

# APPENDIX I. UNITS AND CONVERSIONS

## Prefixes for International System of Units

### Multiples & Submultiples

1,000,000,000,000,000 = $10^{15}$
1,000,000,000,000 = $10^{12}$
1,000,000,000 = $10^9$
1,000,000 = $10^6$
1,000 = $10^3$
100 = $10^2$
10 = $10^1$
0.1 = $10^{-1}$
0.01 = $10^{-2}$
0.001 = $10^{-3}$
0.000001 = $10^{-6}$
0.000000001 = $10^{-9}$
0.000000000001 = $10^{-12}$
0.000000000000001 = $10^{-15}$

### Prefixes Symbols

penta	P
tera	T
giga	G
mega	M
kilo	k
hecto	h
deka	da
deci	d
centi	c
milli	m
micro	$\mu$
nano	n
pico	p
femto	f

## Conversions

### English-Metric Conversions

1 inch	= 25.4 millimeters
1 foot	= 0.3048 meter
1 yard	= 0.9144 meter
1 mile	= 1.609 kilometers
1 sq inch	= 6.4516 sq centimeters
1 sq foot	= 0.0929 sq meter
1 sq yard	= 0.836 sq meter
1 sq mile	= 259 hectares
1 sq mile	= 2.59 sq kilometers
1 acre	= 0.4047 hectare
1 acre	= 4047 sq meters
1 cubic inch	= 16.39 cubic centimeters
1 cubic foot	= 0.0283 cubic meter
1 cubic yard	= 0.7646 cubic meter
1 quart (liq)	= 0.946 liter
1 gallon (U.S.)	= 0.003785 cubic meter
1 ounce (avdp)	= 28.35 grams
1 pound (avdp)	= 0.4536 kilogram
1 short ton	= 907.2 kilograms
1 horsepower	= 0.7457 kilowatt

## Units of Measure

### Linear Measure

1 foot (ft)	= 12 inches (in)
1 mile (mi)	= 5,280 feet (ft)
1 chain (ch)	= 66 ft
1 rod (rd)	= 16.5 ft
1 fathom (fm)	= 6 ft
1 nautical mile	= 6,076.115 ft
1 kilometer (km)	= 1000 meters (m)
1 km	= $10^3$ m
1 centimeter (cm)	= 0.01 m = $10^{-2}$ m
1 millimeter (mm)	= 0.001 m = $10^{-3}$ m
1 angstrom (Å)	= 0.0000000001 m = $10^{-10}$ m
1 micron ( $\mu$ )	= 0.001 mm

### Area Measure

1 square mile	= 640 acres
1 acre	= 43,560 sq ft
1 acre	= 4,840 sq yds = 160 sq rods
1 mile square	= 1 section = 640 acres
6 mile square	= 1 township = 36 sq miles
1 square meter	= 10,000 sq centimeters (cm)
100 square meters	= 1 are (a)
10,000 square meters	= 1 ha
100 ares	= 1 hectare (ha)
100 hectares	= 1 sq km

### Metric-English Conversions

1 millimeter	= 0.0394 inch
1 meter	= 3.281 feet
1 meter	= 1.094 yards
1 kilometer	= 0.6214 mile
1 sq centimeter	= 0.155 sq inch
1 sq meter	= 10.764 sq feet
1 sq meter	= 1.196 sq yards
1 hectare	= 2.471 acres
1 hectare	= 0.003861 sq mile
1 sq kilometer	= 0.3861 sq mile
1 cu centimeter	= 0.061 cu inch
1 cu meter	= 35.3 cu feet
1 cu meter	= 1.308 cu yards
1 liter	= 1.057 quarts
1 cu meter	= 264.2 gallons (U.S.)
1 gram	= 0.0353 ounce (avdp)
1 kilogram	= 2.205 pounds (avdp)
1 metric ton	= 2205 pounds (avdp)
1 kilowatt	= 1.341 horsepower

