the number appears .000'006'241'700, and with the decimal point placed between the first and second periods of the significant part, gives 6.2417. Under  $n^3$  find  $6.22950 = 1.84^3$  and  $6.33163 = 1.85^3$ . The first three figures of the root are 1.84. The first difference is 10,213, and the second difference is 1,220;  $1,220 \div 10,213 = .119$ , or .12, which gives the fourth and fifth figures. There is one cipher period after the decimal point in the number; hence,  $\sqrt[3]{.0000062417} = .018412$ .

(b) Replace all after the sixth figure with ciphers, making the sixth figure 1 greater when the seventh figure is 5 or greater; that is,  $\sqrt[3]{50932700}$  and  $\sqrt[3]{50932676}$  will be the same. Placing the decimal point between the first and second periods gives 50.9327. Under  $n^3$  find  $50.6530 = 3.70^3$  and  $51.0648 = 3.71^3$ . The first three figures of the root are 370.

The second difference  $2,797 \div$  the first difference,  $4,118 = .679$  or  $.68$ . Hence,  $\sqrt[3]{50932676} = 370.68$ .

**Squares.**—If the given number contains less than four significant figures, the significant figures of the square or cube can be found under  $n^2$  or  $n^3$  opposite the given number under  $n$ . The decimal point can be located by the fact that if the column headed  $\sqrt{10n}$  is used, the square will contain twice as many figures as the number to be squared, while if the column headed  $\sqrt{n}$  is used, the square will contain twice as many figures as the number to be squared, less 1. If the number contains an integral part, the principle is applied to the integral part only; if the number is wholly decimal, the square will have twice as many ciphers, or twice as many plus 1, following the decimal point as in the number itself, depending on whether  $\sqrt{10n}$  or  $\sqrt{n}$  column is used.

To square a number containing more than three significant figures, place the decimal point between the first and second significant figures and find in the column headed  $\sqrt{n}$  or  $\sqrt{10n}$  two consecutive numbers, one a little greater and the other a little less than the given number. The remainder of the work is exactly as described for extracting roots. The square will contain twice as many figures as the number itself, or twice as many less 1, according to whether the column headed  $\sqrt{10n}$  or  $\sqrt{n}$  is used. The number of ciphers following the decimal point in the square of a number wholly decimal is indicated in the same way.

EXAMPLE 1.—(a)  $273.42^2 = ?$  (b)  $.052436^2 = ?$

SOLUTION.—(a) Placing the decimal point between the first and second significant figures, the number is  $2.7342$ , which occurs between  $2.73313 = \sqrt{7.47}$  and  $2.73496 = \sqrt{7.48}$ , found under  $\sqrt{n}$ . The first three figures of the square are  $747$ . The second difference  $107 \div$  the first difference  $183 = .584$ , or  $.58$ . Hence,  $273.42^2 = 74,758$ .

(b) With the position of the decimal point changed, the number is  $5.2436$ , which is between  $5.23450 = \sqrt{2.74}$  and  $5.24404 = \sqrt{2.75}$ , both under  $\sqrt{10n}$ . The first three significant figures of the root are  $2.74$  and the second difference

910  $\div$  the first difference 954 = .953, or .95, the next two figures. The number has one cipher following the decimal point, and the column headed  $\sqrt[3]{10n}$  is used; hence, .052436<sup>2</sup> = .0027495.

**Cubes.**—To cube a number, proceed in the same way, but use a column headed  $\sqrt[3]{n}$ ,  $\sqrt[3]{10n}$ , or  $\sqrt[3]{100n}$ . If the number contains an integral part, the number of figures in the integral part of the cube will be three times as many as in the given number if the column headed  $\sqrt[3]{100n}$  is used; it will be three times as many less 1 if the column headed  $\sqrt[3]{10n}$  is used; and it will be three times as many less 2 if the column headed  $\sqrt[3]{n}$  is used. If the number is wholly decimal, the number of ciphers following the decimal point in the cube will be three times, three times plus 1, or three times plus 2, as many as in the given number, depending on whether  $\sqrt[3]{100n}$ ,  $\sqrt[3]{10n}$ , or  $\sqrt[3]{n}$  column is used.

