

Conversion Factors

COMMONLY USED CONVERSION FACTORS		
Multiply	By	To Obtain
Acres	43,560	Square feet
Acres	1.562×10^{-3}	Square miles
Acre-Feet	43,560	Cubic feet
Amperes per sq. cm.	6.452	Amperes per sq. in.
Amperes per sq. in.	0.1550	Amperes per sq. cm.
Ampere-Turns	1.257	Gilberts
Ampere-Turns per cm.	2.540	Ampere-turns per in.
Ampere-Turns per in.	0.3937	Ampere-turns per cm.
Atmospheres	76.0	Cm. of mercury
Atmospheres	29.92	Inches of mercury
Atmospheres	33.90	Feet of water
Atmospheres	14.70	Pounds per sq. in.
British thermal units	252.0	Calories
British thermal units	778.2	Foot-pounds
British thermal units	3.960×10^{-4}	Horsepower-hours
British thermal units	0.2520	Kilogram-calories
British thermal units	107.6	Kilogram-meters
British thermal units	2.931×10^{-4}	Kilowatt-hours
British thermal units	1,055	Watt-seconds
B.t.u. per hour	2.931×10^{-4}	Kilowatts
B.t.u. per minute	2.359×10^{-2}	Horsepower
B.t.u. per minute	1.759×10^{-2}	Kilowatts
Bushels	1.244	Cubic feet
Centimeters	0.3937	Inches
Circular mils	5.067×10^{-6}	Square centimeters
Circular mils	0.7854×10^{-6}	Square inches
Circular mils	0.7854	Square mils
Cords	128	Cubic feet
Cubic centimeters	6.102×10^{-6}	Cubic inches

COMMONLY USED CONVERSION FACTORS *(cont.)*

Multiply	By	To Obtain
Cubic feet	0.02832	Cubic meters
Cubic feet	7.481	Gallons
Cubic feet	28.32	Liters
Cubic inches	16.39	Cubic centimeters
Cubic meters	35.31	Cubic feet
Cubic meters	1.308	Cubic yards
Cubic yards	0.7646	Cubic meters
Degrees (angle)	0.01745	Radians
Dynes	2.248×10^{-6}	Pounds
Ergs.	1	Dyne-centimeters
Ergs.	7.37×10^{-6}	Foot-pounds
Ergs.	10^{-7}	Joules
Farads	10^6	Microfarads
Fathoms	6	Feet
Feet	30.48	Centimeters
Feet of water . . . . .	.08826	Inches of mercury
Feet of water	304.8	Kg. per square meter
Feet of water	62.43	Pounds per square ft.
Feet of water	0.4335	Pounds per square in.
Foot-pounds	1.285×10^{-2}	British thermal units
Foot-pounds	5.050×10^{-7}	Horsepower-hours
Foot-pounds	1.356	Joules
Foot-pounds	0.1383	Kilogram-meters
Foot-pounds	3.766×10^{-7}	Kilowatt-hours
Gallons	0.1337	Cubic feet
Gallons	231	Cubic inches
Gallons	3.785×10^{-3}	Cubic meters
Gallons	3.785	Liters
Gallons per minute	2.228×10^{-3}	Cubic feet per sec.
Gausses	6.452	Lines per square in.
Gilberts	0.7958	Ampere-turns
Henries	10^3	Millihenries
Horsepower	42.41	B.t.u. per min.
Horsepower	2,544	B.t.u. per hour

