

# TABLE OF CONTENTS

## MEASURING UNITS

### THERMAL ENERGY OR HEAT

- 2514 Thermometer Scales
- 2514 Absolute Temperature and Absolute Zero
- 2514 Thermal Energy
- 2514 Fahrenheit-Celsius Conversion
- 2515 Interpolation Factors

### WEIGHTS AND MEASURES

- 2517 Measures of Length
- 2517 Surveyor's Measure
- 2517 Nautical Measure
- 2517 Square Measure
- 2517 Cubic Measure
- 2518 Shipping Measure
- 2518 Dry Measure
- 2518 Liquid Measure
- 2518 Old Liquid Measure
- 2518 Apothecaries' Fluid Measure
- 2518 Avoirdupois or Commercial Weight
- 2518 Troy Weight, used for Weighing Gold and Silver
- 2519 Apothecaries' Weight
- 2519 Measures of Pressure
- 2519 Miscellaneous

### METRIC SYSTEMS OF MEASUREMENT

- 2520 International System of Units
- 2522 Factors and Prefixes
- 2522 Standard of Length
- 2522 Measures of Length
- 2523 Square Measure
- 2523 Surveyor's Square Measure
- 2523 Cubic Measure
- 2523 Dry and Liquid Measure
- 2523 Measures of Weight

### METRIC SYSTEMS OF MEASUREMENT (Cont.)

- 2525 Metric System
- 2525 Metric Conversion Factors
- 2531 Metric and English Equivalents
- 2531 Use of Conversion Tables
- 2532 Ohm's Law
- 2533 Binary Multiples
- 2533 Linear Measure
- 2534 Decimals of an Inch to Millimeters
- 2536 Millimeters to Inches
- 2538 Fractional Inch
- 2539 Microinches to Micrometers
- 2540 Micrometers to Microinches
- 2541 Foot Meter and Mile Kilometer Conversion
- 2541 Square Measure
- 2542 Square Inch Square Centimeter Conversion
- 2542 Cubic Measure
- 2543 Cubic Foot Cubic Meter Conversion
- 2544 Acre Hectare Conversion
- 2545 Gallon Liter Conversion
- 2546 Weight
- 2546 Pound Kilogram Conversion
- 2548 Pounds per Square Inch Kilopascals Conversion
- 2549 Pounds per Cubic Inch Grams per Cubic Centimeter
- 2550 Pounds-force to Newtons Conversion
- 2551 Power and Heat Equivalents
- 2553 British Thermal Unit Joule Conversion
- 2554 Greek Letters and Standard Abbreviations
- 2554 Abbreviations for Scientific and Engineering Terms

## THERMAL ENERGY OR HEAT

**Thermometer Scales.**—There are two thermometer scales in general use: the Fahrenheit (F), which is used in the United States and in other countries still using the English system of units, and the Celsius (C) or Centigrade used throughout the rest of the world.

In the Fahrenheit thermometer, the freezing point of water is marked at 32 degrees on the scale and the boiling point, at atmospheric pressure, at 212 degrees. The distance between these two points is divided into 180 degrees. On the Celsius scale, the freezing point of water is at 0 degrees and the boiling point at 100 degrees. The following formulas may be used for converting temperatures given on any one of the scales to the other scale:

$$\text{Degrees Fahrenheit} = \frac{9 \times \text{degrees C}}{5} + 32$$

$$\text{Degrees Celsius} = \frac{5 \times (\text{degrees F} - 32)}{9}$$

Tables on the pages that follow can be used to convert degrees Celsius into degrees Fahrenheit or vice versa. In the event that the conversions are not covered in the tables, use those applicable portions of the formulas given above for converting.

**Absolute Temperature and Absolute Zero.**—A point has been determined on the thermometer scale, by theoretical considerations, that is called the absolute zero and beyond which a further decrease in temperature is inconceivable. This point is located at  $-273.2$  degrees Celsius or  $-459.7$  degrees F. A temperature reckoned from this point, instead of from the zero on the ordinary thermometers, is called absolute temperature. Absolute temperature in degrees C is known as “degrees Kelvin” or the “Kelvin scale” (K) and absolute temperature in degrees F is known as “degrees Rankine” or the “Rankine scale” (R).

$$\text{Degrees Kelvin} = \text{degrees C} + 273.2$$

$$\text{Degrees Rankine} = \text{degrees F} + 459.7$$

**Measures of the Quantity of Thermal Energy.**—The unit of quantity of thermal energy used in the United States is the British thermal unit, which is the quantity of heat or thermal energy required to raise the temperature of one pound of pure water one degree F. (American National Standard abbreviation, Btu; conventional British symbol, B.Th.U.) The French thermal unit, or *kilogram calorie*, is the quantity of heat or thermal energy required to raise the temperature of one kilogram of pure water one degree C. One kilogram calorie = 3.968 British thermal units = 1000 gram calories. The number of foot-pounds of mechanical energy equivalent to one British thermal unit is called the *mechanical equivalent of heat*, and equals 778 foot-pounds.

In the modern metric or SI system of units, the unit for thermal energy is the *joule* (J); a commonly used multiple being the kilojoule (kJ), or 1000 joules. See page 2520 for an explanation of the SI System. One kilojoule = 0.9478 Btu. Also in the SI System, the *watt* (W), equal to joule per second (J/s), is used for power, where one watt = 3.412 Btu per hour.

**Fahrenheit-Celsius (Centigrade) Conversion.**—A simple way to convert a Fahrenheit temperature reading into a Celsius temperature reading or vice versa is to enter the accompanying table in the center or boldface column of figures. These figures refer to the temperature in either Fahrenheit or Celsius degrees. If it is desired to convert from Fahrenheit to Celsius degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Celsius temperature in the column at the left. If it is desired to convert from Celsius to Fahrenheit degrees, consider the center column as a table of Celsius values, and read the corresponding Fahrenheit temperature on the right.