**Volume and Cubic Measure**

1 quart	= 2 pints = 57.75 cubic inches
4 quarts	= 1 gallon = 231 cubic inches
1 cubic foot	= 1728 cubic inches
1 cubic yard	= 27 cubic feet
1 barrel (oil)	= 42 gallons
1 barrel (proof spirits)	= 40 gallons
1 cubic foot	= 7.48 gallons
1 cubic inch	= 0.554 fluid ounce
1 gallon (U.S.)	= 128 U.S. fluid ounces = 0.833 British gal
1 liter	= 0.001 cubic meter = 1 cubic decimeter
1 liter	= 1000 milliliters
1 deciliter	= 100 milliliters
1 milliliter	= approximately 1 cubic centimeter (cc)
1 cubic meter (m <sup>3</sup> )	= 1,000,000 cubic centimeters

**Weights and Masses**

1 short ton	= 2000 pounds = 907.2 kilograms
1 long ton	= 2240 pounds = 1016 kilograms
1 metric ton	= 2205 pounds = 1000 kilograms
1 pound (avoirdupois)	= 7000 grains
1 ounce (avoirdupois)	= 437.5 grains
1 gram	= 15.432 grains
1000 grams	= 1 kilogram

**Force**

1 dyne (d) = the force that will produce an acceleration of 1 centimeter/second<sup>2</sup> when applied to a 1-gram mass.  
 1 newton (nt) = the force that will produce an acceleration of 1 meter/second<sup>2</sup> when applied to a 1-kilogram mass.  
 1 nt = 100,000 d = 1 × 10<sup>5</sup> d

**Energy and Power**

1 erg = the work done by a force of 1 dyne when its point of application moves through a distance of 1 centimeter in the direction of the force.

1 erg	= 9.48 × 10 <sup>-11</sup> British thermal unit (Btu)
1 erg	= 7.367 × 10 <sup>-8</sup> foot-pounds
1 erg	= 2.778 × 10 <sup>-14</sup> kilowatt-hours
1 kilowatt-hour	= 3413 Btu = 3.6 × 10 <sup>13</sup> ergs = 860,421 calories (cal)
1 Btu	= 2.930 × 10 <sup>-4</sup> kilowatt-hours = 1.0548 × 10 <sup>10</sup> ergs = 252 calories (cal)
1 watt*	= 3.413 Btu/hour
1 watt	= 1.341 × 10 <sup>-3</sup> horsepower
1 watt	= 1 joule per second
1 watt	= 14.34 calories per minute
1 joule*	= 1 × 10 <sup>7</sup> ergs
1 joule	= 1 newton-meter

\* The watt and the joule are the internationally acceptable units for power (energy per unit time) and energy, respectively.

**Heat**

1 calorie (cal) = the amount of heat that will raise the temperature of 1 gram of water 1° Celsius (water at 4° Celsius).  
 1 calorie (gram) = 3.9685 × 10<sup>-3</sup> Btu = 4.186 × 10<sup>7</sup> ergs

**Pressure**

1 millibar (mb) = 1000 dynes per cm<sup>2</sup> = 0.1 kilopascal (kPa)  
 1 atmosphere (atm) = 76 cm mercury = 14.70 lb/in<sup>2</sup> = 1013 millibars (mb)

**Additional Conversions**

1 gallon of water	= 8.3453 pounds of water
1 gallon per min	= 8.0208 cubic ft per hour
1 acre-foot	= 1233.46 m <sup>3</sup> = 325,829 gal
1 ft <sup>3</sup> per second	= 0.0283 m <sup>3</sup> per second
1 ft <sup>3</sup> of fresh water	= 62.4 lb = 28.3 kg
1 billion gallons per day (bgd)	= 3.785 million m <sup>3</sup> per day

**Temperature**

To change from Fahrenheit (F) to Celsius (C)	$^{\circ}\text{C} = \frac{^{\circ}\text{F} - 32^{\circ}}{1.8}$
To change from Celsius (C) to Fahrenheit (F)	$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32^{\circ}$