EXAMPLE 2.—(a)  $129.684^3 = ?$  (b)  $7.6442^3 = ?$  (c)  $.032425^3 = ?$

SOLUTION.—(a) With the position of the decimal point changed, the number 1.29684 is between  $1.29664 = \sqrt[3]{2.18}$  and  $1.29862 = \sqrt[3]{2.19}$ , found under  $\sqrt[3]{n}$ . The second difference 20  $\div$  the first difference 198 = .101+, or .10. Hence, the first five significant figures are 21810; the number of figures in the integral part of the cube is  $3 \times 3 - 2 = 7$ ; and  $129.684^3 = 2,181,000$ , correct to five significant figures.

(b) 7.64420 occurs between  $7.64032 = \sqrt[3]{446}$  and  $7.64603 = \sqrt[3]{447}$ . The first difference is 571; the second difference is 388; and  $388 \div 571 = .679+$ , or .68. Hence, the first five significant figures are 44668; the number of ciphers following the decimal point is  $3 \times 0 = 0$ ; and  $7.6442^3 = 446.68$ , correct to five significant figures.

(c) 3.2425 falls between  $3.24278 = \sqrt[3]{10 \times 3.41}$  and  $3.23961 = \sqrt[3]{10 \times 3.40}$ . The first difference is 317; the second difference is 289;  $289 \div 317 = .911+$ , or .91. Hence, the first five significant figures are 34091; the number of ciphers following the decimal point is  $3 \times 1 + 1 = 4$ ; and  $.032425^3 = .000034091$ , correct to five significant figures.

**Reciprocals.**—The table gives the reciprocals of all numbers expressed by three significant figures correct to six significant figures. The number of ciphers following the decimal point in the reciprocal of a number is 1 less than the number of figures in the integral parts of the number; and if the number is entirely decimal, the number of figures in the integral part of the reciprocal is 1 greater than the number of ciphers following the decimal point in the number. For example, the reciprocal of 3370 = .000296736 and of .00348 = 287.356.

The following examples show the process when the number contains more than three significant figures:

**EXAMPLE.**—The reciprocal (a) of 379.426 = ? (b) of .0004692 = ?

**SOLUTION.**—(a) .379426 falls between  $.378788 = \frac{1}{2.64}$  and  $.380228 = \frac{1}{2.63}$ . The first difference is  $380,228 - 378,788 = 1,440$ ; the second difference is  $380,228 - 379,426 = 802$ ;  $802 \div 1,440 = .557$ , or .56. Hence, the first five significant figures are 26356, and the reciprocal of 379.426 is .0026356, to five significant figures.

(b) .469200 falls between  $.469484 = \frac{1}{2.13}$  and  $.467290 = \frac{1}{2.14}$ . The first difference is 2,194; the second difference is 284;  $284 \div 2,194 = .129$ , or .13. Hence,  $\frac{1}{.0004692} = 2,131.3$ , correct to five significant figures.

---

## MENSURATION

In the following formulas, unless otherwise stated, the letters have the meanings here given:

$A$  = area of a plane figure;

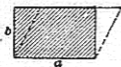
$d$  = diameter;

$r$  = radius;

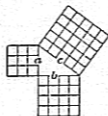
$p$  = perimeter, or circumference;

$\pi$  = ratio of any circumference to its diameter.