**Fahrenheit-Celsius (Centigrade) Conversion Table** (Continued)

deg C	deg F	deg C	deg F	deg C	deg F	deg C	deg F				
42.8	<b>109</b>	228.2	70.0	<b>158</b>	316.4	97.2	<b>207</b>	404.6	343.3	<b>650</b>	1202
43.3	<b>110</b>	230.0	70.6	<b>159</b>	318.2	97.8	<b>208</b>	406.4	348.9	<b>660</b>	1220
43.9	<b>111</b>	231.8	71.1	<b>160</b>	320.0	98.3	<b>209</b>	408.2	354.4	<b>670</b>	1238
44.4	<b>112</b>	233.6	71.7	<b>161</b>	321.8	98.9	<b>210</b>	410.0	360.0	<b>680</b>	1256
45.0	<b>113</b>	235.4	72.2	<b>162</b>	323.6	99.4	<b>211</b>	411.8	365.6	<b>690</b>	1274
45.6	<b>114</b>	237.2	72.8	<b>163</b>	325.4	100.0	<b>212</b>	413.6	371.1	<b>700</b>	1292
46.1	<b>115</b>	239.0	73.3	<b>164</b>	327.2	104.4	<b>220</b>	428.0	376.7	<b>710</b>	1310
46.7	<b>116</b>	240.8	73.9	<b>165</b>	329.0	110.0	<b>230</b>	446.0	382.2	<b>720</b>	1328
47.2	<b>117</b>	242.6	74.4	<b>166</b>	330.8	115.6	<b>240</b>	464.0	387.8	<b>730</b>	1346
47.8	<b>118</b>	244.4	75.0	<b>167</b>	332.6	121.1	<b>250</b>	482.0	393.3	<b>740</b>	1364
48.3	<b>119</b>	246.2	75.6	<b>168</b>	334.4	126.7	<b>260</b>	500.0	398.9	<b>750</b>	1382
48.9	<b>120</b>	248.0	76.1	<b>169</b>	336.2	132.2	<b>270</b>	518.0	404.4	<b>760</b>	1400
49.4	<b>121</b>	249.8	76.7	<b>170</b>	338.0	137.8	<b>280</b>	536.0	410.0	<b>770</b>	1418
50.0	<b>122</b>	251.6	77.2	<b>171</b>	339.8	143.3	<b>290</b>	554.0	415.6	<b>780</b>	1436
50.6	<b>123</b>	253.4	77.8	<b>172</b>	341.6	148.9	<b>300</b>	572.0	421.1	<b>790</b>	1454
51.1	<b>124</b>	255.2	78.3	<b>173</b>	343.4	154.4	<b>310</b>	590.0	426.7	<b>800</b>	1472
51.7	<b>125</b>	257.0	78.9	<b>174</b>	345.2	160.0	<b>320</b>	608.0	432.2	<b>810</b>	1490
52.2	<b>126</b>	258.8	79.4	<b>175</b>	347.0	165.6	<b>330</b>	626.0	437.8	<b>820</b>	1508
52.8	<b>127</b>	260.6	80.0	<b>176</b>	348.8	171.1	<b>340</b>	644.0	443.3	<b>830</b>	1526
53.3	<b>128</b>	262.4	80.6	<b>177</b>	350.6	176.7	<b>350</b>	662.0	448.9	<b>840</b>	1544
53.9	<b>129</b>	264.2	81.1	<b>178</b>	352.4	182.2	<b>360</b>	680.0	454.4	<b>850</b>	1562
54.4	<b>130</b>	266.0	81.7	<b>179</b>	354.2	187.8	<b>370</b>	698.0	460.0	<b>860</b>	1580
55.0	<b>131</b>	267.8	82.2	<b>180</b>	356.0	193.3	<b>380</b>	716.0	465.6	<b>870</b>	1598
55.6	<b>132</b>	269.6	82.8	<b>181</b>	357.8	198.9	<b>390</b>	734.0	471.1	<b>880</b>	1616
56.1	<b>133</b>	271.4	83.3	<b>182</b>	359.6	204.4	<b>400</b>	752.0	476.7	<b>890</b>	1634
56.7	<b>134</b>	273.2	83.9	<b>183</b>	361.4	210.0	<b>410</b>	770.0	482.2	<b>900</b>	1652
57.2	<b>135</b>	275.0	84.4	<b>184</b>	363.2	215.6	<b>420</b>	788	487.8	<b>910</b>	1670
57.8	<b>136</b>	276.8	85.0	<b>185</b>	365.0	221.1	<b>430</b>	806	493.3	<b>920</b>	1688
58.3	<b>137</b>	278.6	85.6	<b>186</b>	366.8	226.7	<b>440</b>	824	498.9	<b>930</b>	1706
58.9	<b>138</b>	280.4	86.1	<b>187</b>	368.6	232.2	<b>450</b>	842	504.4	<b>940</b>	1724
59.4	<b>139</b>	282.2	86.7	<b>188</b>	370.4	237.8	<b>460</b>	860	510.0	<b>950</b>	1742
60.0	<b>140</b>	284.0	87.2	<b>189</b>	372.2	243.3	<b>470</b>	878	515.6	<b>960</b>	1760
60.6	<b>141</b>	285.8	87.8	<b>190</b>	374.0	248.9	<b>480</b>	896	521.1	<b>970</b>	1778
61.1	<b>142</b>	287.6	88.3	<b>191</b>	375.8	254.4	<b>490</b>	914	526.7	<b>980</b>	1796
61.7	<b>143</b>	289.4	88.9	<b>192</b>	377.6	260.0	<b>500</b>	932	532.2	<b>990</b>	1814
62.2	<b>144</b>	291.2	89.4	<b>193</b>	379.4	265.6	<b>510</b>	950	537.8	<b>1000</b>	1832
62.8	<b>145</b>	293.0	90.0	<b>194</b>	381.2	271.1	<b>520</b>	968	565.6	<b>1050</b>	1922
63.3	<b>146</b>	294.8	90.6	<b>195</b>	383.0	276.7	<b>530</b>	986	593.3	<b>1100</b>	2012
63.9	<b>147</b>	296.6	91.1	<b>196</b>	384.8	282.2	<b>540</b>	1004	621.1	<b>1150</b>	2102
64.4	<b>148</b>	298.4	91.7	<b>197</b>	386.6	287.8	<b>550</b>	1022	648.9	<b>1200</b>	2192
65.0	<b>149</b>	300.2	92.2	<b>198</b>	388.4	293.3	<b>560</b>	1040	676.7	<b>1250</b>	2282
65.6	<b>150</b>	302.0	92.8	<b>199</b>	390.2	298.9	<b>570</b>	1058	704.4	<b>1300</b>	2372
66.1	<b>151</b>	303.8	93.3	<b>200</b>	392.0	304.4	<b>580</b>	1076	732.2	<b>1350</b>	2462
66.7	<b>152</b>	305.6	93.9	<b>201</b>	393.8	310.0	<b>590</b>	1094	760.0	<b>1400</b>	2552
67.2	<b>153</b>	307.4	94.4	<b>202</b>	395.6	315.6	<b>600</b>	1112	787.8	<b>1450</b>	2642
67.8	<b>154</b>	309.2	95.0	<b>203</b>	397.4	321.1	<b>610</b>	1130	815.6	<b>1500</b>	2732
68.3	<b>155</b>	311.0	95.6	<b>204</b>	399.2	326.7	<b>620</b>	1148	1093.9	<b>2000</b>	3632
68.9	<b>156</b>	312.8	96.1	<b>205</b>	401.0	332.2	<b>630</b>	1166	1648.9	<b>3000</b>	5432
69.4	<b>157</b>	314.6	96.7	<b>206</b>	402.8	337.8	<b>640</b>	1184	2760.0	<b>5000</b>	9032