COMMONLY USED CONVERSION FACTORS *(cont.)*

Multiply	By	To Obtain
Horsepower	550	Foot-pounds per sec.
Horsepower	33,000	Foot-pounds per min.
Horsepower	1.014	Horsepower (metric)
Horsepower	10.70	Kg. calories per min.
Horsepower	0.7457	Kilowatts
Horsepower (boiler)	33,520	B.t.u. per hour
Horsepower-hours	2,544	British thermal units
Horsepower-hours	1.98×10^6	Foot-pounds
Horsepower-hours	2.737×10^5	Kilogram-meters
Horsepower-hours	0.7457	Kilowatt-hours
Inches	2.540	Centimeters
Inches of mercury	1.133	Feet of water
Inches of mercury	70.73	Pounds per square ft.
Inches of mercury	0.4912	Pounds per square in.
Inches of water	25.40	Kg. per square meter
Inches of water	0.5781	Ounces per square in.
Inches of water	5.204	Pounds per square ft
Joules	9.478×10^{-4}	British thermal units
Joules	0.2388	Calories
Joules	10^7	Ergs
Joules	0.7376	Foot-pounds
Joules	2.778×10^{-7}	Kilowatt-hours
Joules	0.1020	Kilogram-meters
Joules	1	Watt-seconds
Kilograms	2.205	Pounds
Kilogram-calories	3.968	British thermal units
Kilogram meters	7.233	Foot-pounds
Kg per square meter	3.281×10^{-3}	Feet of water
Kg per square meter	0.2048	Pounds per square ft.
Kg per square meter	1.422×10^{-3}	Pounds per square in.
Kilolines	10^3	Maxwells
Kilometers	3.281	Feet
Kilometers	0.6214	Miles
Kilowatts	56.87	B.t.u. per min.

COMMONLY USED CONVERSION FACTORS *(cont.)*

Multiply	By	To Obtain
Kilowatts	737.6	Foot-pounds per sec.
Kilowatts	1.341	Horsepower
Kilowatts-hours	3409.5	British thermal units
Kilowatts-hours	2.655×10^6	Foot-pounds
Knots	1.152	Miles
Liters	0.03531	Cubic feet
Liters	61.02	Cubic inches
Liters	0.2642	Gallons
Log N_e or in N	0.4343	Log ₁₀ N
Log N	2.303	Log _e N or in N
Lumens per square ft.	1	Footcandles
Maxwells	10^{-3}	Kilolines
Megalines	10^6	Maxwells
Megaohms	10^6	Ohms
Meters	3.281	Feet
Meters	39.37	Inches
Meter-kilograms	7.233	Pound-feet
Microfarads	10^{-6}	Farads
Microhms	10^{-6}	Ohms
Microhms per cm. cube	0.3937	Microhms per in. cube
Microhms per cm. cube	6.015	Ohms per mil. foot
Miles	5,280	Feet
Miles	1.609	Kilometers
Miner's inches	1.5	Cubic feet per min.
Ohms	10^{-6}	Megohms
Ohms	10^6	Microhms
Ohms per mil foot	0.1662	Microhms per cm. cube
Ohms per mil foot	0.06524	Microhms per in. cube
Poundals	0.03108	Pounds
Pounds	32.17	Poundals
Pound-feet	0.1383	Meter-Kilograms
Pounds of water	0.01602	Cubic feet
Pounds of water	0.1198	Gallons
Pounds per cubic foot	16.02	Kg. per cubic meter
Pounds per cubic foot	5.787×10^{-4}	Pounds per cubic in.