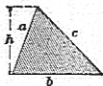
## POLYGONS



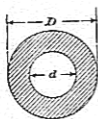
Rectangle and  
parallelogram  
 $A = ab$



Right-angled triangle  
 $c^2 = a^2 + b^2$   
 $A = \frac{1}{2} ab$



Any triangle  
 $A = \frac{1}{2} bh$

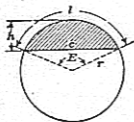
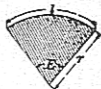


CIRCLES  
The circle:  $p = \pi d = 2\pi r$   
 $A = \pi r^2 = \frac{\pi d^2}{4}$   
The ring:  $A = \frac{\pi}{4}(D^2 - d^2)$

The sector:

$$A = \frac{1}{2}lr = \frac{E}{360}\pi r^2 = .008727r^2E$$

$E = \text{angle}; l = \text{length of arc}$



The segment:

$$A = \frac{1}{2}[lr - c(r-h)] = \frac{E}{360}\pi r^2 - \frac{c}{2}(r-h)$$

$$l = \frac{\pi r E}{180} = .0175rE$$

$$c = \text{chord} = 2\sqrt{2hr - h^2}$$

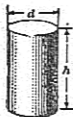
## ELLIPSE

$$p = \pi \sqrt{\frac{D^2 + d^2}{2} - \frac{(D-d)^2}{8.8}}$$

$$A = \frac{\pi}{4}Dd$$



## SOLIDS



The cylinder: Convex surface  $= \pi dh$   
Both end surfaces  $= \frac{\pi d^2}{2}$   
Volume  $= \frac{\pi d^2}{4} h$



The sphere:

$$\text{Surface} = \pi d^2 = 4\pi r^2$$

$$\text{Volume} = \frac{1}{6}\pi d^3 = \frac{4}{3}\pi r^3$$



### USEFUL NUMBERS

$$\frac{1}{\pi} = .3183$$

$$\pi^2 = 9.8696$$

$$\frac{1}{\pi^2} = .1013$$

$$\sqrt{\pi} = 1.7725$$

$$\frac{1}{\sqrt{\pi}} = .5642$$

## MECHANICS

### FALLING BODIES

Let  $g = 32.16$  = constant acceleration due to the attraction of the earth;

$t$  = number of seconds that the body falls;

$v$  = velocity in feet per second at the end of the time  $t$ ;

$h$  = distance, in feet, that the body falls during the time  $t$ .

$$\text{Then, } v = gt = \frac{2h}{t} = \sqrt{2gh} = 8.02\sqrt{h};$$

$$h = \frac{vt}{2} = \frac{gt^2}{2} = \frac{v^2}{2g} = .015547v^2;$$

$$t = \frac{v}{g} = \frac{2h}{v} = \sqrt{\frac{2h}{g}} = .24938\sqrt{h}.$$

If  $h$  is in centimeters and  $v$  in centimeters per second, then  $g = 981$  at Paris.

### CENTRIFUGAL FORCE

$F$  = centrifugal force, in pounds;

$W$  = weight of revolving body, in pounds;

$$m = \text{mass of body} = \frac{W}{g};$$

$r$  = distance from axis of motion to center of gravity of body, in feet;

$N$  = number of revolutions per minute;

$v$  = velocity, in feet per second.

$$F = \frac{Wv^2}{gr} = \frac{Mv^2}{r} = .00034WrN^2.$$

In calculating the centrifugal force of flywheels, it is customary to neglect the arms and take  $r$  equal to the mean radius of the rim; in such cases,  $W$  is taken as one-half the weight of the rim. The result thus obtained, divided by  $\pi$ , is approximately the force tending to burst the flywheel rim.

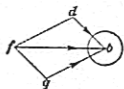
EXAMPLE.—What is the force tending to burst a flywheel rim weighing 7 tons, making 150 rev. per min., and having a mean radius of 5 ft.?