Above 1000 in the center column, the table increases in increments of 50. To convert 1462 degrees F to Celsius, for instance, add to the Celsius equivalent of 1400 degrees F ten times the interpolation factor for 6 and the interpolation factor for 2 or  $760.0 + 33.3 + 1.11$ , which equals 794.4.

**WEIGHTS AND MEASURES****Measures of Length**

*1 mile* = 1760 yards = 5280 feet

*1 yard* = 3 feet = 36 inches    *1 foot* = 12 inches

*1 mil* = 0.001 inch

*1 fathom* = 2 yards = 6 feet    *1 rod* = 5.5 yards = 16.5 feet.

*1 hand* = 4 inches    *1 span* = 9 inches

*1 micro-inch* = one millionth inch or 0.000001 inch (1 micrometer or micron one millionth meter = 0.00003937 inch.)

**Surveyor's Measure**

*1 mile* = 8 furlongs = 80 chains

*1 furlong* = 10 chains = 220 yards

*1 chain* = 4 rods = 22 yards = 66 feet = 100 links

*1 link* = 7.92 inches

**Nautical Measure**

*1 league* = 3 nautical miles

*1 nautical mile* = 6076.11549 feet = 1.1508 statute miles

*1 knot* = nautical unit of speed = 1 nautical mile per hour

*One degree at the equator* = 60 nautical miles = 69.047 statute miles  
360 degrees = 21,600 nautical miles = 24,856.8 statute miles = circumference at equator

**Square Measure**

*1 square mile* = 640 acres = 6400 square chains

*1 acre* = 10 square chains = 4840 square yards = 43,560 square feet. An acre is equal to a square, the side of which is 208.7 feet.

*1 square chain* = 16 square rods = 484 square yards = 4356 square feet.

*1 square rod* = 30.25 square yards = 272.25 square feet = 625 square links

*1 square yard* = 9 square feet

*1 square foot* = 144 square inches

**Measure used for Diameters and Areas of Electric Wires**

*1 circular inch* = area of circle 1 inch in diameter = 0.7854 square inch

*1 circular inch* = 1,000,000 circular mils

*1 square inch* = 1.2732 circular inch = 1,273,239 circular mils

*1 circular mil* = the area of a circle 0.001 inch in diameter

**Cubic Measure**

*1 cubic yard* = 27 cubic feet

*1 cubic foot* = 1728 cubic inches

The following measures are also used for wood and masonry:

*1 cord of wood* =  $4 \times 4 \times 8$  feet = 128 cubic feet

*1 perch of masonry* =  $16\frac{1}{2} \times 1\frac{1}{2} \times 1$  foot =  $24\frac{3}{4}$  cubic feet

**Shipping Measure**

For measuring entire internal capacity of a vessel:

*1 register ton* = 100 cubic feet

For measurement of cargo:

Approximately 40 cubic feet of merchandise is considered a shipping ton, unless that bulk would weigh more than 2000 pounds, in which case the freight charge may be based upon weight

*40 cubic feet* = 32.143 U.S. bushels = 31.16 Imperial bushels

**Dry Measure**

*1 bushel* = 1.2445 cubic feet = 2150.42 cubic inches  
(U.S. or Winchester struck bushel)

*1 bushel* = 4 pecks = 32 quarts = 64 pints

*1 peck* = 8 quarts = 16 pints

*1 quart* = 2 pints

*1 heaped bushel* =  $1\frac{1}{4}$  struck bushel

*1 cubic foot* = 0.8036 struck bushel

*1 British Imperial bushel* = 8 Imperial gallons = 1.2837 cubic feet = 2218.19 cubic inches

**Liquid Measure**

*1 U.S. gallon* = 0.1337 cubic foot = 231 cubic inches = 4 quarts = 8 pints

*1 quart* = 2 pints = 8 gills    *1 pint* = 4 gills

*1 British Imperial gallon* = 1.2009 U.S. gallon = 277.42 cubic inches

*1 cubic foot* = 7.48 U.S. gallons

**Old Liquid Measure**

*1 barrel* =  $31\frac{1}{2}$  gallons    *1 hogshead* = 2 barrels = 63 gallons

*1 pipe or butt* = 2 hogsheads = 4 barrels = 126 gallons

*1 tierce* = 42 gallons    *1 puncheon* = 2 tierces = 84 gallons

*1 tun* = 2 pipes = 3 puncheons

**Apothecaries' Fluid Measure**

*1 U.S. fluid ounce* = 8 drachms = 1.805 cubic inch =  $\frac{1}{128}$  U.S. gallon