COMMONLY USED CONVERSION FACTORS *(cont.)*

Multiply	By	To Obtain
Pounds per cubic inch . . .	27.68	Grams per cubic cm.
Pounds per cubic inch . . .	2.768×10^{-4}	Kg. per cubic meter
Pounds per cubic inch . . .	1.728	Pounds per cubic ft.
Pounds per square foot . .	0.01602	Feet of water
Pounds per square foot . .	4.882	Kg. per square meter
Pounds per square foot . .	6.944×10^{-3}	Pounds per sq. in.
Pounds per square inch . .	2.307	Feet of water
Pounds per square inch . .	2.036	Inches of mercury
Pounds per square inch . .	703.1	Kg. per square meter
Radians	57.30	Degrees
Square centimeters	1.973×10^5	Circular mils
Square Feet	2.296×10^{-5}	Acres
Square Feet	0.09290	Square meters
Square inches	1.273×10^6	Circular mils
Square inches	6.452	Square centimeters
Square Kilometers	0.3861	Square miles
Square meters	10.76	Square feet
Square miles	640	Acres
Square miles	2.590	Square kilometers
Square Millimeters	1.973×10^3	Circular mils
Square mils	1.273	Circular mils
Tons (long)	2,240	Pounds
Tons (metric)	2,205	Pounds
Tons (short)	2,000	Pounds
Watts	0.05686	B.t.u. per minute
Watts	10^7	Ergs per sec.
Watts	44.26	Foot-pounds per min.
Watts	1.341×10^{-3}	Horsepower
Watts	14.34	Calories per min.
Watts-hours	3.412	British thermal units
Watts-hours	2,655	Footpounds
Watts-hours	1.341×10^{-3}	Horsepower-hours
Watts-hours	0.8605	Kilogram-calories
Watts-hours	376.1	Kilogram-meters
Webers	10^8	Maxwells

CONVERSION TABLE FOR TEMPERATURE – °F / °C

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
-459.4	.....-273	-22.0	.....-30	35.6	......2	93.2	......34	150.8	......66
-418.0	.....-250	-18.4	.....-28	39.2	......4	96	......36	154.4	......68
-328.0	.....-200	-14.8	.....-26	42.8	......6	100.4	......38	158.0	......70
-238.0	.....-150	-11.2	.....-24	46.4	......8	104.0	......40	161.6	......72
-193.0	.....-125	-7.6	.....-22	50.0	......10	107.6	......42	165.2	......74
-148.0	.....-100	-4.0	.....-20	53.6	......12	111.2	......44	168.8	......76
-130.0	.....-90	-0.4	.....-18	57.2	......14	114.8	......46	172.4	......78
-112.0	.....-80	3.2	.....-16	60.8	......16	118.4	......48	176.0	......80
-94.0	.....-70	6.8	.....-14	64.4	......18	122.0	......50	179.6	......82
-76.0	.....-60	10.4	.....-12	68.0	......20	125.6	......52	183.2	......84
-58.0	.....-50	14.0	.....-10	71.6	......22	129.2	......54	186.8	......86
-40.0	.....-40	17.6	.....-8	75.2	......24	132.8	......56	190.4	......88
-36.4	.....-38	21.2	.....-6	78.8	......26	136.4	......58	194.0	......90
-32.8	.....-36	24.8	.....-4	82.4	......28	140.0	......60	197.6	......92
-29.2	.....-34	28.4	.....-2	86.0	......30	143.6	......62	201.2	......94
-25.6	.....-32	32.0	......0	89.6	......32	147.2	......64	204.8	......96

208.4 .....98	347.0 .....175	590 .....310	1004 .....540	6332 .....3500
212.0 .....100	356.0 .....180	608 .....320	1040 .....560	7232 .....4000
221.0 .....105	365.0 .....185	626 .....330	1076 .....580	4500 .....8132
230.0 .....110	374.0 .....190	644 .....340	1112 .....600	9032 .....5000
239.0 .....115	383.0 .....195	662 .....350	1202 .....650	9932 .....5500
248.0 .....120	392.0 .....200	680 .....360	1292 .....700	10832 .....6000
257.0 .....125	410 .....210	698 .....370	1382 .....750	11732 .....6500
266.0 .....130	428 .....220	716 .....380	1472 .....800	12632 .....7000
275.0 .....135	446 .....230	734 .....390	1562 .....850	13532 .....7500
284.0 .....140	464 .....240	752 .....400	1652 .....900	14432 .....8000
293.0 .....145	482 .....250	788 .....420	1742 .....950	15332 .....8500
302.0 .....150	500 .....260	824 .....440	1832 .....1000	16232 .....9000
311.0 .....155	518 .....270	860 .....460	2732 .....1500	17132 .....9500
320.0 .....160	536 .....280	896 .....480	3632 .....2000	18032 .....10000
329.0 .....165	554 .....290	932 .....500	4532 .....2500	
338.0 .....170	572 .....300	968 .....520	5432 .....3000	

1 degree F is 1/180 of the difference between the temperature of melting ice and boiling water.
1 degree C is 1/100 of the difference between the temperature of melting ice and boiling water.
Absolute Zero = 273.16° C = -459.69° F

DECIBEL LEVELS OF SOUNDS

The definition of sound intensity is energy (erg) transmitted per 1 second over a square centimeter surface. Sounds are measured in decibels. A decibel (db) change of 1 is the smallest change detected by humans.