SOLUTION.—

$$F = \frac{.00034 \times (\frac{1}{2} \times 7 \times 2,000) 5 \times 150^2}{3.1416} = 85,227 \text{ lb.}$$

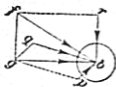
## PARALLELOGRAM OF FORCES

Let  $db$  and  $qb$  represent the magnitudes and directions of two forces that act to move the body  $b$ . By completing the parallelogram, there will be obtained a diagonal force  $fb$ , whose magnitude and direction are equal to the effect produced by  $db$  and  $qb$ .  $fb$  is called the resultant of  $db$  and  $qb$ . If three or more



forces act in different directions to move a body  $b$ , find the resultant of any two of them, and consider it as a single force. Between this and the next force find a second resultant. Thus,  $pb$ ,  $qb$ , and  $rb$  are magnitudes and directions of the forces.

$pb + qb + rb = gb + rb = fb$ , which is the resultant in the magnitude and direction of the three forces  $pb$ ,  $qb$ , and  $rb$ .



## WORK AND POWER

Work is the overcoming of resistance through a distance. The unit of work is the *foot-pound*; that is, it equals 1 lb. raised vertically 1 ft. The amount of work done is equal to

the resistance in pounds multiplied by the distance in feet through which it is overcome. If a body is lifted, the resistance is the weight or the overcoming of the attraction of gravity, the work done being the weight in pounds multiplied by the height of the lift in feet. If a body moves in a horizontal direction, the work done is the friction overcome, or the force needed to move a resistant body or combination of bodies, multiplied by the distance moved through.

Power is the rate of doing work, or the quantity of work done in unit time. The ordinary unit of mechanical power is the horsepower, which is equivalent to 33,000 ft.-lb. per min., or 550 ft.-lb. per sec.

The work necessary to be done in raising a body weighing  $W$  lb. through a height of  $h$  ft. equals  $Wh$  ft.-lb. The total work that any moving body is capable of doing in being brought to rest equals its kinetic energy, or  $\frac{Wv^2}{2g} = \frac{1}{2}mv^2$ .

The kinetic energy of a 200,000-lb. train running at 40 mi. per hr. (58.7 ft. per sec.) is  $200,000 \times 58.7^2 \div (2 \times 32.16) = 10,714,220$  ft.-lb.; the retarding force necessary to stop the train within 2,000 ft. is  $10,714,220 \div 2,000 = 5357.1$  lb., and the average power required to stop the train in  $\frac{1}{2}$  min. is  $10,714,220 \div \frac{1}{2} = 21,428,440$  ft.-lb. per min. or  $21,428,440 \div 33,000 = 649.3$  H. P.

## BELTS, SHAFTING, ETC.

To find the angle of contact of a belt on each pulley:

Let  $D$  = diameter of the larger pulley, in inches;

$d$  = diameter of the smaller pulley, in inches;

$l$  = distance between the pulley centers, in inches;

$\alpha$  =  $\frac{1}{2}$  the arc of contact on the smaller pulley.

Then, 
$$\cos \alpha = \frac{D-d}{2l}.$$

From a table of natural cosines the angle  $\alpha$  can be found and  $2\alpha$  = the arc of contact on the smaller pulley;  $360^\circ - 2\alpha$  = the arc of contact on the larger pulley. In calculating belts, only the arc of contact on the smaller pulley need be considered.

To find the length  $L$  of a belt,

$$L = \frac{D+d}{2} \times 3\frac{1}{2} + 2l, \text{ approximately.}$$

NOTE.—These formulas apply only to ordinary open belts and not to crossed belts.

EXAMPLE.—A 12-in. pulley and a 60-in. pulley with centers 15 ft. apart are connected by an open belt. (a) Find the arc of contact of the belt on each pulley. (b) Find the length of the belt.

SOLUTION.—(a) 15 ft. = 180 in.  $(60 - 12) \div (2 \times 180) = .1333 = \cos 82^\circ 20'$ .

Arc of contact on smaller pulley =  $2 \times 82^\circ 20' = 164^\circ 40'$ .

Arc of contact on larger pulley =  $360 - 164^\circ 40' = 195^\circ 20'$ .