*1 fluid drachm* = 60 minims

*1 British fluid ounce* = 1.732 cubic inch

**Avoirdupois or Commercial Weight**

*1 gross or long ton* = 2240 pounds    *1 net or short ton* = 2000 pounds

*1 pound* = 16 ounces = 7000 grains

*1 ounce* = 16 drachms = 437.5 grains

The following measures for weight are now seldom used in the United States: *1 hundred-weight* = 4 quarters = 112 pounds (*1 gross or long ton* = 20 hundred-weights); *1 quarter* = 28 pounds; *1 stone* = 14 pounds; *1 quintal* = 100 pounds

**Troy Weight, used for Weighing Gold and Silver**

*1 pound* = 12 ounces = 5760 grains

*1 ounce* = 20 pennyweights = 480 grains

*1 pennyweight* = 24 grains

*1 carat* = 3.086 grains (used in weighing diamonds)

*1 grain Troy* = 1 grain avoirdupois = 1 grain apothecaries' weight

**Apothecaries' Weight**

- 1 pound* = 12 ounces = 5760 grains  
*1 ounce* = 8 drachms = 480 grains  
*1 drachm* = 3 scruples = 60 grains  
*1 scruple* = 20 grains

**Measures of Pressure**

- 1 pound per square inch* = 144 pounds per square foot = 0.068 atmosphere = 2.042 inches of mercury at 62° F. = 27.7 inches of water at 62° F. = 2.31 feet of water at 62° F  
*1 atmosphere* = 30 inches of mercury at 62° F. = 14.7 pounds per square inch = 2116.3 pounds per square foot = 33.95 feet of water at 62° F  
*1 foot of water at 62° F* = 62.355 pounds per square foot = 0.433 pound per square inch  
*1 inch of mercury at 62° F* = 1.132 foot of water = 13.58 inches of water = 0.491 pound per square inch

**Miscellaneous**

- 1 great gross* = 12 gross = 144 dozen  
*1 quire* = 24 sheets  
*1 gross* = 12 dozen = 144 units  
*1 ream* = 20 quires = 480 sheets  
*1 dozen* = 12 units  
*1 ream printing paper* = 500 sheets  
*1 score* = 20 units

**Decimal Equivalents of Fractions of an Inch**

$\frac{1}{64}$	0.015 625	$\frac{11}{32}$	0.343 75	$\frac{43}{64}$	0.671 875
$\frac{1}{32}$	0.031 25	$\frac{23}{64}$	0.359 375	$\frac{11}{16}$	0.687 5
$\frac{3}{64}$	0.046 875	$\frac{3}{8}$	0.375	$\frac{45}{64}$	0.703 125
$\frac{1}{16}$	0.062 5	$\frac{25}{64}$	0.390 625	$\frac{23}{32}$	0.718 75
$\frac{5}{64}$	0.078 125	$\frac{13}{32}$	0.406 25	$\frac{47}{64}$	0.734 375
$\frac{3}{32}$	0.093 75	$\frac{27}{64}$	0.421 875	$\frac{3}{4}$	0.750
$\frac{7}{64}$	0.109 375	$\frac{7}{16}$	0.437 5	$\frac{49}{64}$	0.765 625
$\frac{1}{8}$	0.125	$\frac{29}{64}$	0.453 125	$\frac{25}{32}$	0.781 25
$\frac{9}{64}$	0.140 625	$\frac{15}{32}$	0.468 75	$\frac{51}{64}$	0.796 875
$\frac{5}{32}$	0.156 25	$\frac{31}{64}$	0.484 375	$\frac{13}{16}$	0.812 5
$\frac{11}{64}$	0.171 875	$\frac{1}{2}$	0.500	$\frac{53}{64}$	0.828 125
$\frac{3}{16}$	0.187 5	$\frac{33}{64}$	0.515 625	$\frac{27}{32}$	0.843 75
$\frac{13}{64}$	0.203 125	$\frac{17}{32}$	0.531 25	$\frac{55}{64}$	0.859 375
$\frac{7}{32}$	0.218 75	$\frac{35}{64}$	0.546 875	$\frac{7}{8}$	0.875
$\frac{15}{64}$	0.234 375	$\frac{9}{16}$	0.562 5	$\frac{57}{64}$	0.890 625
$\frac{1}{4}$	0.250	$\frac{37}{64}$	0.578 125	$\frac{29}{32}$	0.906 25
$\frac{17}{64}$	0.265 625	$\frac{19}{32}$	0.593 75	$\frac{59}{64}$	0.921 875
$\frac{9}{32}$	0.281 25	$\frac{39}{64}$	0.609 375	$\frac{15}{16}$	0.937 5
$\frac{19}{64}$	0.296 875	$\frac{5}{8}$	0.625	$\frac{61}{64}$	0.953 125
$\frac{5}{16}$	0.312 5	$\frac{41}{64}$	0.640 625	$\frac{31}{32}$	0.968 75
$\frac{21}{64}$	0.328 125	$\frac{21}{32}$	0.656 25	$\frac{63}{64}$	0.984 375

## METRIC SYSTEMS OF MEASUREMENT

A metric system of measurement was first established in France in the years following the French Revolution, and various systems of metric units have been developed since that time. All metric unit systems are based, at least in part, on the International Metric Standards, which are the meter and kilogram, or decimal multiples or submultiples of these standards.