Hearing Intensity	Decibel Level	Examples of Sounds
Barely Audible	0	Dead silence
(Very Light)	10	Audible hearing threshold
	20	Room (sound proof)
		Empty auditorium
		Ticking of a stopwatch
Audible Light	30	Soft whispering
	40	People talking quietly
		Quiet street noise without autos
Medium Loud	45	Telephone operator
	50	Fax machine in office
	60	Close conversation
Loud	70	Stereo system
		Computer printer
	80	Fire truck/ambulance siren
		Cat/dog fight
Extremely Loud	90	Industrial machinery
		High school marching band
Damage Possible	100	Heavy duty grinder in a machine/welding shop
Damaging	100+	Begins ear damage
	110	Diesel engine of a train
	120	Lightning strike (thunderstorm)
		60 ton metal forming factory press
	130	60" fan in a bus vacuum system
	140	Commercial/military jet engine
Ear Drum Shattering	194	Space shuttle engines
	225	16" guns on a battleship

SOUND AWARENESS AND SAFETY

Sound Awareness Changes

The typical range of human hearing is 30 hertz - 15,000 hertz. Human hearing recognizes an increase of 20 decibels, such as a stereo sound level increase, as being four times as loud at the higher level than it was at the lower level.

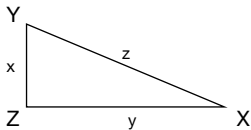
Awareness in Human Hearing	Decibel Change
Noticeably Louder	10
Easily Audible	5
Faintly Audible	3

HEARING PROTECTION LEVELS

Because of the Occupational Safety and Health Act of 1970, hearing protection is mandatory if the following time exposures to decibel levels are exceeded because of possible damage to human hearing.

Decibel Level	Time Exposure Per Day
115	15 minutes
110	30 minutes
105	1 hour
102	1½ hours
100	2 hours
97	3 hours
95	4 hours
92	6 hours
90	8 hours

TRIGONOMETRIC FORMULAS – RIGHT TRIANGLE



Angles = X, Y, Z
 Distances = x, y, z
 Area = $\frac{x y}{2}$

Pythagorean Theorem states

That $x^2 + y^2 = z^2$

Thus $x = \sqrt{z^2 - y^2}$

$\sin X = \frac{x}{z}$ $\cos X = \frac{y}{z}$

Thus $y = \sqrt{z^2 - x^2}$

$\tan X = \frac{x}{y}$ $\cot X = \frac{y}{x}$

Thus $z = \sqrt{x^2 + y^2}$

Given X and z, find Y, x and y

$$Y = 90^\circ - X, \quad x = z \sin X, \quad y = z \cos X$$

Given x and z, find X, Y and y

$$\sin X = \frac{x}{z} = \cos Y, \quad y = \sqrt{(z^2 - x^2)} = z \sqrt{1 - \frac{x^2}{z^2}}$$

Given X and z, find Y, x and z

$$Y = 90^\circ - X, \quad x = y \tan X, \quad z = \frac{y}{\cos X}$$

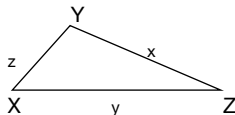
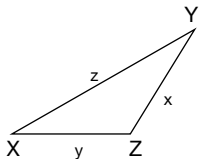
Given x and y, find X, Y and z

$$\tan X = \frac{x}{y} = \cot Y, \quad z = \sqrt{x^2 + y^2} = x \sqrt{1 + \frac{y^2}{x^2}}$$