(b)  $\frac{60+12}{2} \times 3\frac{1}{2} + 2 \times 180 = 477$  in. = 39 ft. 9 in.

The following formulas give conservative results:

Let  $C$  = allowable effective pull, in pounds per inch, width of belt (see table);

$H$  = horsepower to be transmitted;

$W$  = width of belt, in inches;

$V$  = belt speed, in feet per minute.

$$\text{Then, } W = \frac{33,000H}{VC}; \quad H = \frac{VCW}{33,000}$$

#### ALLOWABLE BELT PULL

Arc Covered by Belt		Allowable Pull per Inch Width in Pounds	
Degrees	Fraction of Circumference	Single belt	Double belt
90	.250	23	32.9
112½	.312	27.4	39.2
120	.333	28.8	41.2
135	.375	31.3	44.7
150	.417	33.8	48.3
157½	.437	34.9	49.9
180	.500	38.1	54.5

Single belting is  $\frac{3}{16}$  in. thick; four-ply cotton belting is generally considered equivalent to single belting. To install one pulley directly over the other, so that the belt runs vertical should be avoided if possible; it is better that the angle between the belt and the floor does not exceed  $45^\circ$ , and the bottom side of the belt should be the driving side. The distance between pulley centers depends on the size of the pulleys and of the belt; it should be great enough so that the belt will run with a slight sag and a gently undulating motion, but not great enough to cause excessive sag and an unsteady flapping motion of the belt. In general, the centers of small pulleys carrying light narrow belts should be about 15 ft. apart and the belt sag  $1\frac{1}{2}$  to 2 in.; for large pulleys and heavy belts the distance should be 20 to 30 ft. and the sag  $2\frac{1}{2}$  to 5 in.

Loose-running belts will last much longer than tight ones, and will be less likely to cause heating and wear of pulley bearings. High-speed belts are less likely to slip than low-speed belts; hence, pulleys should be selected so as to make the belt speeds high, provided they do not exceed 3,500 ft. per min. for laced belts and 5,000 ft. per min. for endless belts. Leather belts should be run with the grain, or hair, side next to the pulley; they should be kept clean, dry, and free from grease and lubricating oil. A dry, husky, leather belt can be made soft and pliable by the application of a coat of melted tallow and beeswax; this should be done only when the belt becomes dry and hard.

### SHAFTING

The diameter of a shaft may be found by the following formulas. The first is used when great stiffness is required and the shafts are very long; the second when strength only is required to be considered; and the third for calculating the diameters of steel shafts for dynamos.

$d$  = diameter of shaft, in inches;

$H$  = horsepower transmitted;

$W$  = kilowatts output;

$N$  = number of revolutions per minute;

$c$  = constant in formula (1);

$c'$  = constant in formula (2);

$k$  = constant in formula (3).

$$d = c \sqrt[4]{\frac{H}{N}} \quad (1) \quad d = c' \sqrt[4]{\frac{H}{N}} \quad (2) \quad d = k \sqrt[4]{\frac{W}{N}} \quad (3)$$

$c = 5.26$  for cast iron; 4.75 for wrought iron; 3.96 for steel;

$c' = 4.02$  for cast iron; 3.63 for wrought iron; 3.03 for steel.

$k = .9$  to 1 for 1- to 10-kilowatt dynamos;

$k = 1.1$  to 1.4 for 50- to 500-kilowatt dynamos.

NOTE.—To extract the fourth root, extract the square root twice.

### ROPES AND CHAINS

$D$  = diameter of the rope in inches = diameter of iron from which the link in chain is made;

$W$  = safe load in tons of 2,000 lb.

For common hemp rope,  $W = \frac{1}{3} D^2$ .

For iron-wire rope,  $W = \frac{1}{3} D^2$ .

For steel-wire rope,  $W = \frac{1}{3} D^2$ .

For close-link wrought-iron chain,  $W = 6 D^2$ .

For stud-link wrought-iron chain,  $W = 9 D^2$ .