In 1795, a metric system called the centimeter-gram-second (cgs) system was proposed, and was adopted in France in 1799. In 1873, the British Association for the Advancement of Science recommended the use of the cgs system, and since then it has been widely used in all branches of science throughout the world. From the base units in the cgs system are derived the following:

*Unit of velocity* = 1 centimeter per second

*Acceleration due to gravity (at Paris)* = 981 centimeters per second per second

*Unit of force* = 1 dyne =  $\frac{1}{981}$  gram

*Unit of work* = 1 erg = 1 dyne-centimeter

*Unit of power* = 1 watt = 10,000,000 ergs per second

Another metric system called the MKS (meter-kilogram-second) system of units was proposed by Professor G. Giorgi in 1902. In 1935, the International Electro-technical Commission (IEC) accepted his recommendation that this system of units of mechanics should be linked with the electromagnetic units by the adoption of a fourth base unit. In 1950, the IEC adopted the ampere, the unit of electric current, as the fourth unit, and the MKSA system thus came into being.

A gravitational system of metric units, known as the technical system, is based on the meter, the kilogram as a force, and the second. It has been widely used in engineering. Because the standard of force is defined as the weight of the mass of the standard kilogram, the fundamental unit of force varies due to the difference in gravitational pull at different locations around the earth. By international agreement, a standard value for acceleration due to gravity was chosen (9.81 meters per second squared) that for all practical measurements is approximately the same as the local value at the point of measurement.

**The International System of Units (SI).**—The Conference Generale des Poids et Mesures (CGPM), which is the body responsible for all international matters concerning the metric system, adopted in 1954, a rationalized and coherent system of units, based on the four MKSA units (see above), and including the *kelvin* as the unit of temperature and the *candela* as the unit of luminous intensity. In 1960, the CGPM formally named this system the *Système International d'Unites*, for which the abbreviation is SI in all languages. In 1971, the 14th CGPM adopted a seventh base unit, the *mole*, which is the unit of quantity ("amount of substance").

In the period since the first metric system was established in France toward the end of the 18th century, most of the countries of the world have adopted a metric system. At the present time, most of the industrially advanced metric-using countries are changing from their traditional metric system to SI. Those countries that are currently changing or considering change from the English system of measurement to metric have the advantage that they can convert directly to the modernized system. The United Kingdom, which can be said to have led the now worldwide move to change from the English system, went straight to SI.

The use of SI units instead of the traditional metric units has little effect on everyday life or trade. The units of linear measurement, mass, volume, and time remain the same, viz. meter, kilogram, liter, and second.

The SI, like the traditional metric system, is based on decimal arithmetic. For each physical quantity, units of different sizes are formed by multiplying or dividing a single base value by powers of 10. Thus, changes can be made very simply by adding zeros or shifting



decimal points. For example, the meter is the basic unit of length; the kilometer is a multiple (1000 meters); and the millimeter is a sub-multiple (one-thousandth of a meter).

In the older metric systems, the simplicity of a series of units linked by powers of ten is an advantage for plain quantities such as length, but this simplicity is lost as soon as more complex units are encountered. For example, in different branches of science and engineering, energy may appear as the erg, the calorie, the kilogram-meter, the liter-atmosphere, or the horsepower-hour. In contrast, the SI provides only one basic unit for each physical quantity, and universality is thus achieved.

As mentioned before, there are seven base units, which are for the basic quantities of length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity, expressed as the meter (m), the kilogram (kg), the second (s), the ampere (A), the kelvin (K), the mole (mol), and the candela (cd). The units are defined in the accompanying table.

The SI is a coherent system. A system is said to be coherent if the product or quotient of any two unit quantities in the system is the unit of the resultant quantity. For example, in a coherent system in which the foot is the unit of length, the square foot is the unit of area, whereas the acre is not.

Other physical quantities are derived from the base units. For example, the unit of velocity is the meter per second (m/s), which is a combination of the base units of length and time. The unit of acceleration is the meter per second squared ( $m/s^2$ ). By applying Newton's second law of motion—force is proportional to mass multiplied by acceleration—the unit of force is obtained that is the kilogram-meter per second squared ( $kg\cdot m/s^2$ ). This unit is known as the newton, or N. Work, or force times distance is the kilogram-meter squared per second squared ( $kg\cdot m^2/s^2$ ), which is the joule (1 joule = 1 newton-meter), and energy is also expressed in these terms. The abbreviation for joule is J. Power or work per unit time is the kilogram-meter squared per second cubed ( $kg\cdot m^2/s^3$ ), which is the watt (1 watt = 1 joule per second = 1 newton-meter per second). The abbreviation for watt is W. The term horsepower is not used in the SI and is replaced by the watt, which together with multiples and submultiples—kilowatt and milliwatt, for example—is the same unit as that used in electrical work.

The use of the newton as the unit of force is of particular interest to engineers. In practical work using the English or traditional metric systems of measurements, it is a common practice to apply weight units as force units. Thus, the unit of force in those systems is that force that when applied to unit mass produces an acceleration  $g$  rather than unit acceleration. The value of gravitational acceleration  $g$  varies around the earth, and thus the weight of a given mass also varies. In an effort to account for this minor error, the kilogram-force and pound-force were introduced, which are defined as the forces due to "standard gravity" acting on bodies of one kilogram or one pound mass, respectively. The standard gravitational acceleration is taken as 9.80665 meters per second squared or 32.174 feet per second squared. The newton is defined as "that force, which when applied to a body having a mass of one kilogram, gives it an acceleration of one meter per second squared." It is independent of  $g$ . As a result, the factor  $g$  disappears from a wide range of formulas in dynamics. However, in some formulas in statics, where the weight of a body is important rather than its mass,  $g$  does appear where it was formerly absent (the weight of a mass of  $W$  kilograms is equal to a force of  $Wg$  newtons, where  $g$  = approximately 9.81 meters per second squared). Details concerning the use of SI units in mechanics calculations are given on page 116 and throughout the Mechanics section in this Handbook. The use of SI units in strength of materials calculations is covered in the section on that subject.

Decimal multiples and sub-multiples of the SI units are formed by means of the prefixes given in the following table, which represent the numerical factors shown.