Given X and x, find Y, y and z

$$Y = 90^\circ - X, \quad y = x \cot X, \quad z = \frac{x}{\sin X}$$

TRIGONOMETRIC FORMULAS – OBLIQUE TRIANGLES



Given x, y and z , Find X, Y and Z

$$s = \frac{x + y + z}{2}, \sin \frac{1}{2} X = \sqrt{\frac{(s-y)(s-z)}{yz}}$$

$$\sin \frac{1}{2} Y = \sqrt{\frac{(s-x)(s-z)}{xz}}, C = 180^\circ - (X + Y)$$

Given x, y and z , find the Area

$$s = \frac{x + y + z}{2}, \text{Area} = \sqrt{S(s-x)(s-y)(s-z)}$$

$$\text{Area} = \frac{yz \sin X}{2}, \text{Area} = \frac{x^2 \sin Y \sin Z}{2 \sin X}$$

Given x, y , and Z , find X, Y and z

$$X + Y = 180^\circ - Z, z = \frac{x \sin Z}{\sin X}, \tan X = \frac{x \sin Z}{y - (x \cos Z)}$$

Given X, x and y , Find Y, Z and z

$$\sin Y = \frac{y \sin X}{x}, Z = 180^\circ - (X + Y), z = \frac{x \sin Z}{\sin X}$$

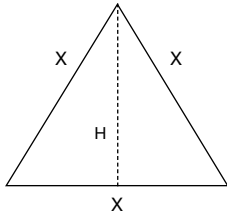
Given X, Y and x , Find y, Z and z

$$y = \frac{x \sin Y}{\sin X}, Z = 180^\circ - (X + Y), z = \frac{x \sin Z}{\sin X}$$

TRIGONOMETRIC FORMULAS – SHAPES

Equilateral Triangle

X = Sides (Equal Lengths)



$$\text{Area} = X^2 \frac{\sqrt{3}}{4} = .433 X^2$$

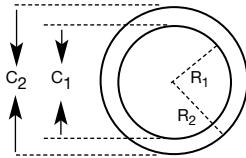
$$\text{Perimeter} = 3 X$$

$$H = \frac{X}{2} \sqrt{3} = .866 X$$

Annulus

C_1 and R_1 = Inside Circle

C_2 and R_2 = Outside Circle



C = Circumference

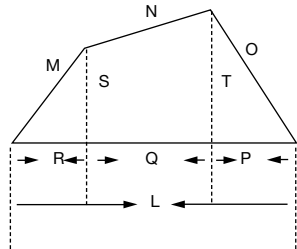
R = Radius

$$\text{Area} = \pi (R_1 + R_2) (R_2 - R_1)$$

$$\text{Area} = \left((C_2)^2 - (C_1)^2 \right) .7854$$

Trapezium

Perimeter is the
Sum of L, M, N and O

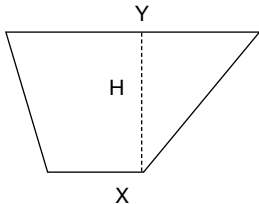


$$\text{Area} = \frac{(S + T) Q + RS + PT}{2}$$

Trapezoid

Perimeter =
The Sum of the
lengths of all
four sides

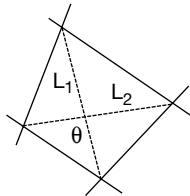
$$\text{Area} = \frac{(X + Y)}{2}$$



Quadrilateral

$$\text{Area} = \frac{L_1 \cdot L_2 \cdot \sin \theta}{2}$$

Where θ =
Degrees
of Angle

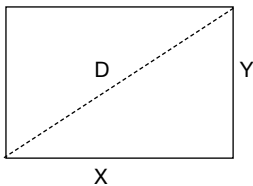


Rectangle

Area = XY
Diagonal Line (D)

$$= \sqrt{X^2 + Y^2}$$

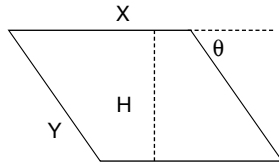
Perimeter =
 $2(X + Y)$
If a square
then $X = Y$