### Factors and Prefixes for Forming Decimal Multiples and Sub-multiples of the SI Units

Factor by which the unit is multiplied	Prefix	Symbol	Factor by which the unit is multiplied	Prefix	Symbol
$10^{12}$	tera	T	$10^{-2}$	centi	c
$10^9$	giga	G	$10^{-3}$	milli	m
$10^6$	mega	M	$10^{-6}$	micro	$\mu$
$10^3$	kilo	k	$10^{-9}$	nano	n
$10^2$	hecto	h	$10^{-12}$	pico	p
10	deka	da	$10^{-15}$	femto	f
$10^{-1}$	deci	d	$10^{-18}$	atto	a

**Standard of Length.**—In 1866 the United States, by act of Congress, passed a law making legal the meter, the only measure of length that has been legalized by the United States Government. The United States yard is defined by the relation: 1 yard =  $\frac{3600}{3937}$  meter. The legal equivalent of the meter for commercial purposes was fixed as 39.37 inches, by law, in July, 1866, and experience having shown that this value was exact within the error of observation, the United States Office of Standard Weights and Measures was, in 1893, authorized to derive the yard from the meter by the use of this relation. The United States prototype meters Nos. 27 and 21 were received from the International Bureau of Weights and Measures in 1889. Meter No. 27, sealed in its metal case, is preserved in a fireproof vault at the Bureau of Standards.

Comparisons made prior to 1893 indicated that the relation of the yard to the meter, fixed by the Act of 1866, was by chance the exact relation between the international meter and the British imperial yard, within the error of observation. A subsequent comparison made between the standards just mentioned indicates that the legal relation adopted by Congress is in error 0.0001 inch; but, in view of the fact that certain comparisons made by the English Standards Office between the imperial yard and its authentic copies show variations as great if not greater than this, it cannot be said with certainty that there is a difference between the imperial yard of Great Britain and the United States yard derived from the meter. The bronze yard No. 11, which was an exact copy of the British imperial yard both in form and material, had shown changes when compared with the imperial yard in 1876 and 1888, which could not reasonably be said to be entirely due to changes in Bronze No. 11. On the other hand, the new meters represented the most advanced ideas of standards, and it therefore seemed that greater stability as well as higher accuracy would be secured by accepting the international meter as a fundamental standard of length.

For more information on SI practice, the reader is referred to the following publications:

*Metric Practice Guide*, published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

*ISO International Standard 1000*. This publication covers the rules for use of SI units, their multiples and sub-multiples. It can be obtained from the American National Standards Institute 11 West 42nd Street, New York, NY 10036.

*The International System of Units*, Special Publication 330 of the National Bureau of Standards—available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

### Traditional Metric Measures

#### Measures of Length

10 millimeters (mm) = 1 centimeter (cm)

10 centimeters = 1 decimeter (dm)

10 decimeters = 1 meter (m)

1000 meters = 1 kilometer (km)

**Square Measure**

100 square millimeters ( $mm^2$ ) = 1 square centimeter ( $cm^2$ )

100 square centimeters = 1 square decimeter ( $dm^2$ )

100 square decimeters = 1 square meter ( $m^2$ ).

**Surveyor's Square Measure**

100 square meters ( $m^2$ ) = 1 are (a).

100 ares = 1 hectare (ha).

100 hectares = 1 square kilometer ( $km^2$ ).

**Cubic Measure**

1000 cubic millimeters ( $mm^3$ ) = 1 cubic centimeter ( $cm^3$ ).

1000 cubic centimeters = 1 cubic decimeter ( $dm^3$ ).

100 cubic decimeters = 1 cubic meter ( $m^3$ ).

**Dry and Liquid Measure**

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

10 centiliters = 1 deciliter (dl).

10 deciliters = 1 liter (l).

100 liters = 1 hectoliter (hl).

1 liter = 1 cubic decimeter = the volume of 1 kilogram of pure water at a temperature of 39.2 degrees F.

**Measures of Weight**

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

10 centigrams = 1 decigram (dg).

10 decigrams = 1 gram (g).

10 grams = 1 dekagram (dag).

10 dekagrams = 1 hectogram (hg).

10 hectograms = 1 kilogram (kg).

1000 kilograms = 1 (metric) ton (t).

**Table 1. International System (SI) Units**

PHYSICAL QUANTITY	NAME OF UNIT	UNIT SYMBOL	DEFINITION
Basic SI Units			
Length	meter	m	Distance traveled by light in vacuo during $1/299,792,458$ of a second.
Mass	kilogram	kg	Mass of the international prototype which is in the custody of the Bureau International des Poids et Mesures (BIPM) at Sèvres, near Paris.
Time	second	s	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.
Electric Current	ampere	A	The constant current which, if maintained in two parallel rectilinear conductors of infinite length, of negligible circular cross section, and placed at a distance of one meter apart in a vacuum, would produce between these conductors a force equal to $2 \times 10^{-7}$ N/m length.
Thermodynamic Temperature	degree kelvin	K	The fraction $1/273.16$ of the thermodynamic temperature of the triple point of water.
Amount of Substance	mole	mol	The amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.
Luminous Intensity	candela	cd	Luminous intensity, in the perpendicular direction, of a surface of $1/600,000$ square meter of a black body at the temperature of freezing platinum under a pressure of 101,325 newtons per square meter.

**Table 1. (Continued) International System (SI) Units**

PHYSICAL QUANTITY	NAME OF UNIT	UNIT SYMBOL	DEFINITION
SI Units Having Special Names			
Force	newton	$N = \text{kg}\cdot\text{m}/\text{s}^2$	That force which, when applied to a body having a mass of one kilogram, gives it an acceleration of one meter per second squared.
Work, Energy, Quantity of Heat	joule	$J = \text{N}\cdot\text{m}$	The work done when the point of application of a force of one newton is displaced through a distance of one meter in the direction of the force.
Electric Charge	coulomb	$C = \text{A}\cdot\text{s}$	The quantity of electricity transported in one second by a current of one ampere.
Electric Potential	volt	$V = \text{W}/\text{A}$	The difference of potential between two points of a conducting wire carrying a constant current of one ampere, when the power dissipated between these points is equal to one watt.
Electric Capacitance	farad	$F = C/V$	The capacitance of a capacitor between the plates of which there appears a difference of potential of one volt when it is charged by a quantity of electricity equal to one coulomb.
Electric Resistance	ohm	$\Omega = \text{V}/\text{A}$	The resistance between two points of a conductor when a constant difference of potential of one volt, applied between these two points, produces in this conductor a current of one ampere, this conductor not being the source of any electromotive force.
Magnetic Flux	weber	$\text{Wb} = \text{V s}$	The flux which, linking a circuit of one turn produces in it an electromotive force of one volt as it is reduced to zero at a uniform rate in one second.
Inductance	henry	$H = \text{V s}/\text{A}$	The inductance of a closed circuit in which an electromotive force of one volt is produced when the electric current in the circuit varies uniformly at the rate of one ampere per second.
Luminous Flux	lumen	$\text{lm} = \text{cd sr}$	The flux emitted within a unit solid angle of one steradian by a point source having a uniform intensity of one candela.
Illumination	lux	$\text{lx} = \text{lm}/\text{m}^2$	An illumination of one lumen per square meter.

**Table 2. International System (SI) Units with Complex Names**

PHYSICAL QUANTITY	SI UNIT	UNIT SYMBOL
SI Units Having Complex Names		
Area	square meter	$\text{m}^2$
Volume	cubic meter	$\text{m}^3$
Frequency	hertz <sup>a</sup>	Hz
Density (Mass Density)	kilogram per cubic meter	$\text{kg}/\text{m}^3$
Velocity	meter per second	$\text{m}/\text{s}$
Angular Velocity	radian per second	$\text{rad}/\text{s}$
Acceleration	meter per second squared	$\text{m}/\text{s}^2$
Angular Acceleration	radian per second squared	$\text{rad}/\text{s}^2$
Pressure	pascal <sup>b</sup>	Pa
Surface Tension	newton per meter	$\text{N}/\text{m}$
Dynamic Viscosity	newton second per meter squared	$\text{N s}/\text{m}^2$
Kinematic Viscosity	} meter squared per second	$\text{m}^2/\text{s}$
Diffusion Coefficient		
Thermal Conductivity	watt per meter degree Kelvin	$\text{W}/(\text{m } ^\circ\text{K})$
Electric Field Strength	volt per meter	$\text{V}/\text{m}$
Magnetic Flux Density	tesla <sup>c</sup>	T
Magnetic Field Strength	ampere per meter	$\text{A}/\text{m}$
Luminance	candela per square meter	$\text{cd}/\text{m}^2$

<sup>a</sup> Hz = cycle/second.<sup>b</sup> Pa = newton/meter<sup>2</sup>.<sup>c</sup> T = weber/meter<sup>2</sup>.

## Metric System

In the table of conversion factors that follows, the symbols of SI units, multiples and sub-multiples are given in parentheses in the right hand column.

Table 1. Metric Conversion Factors

Multiply	By	To Obtain
Length		
centimeter	0.03280840	foot
centimeter	0.3937008	inch
fathom	1.8288 <sup>a</sup>	meter (m)
foot	0.3048 <sup>a</sup>	meter (m)
foot	30.48 <sup>a</sup>	centimeter (cm)
foot	304.8 <sup>a</sup>	millimeter (mm)
inch	0.0254 <sup>a</sup>	meter (m)
inch	2.54 <sup>a</sup>	centimeter (cm)
inch	25.4 <sup>a</sup>	millimeter (mm)
kilometer	0.6213712	mile [U.S. statute]
meter	39.37008	inch
meter	0.5468066	fathom
meter	3.280840	foot
meter	0.1988388	rod
meter	1.093613	yard
meter	0.0006213712	mile [U. S. statute]
microinch	0.0254 <sup>a</sup>	micrometer [micron] ( $\mu\text{m}$ )
micrometer [micron]	39.37008	microinch
mile [U. S. statute]	1609.344 <sup>a</sup>	meter (m)
mile [U. S. statute]	1.609344 <sup>a</sup>	kilometer (km)
millimeter	0.003280840	foot
millimeter	0.03937008	inch
rod	5.0292 <sup>a</sup>	meter (m)
yard	0.9144 <sup>a</sup>	meter (m)
Area		
acre	4046.856	meter <sup>2</sup> (m <sup>2</sup> )
acre	0.4046856	hectare
centimeter <sup>2</sup>	0.1550003	inch <sup>2</sup>
centimeter <sup>2</sup>	0.001076391	foot <sup>2</sup>
foot <sup>2</sup>	0.09290304 <sup>a</sup>	meter <sup>2</sup> (m <sup>2</sup> )
foot <sup>2</sup>	929.0304 <sup>a</sup>	centimeter <sup>2</sup> (cm <sup>2</sup> )
foot <sup>2</sup>	92,903.04 <sup>a</sup>	millimeter <sup>2</sup> (mm <sup>2</sup> )
hectare	2.471054	acre
inch <sup>2</sup>	645.16 <sup>a</sup>	millimeter <sup>2</sup> (mm <sup>2</sup> )
inch <sup>2</sup>	6.4516 <sup>a</sup>	centimeter <sup>2</sup> (cm <sup>2</sup> )
inch <sup>2</sup>	0.00064516 <sup>a</sup>	meter <sup>2</sup> (m <sup>2</sup> )
meter <sup>2</sup>	1550.003	inch <sup>2</sup>
meter <sup>2</sup>	10.763910	foot <sup>2</sup>
meter <sup>2</sup>	1.195990	yard <sup>2</sup>
meter <sup>2</sup>	0.0002471054	acre