Parallelogram

Where θ =
Degrees
of Angle

Area =
 $XH = XY \sin \theta$
Perimeter =
 $2(X + Y)$



COMMON ENGINEERING UNITS AND THEIR RELATIONSHIP

Quantity	SI Metric Units/Symbols	Customary Units	Relationship of Units
Acceleration	meters per second squared (m/s ²)	feet per second squared (ft/s ²)	$m/s^2 = ft/s^2 \times 3.281$
Area	square meter (m ²) square millimeter (mm ²)	square foot (ft ²) square inch (in ²)	$m^2 = ft^2 \times 10.764$ $mm^2 = in^2 \times 0.00155$
Density	kilograms per cubic meter (kg/m ³) grams per cubic centimeter (g/cm ³)	pounds per cubic foot (lb/ft ³) pounds per cubic inch (lb/in ³)	$kg/m^3 = lb/ft^3 \times 16.02$ $g/cm^3 = lb/in^3 \times 0.036$
Work	Joule (J)	foot pound force (ft lbf or ft lb)	$J = ft\ lbf \times 1.356$
Heat	Joule (J)	British thermal unit (Btu) Calorie (Cal)	$J = Btu \times 1.055$ $J = cal \times 4.187$
Energy	kilowatt (kW)	Horsepower (HP)	$kW = HP \times 0.7457$

Force	Newton (N) Newton (N)	Pound-force (lbf, lb · f, or lb) kilogram-force (kgf, kg · f, or kp)	$N = \text{lbf} \times 4.448$ $N = \frac{\text{kgf}}{9.807}$
Length	meter (m) millimeter (mm)	foot (ft) inch (in)	$m = \text{ft} \times 3.281$ $\text{mm} = \frac{\text{in}}{25.4}$
Mass	kilogram (kg) gram (g)	pound (lb) ounce (oz)	$\text{kg} = \text{lb} \times 2.2$ $\text{g} = \frac{\text{oz}}{28.35}$
Stress	Pascal = Newton per second (Pa = N/s)	pounds per square inch (lb/in ² or psi)	$\text{Pa} = \text{lb/in}^2 \times 6,895$
Temperature	degree Celsius (°C)	degree Fahrenheit (°F)	$^{\circ}\text{C} = \frac{^{\circ}\text{F} - 32}{1.8}$
Torque	Newton meter (N · m)	foot-pound (ft lb) inch-pound (in lb)	$N \cdot m = \text{ft lbf} \times 1.356$ $N \cdot m = \text{in lbf} \times 0.113$
Volume	cubic meter (m ³) cubic centimeter (cm ³)	cubic foot (ft ³) cubic inch (in ³)	$\text{m}^3 = \text{ft}^3 \times 35.314$ $\text{cm}^3 = \frac{\text{in}^3}{16.387}$

DECIMAL EQUIVALENTS OF FRACTIONS

<u>8ths</u>	<u>32nds</u>	<u>64ths</u>	<u>64ths</u>
$\frac{1}{8} = .125$	$\frac{1}{32} = .03125$	$\frac{1}{64} = 0.15625$	$\frac{33}{64} = .515625$
$\frac{1}{4} = .250$	$\frac{3}{32} = .09375$	$\frac{3}{64} = .046875$	$\frac{35}{64} = .546875$
$\frac{3}{8} = .375$	$\frac{5}{32} = .15625$	$\frac{5}{64} = .078125$	$\frac{37}{64} = .57812$
$\frac{1}{2} = .500$	$\frac{7}{32} = .21875$	$\frac{7}{64} = .109375$	$\frac{39}{64} = .609375$
$\frac{5}{8} = .625$	$\frac{9}{32} = .28125$	$\frac{9}{64} = .140625$	$\frac{41}{64} = .640625$
$\frac{3}{4} = .750$	$\frac{11}{32} = .34375$	$\frac{11}{64} = .171875$	$\frac{43}{64} = .671875$
$\frac{7}{8} = .875$	$\frac{13}{32} = .40625$	$\frac{13}{64} = .203128$	$\frac{45}{64} = .703125$
<u>16ths</u>	$\frac{15}{32} = .46875$	$\frac{15}{64} = .234375$	$\frac{47}{64} = .734375$
$\frac{1}{16} = .0625$	$\frac{17}{32} = .53125$	$\frac{17}{64} = .265625$	$\frac{49}{64} = .765625$
$\frac{3}{16} = .1875$	$\frac{19}{32} = .59375$	$\frac{19}{64} = .296875$	$\frac{51}{64} = .796875$
$\frac{5}{16} = .3125$	$\frac{21}{32} = .65625$	$\frac{21}{64} = .328125$	$\frac{53}{64} = .828125$
$\frac{7}{16} = .4375$	$\frac{23}{32} = .71875$	$\frac{23}{64} = .359375$	$\frac{55}{64} = .859375$
$\frac{9}{16} = .5625$	$\frac{25}{32} = .78125$	$\frac{25}{64} = .390625$	$\frac{57}{64} = .890625$
$\frac{11}{16} = .6875$	$\frac{27}{32} = .84375$	$\frac{27}{64} = .421875$	$\frac{59}{64} = .921875$
$\frac{13}{16} = .8125$	$\frac{29}{32} = .90625$	$\frac{29}{64} = .453125$	$\frac{61}{64} = .953125$
$\frac{15}{16} = .9375$	$\frac{31}{32} = .96875$	$\frac{31}{64} = .484375$	$\frac{63}{64} = .984375$

COMMONLY USED GEOMETRICAL RELATIONSHIPS

Diameter of a circle $\times 3.1416 =$ Circumference.

Radius of a circle $\times 6.283185 =$ Circumference.

Square of the radius of a circle $\times 3.1416 =$ Area.

Square of the diameter of a circle $\times 0.7854 =$ Area.

Square of the circumference of a circle $\times 0.07958 =$ Area.

Half the circumference of a circle \times half its diameter $=$ Area.

Circumference of a circle $\times 0.159155 =$ Radius.

Square root of the area of a circle $\times 0.56419 =$ Radius.

Circumference of a circle $\times 0.31831 =$ Diameter.

Square root of the area of a circle $\times 1.12838 =$ Diameter.

Diameter of a circle $\times 0.866 =$ Side of an inscribed equilateral triangle.

Diameter of a circle $\times 0.7071 =$ Side of an inscribed square.

Circumference of a circle $\times 0.225 =$ Side of an inscribed square.

Circumference of a circle $\times 0.282 =$ Side of an equal square.

Diameter of a circle $\times 0.8862 =$ Side of an equal square.

Base of a triangle \times one-half the altitude $=$ Area.

Multiplying both diameters and .7854 together $=$ Area of an ellipse.

Surface of a sphere \times one-sixth of its diameter $=$ Volume.

Circumference of a sphere \times its diameter $=$ Surface.

Square of the diameter of a sphere $\times 3.1416 =$ Surface.

Square of the circumference of a sphere $\times 0.3183 =$ Surface.

Cube of the diameter of a sphere $\times 0.5236 =$ Volume.

Cube of the circumference of a sphere $\times 0.016887 =$ Volume.

Radius of a sphere $\times 1.1547 =$ Side of an inscribed cube.

Diameter of a sphere divided by $\sqrt{3} =$ Side of an inscribed cube.

Area of its base \times one-third of its altitude $=$ Volume of a cone or pyramid whether round, square or triangular.

Area of one of its sides $\times 6 =$ Surface of the cube.

Altitude of trapezoid \times one-half the sum of its parallel sides $=$ Area.