**Table 1. (Continued) Metric Conversion Factors**

Multiply	By	To Obtain
mile <sup>2</sup>	2.5900	kilometer <sup>2</sup>
millimeter <sup>2</sup>	0.00001076391	foot <sup>2</sup>
millimeter <sup>2</sup>	0.001550003	inch <sup>2</sup>
yard <sup>2</sup>	0.8361274	meter <sup>2</sup> (m <sup>2</sup> )
Volume (including Capacity)		
centimeter <sup>3</sup>	0.06102376	inch <sup>3</sup>
foot <sup>3</sup>	28.31685	liter
foot <sup>3</sup>	28.31685	liter
gallon [U.K. liquid]	0.004546092	meter <sup>3</sup> (m <sup>3</sup> )
gallon [U.K. liquid]	4.546092	liter
gallon [U. S. liquid]	0.003785412	meter <sup>3</sup> (m <sup>3</sup> )
gallon [U.S. liquid]	3.785412	liter
inch <sup>3</sup>	16,387.06	millimeter <sup>3</sup> (mm <sup>3</sup> )
inch <sup>3</sup>	16.38706	centimeter <sup>3</sup> (cm <sup>3</sup> )
inch <sup>3</sup>	0.00001638706	meter <sup>3</sup> (m <sup>3</sup> )
liter	0.001 <sup>a</sup>	meter <sup>3</sup> (m <sup>3</sup> )
liter	0.2199692	gallon [U. K. liquid]
liter	0.2641720	gallon [U. S. liquid]
liter	0.03531466	foot <sup>3</sup>
meter <sup>3</sup>	219.9692	gallon [U. K. liquid]
meter <sup>3</sup>	264.1720	gallon [U. S. liquid]
meter <sup>3</sup>	35.31466	foot <sup>3</sup>
meter <sup>3</sup>	1.307951	yard <sup>3</sup>
meter <sup>3</sup>	1000. <sup>a</sup>	liter
meter <sup>3</sup>	61,023.76	inch <sup>3</sup>
millimeter <sup>3</sup>	0.00006102376	inch <sup>3</sup>
quart[U.S. Liquid]	0.946	liter
quart[U.K. Liquid]	1.136	liter
yard <sup>3</sup>	0.7645549	meter <sup>3</sup> (m <sup>3</sup> )
Velocity, Acceleration, and Flow		
centimeter/second	1.968504	foot/minute
centimeter/second	0.03280840	foot/second
centimeter/minute	0.3937008	inch/minute
foot/hour	0.00008466667	meter/second (m/s)
foot/hour	0.00508 <sup>a</sup>	meter/minute
foot/hour	0.3048 <sup>a</sup>	meter/hour
foot/minute	0.508 <sup>a</sup>	centimeter/second
foot/minute	18.288 <sup>a</sup>	meter/hour
foot/minute	0.3048 <sup>a</sup>	meter/minute
foot/minute	0.00508 <sup>a</sup>	meter/second (m/s)
foot/second	30.48 <sup>a</sup>	centimeter/second
foot/second	18.288 <sup>a</sup>	meter/minute
foot/second	0.3048 <sup>a</sup>	meter/second (m/s)
foot/second <sup>2</sup>	0.3048 <sup>a</sup>	meter/second <sup>2</sup> (m/s <sup>2</sup> )
foot <sup>3</sup> /minute	28.31685	liter/minute

Table 1. (Continued) Metric Conversion Factors

Multiply	By	To Obtain
foot <sup>3</sup> /minute	0.0004719474	meter <sup>3</sup> /second (m <sup>3</sup> /s)
gallon [U. S. liquid]/min.	0.003785412	meter <sup>3</sup> /minute
gallon [U. S. liquid]/min.	0.00006309020	meter <sup>3</sup> /second (m <sup>3</sup> /s)
gallon [U. S. liquid]/min.	0.06309020	liter/second
gallon [U. S. liquid]/min.	3.785412	liter/minute
gallon [U. K. liquid]/min.	0.004546092	meter <sup>3</sup> /minute
gallon [U. K. liquid]/min.	0.00007576820	meter <sup>3</sup> /second (m <sup>3</sup> /s)
inch/minute	25.4 <sup>a</sup>	millimeter/minute
inch/minute	2.54 <sup>a</sup>	centimeter/minute
inch/minute	0.0254 <sup>a</sup>	meter/minute
inch/second <sup>2</sup>	0.0254 <sup>a</sup>	meter/second <sup>2</sup> (m/s <sup>2</sup> )
kilometer/hour	0.6213712	mile/hour [U. S. statute]
liter/minute	0.03531466	foot <sup>3</sup> /minute
liter/minute	0.2641720	gallon [U.S. liquid]/minute
liter/second	15.85032	gallon [U. S. liquid]/minute
mile/hour	1.609344 <sup>a</sup>	kilometer/hour
millimeter/minute	0.03937008	inch/minute
meter/second	11,811.02	foot/hour
meter/second	196.8504	foot/minute
meter/second	3.280840	foot/second
meter/second <sup>2</sup>	3.280840	foot/second <sup>2</sup>
meter/second <sup>2</sup>	39.37008	inch/second <sup>2</sup>
meter/minute	3.280840	foot/minute
meter/minute	0.05468067	foot/second
meter/minute	39.37008	inch/minute
meter/hour	3.280840	foot/hour
meter/hour	0.05468067	foot/minute
meter <sup>3</sup> /second	2118.880	foot <sup>3</sup> /minute
meter <sup>3</sup> /second	13,198.15	gallon [U. K. liquid]/minute
meter <sup>3</sup> /second	15,850.32	gallon [U. S. liquid]/minute
meter <sup>3</sup> /minute	219.9692	gallon [U. K. liquid]/minute
meter <sup>3</sup> /minute	264.1720	gallon [U. S. liquid]/minute
Mass and Density		
grain [ $\frac{1}{7000}$ lb avoirdupois]	0.06479891	gram (g)
gram	15.43236	grain
gram	0.001 <sup>a</sup>	kilogram (kg)
gram	0.03527397	ounce [avoirdupois]
gram	0.03215074	ounce [troy]
gram/centimeter <sup>3</sup>	0.03612730	pound/inch <sup>3</sup>
hundredweight [long]	50.80235	kilogram (kg)
hundredweight [short]	45.35924	kilogram (kg)
kilogram	1000. <sup>a</sup>	gram (g)
kilogram	35.27397	ounce [avoirdupois]
kilogram	32.15074	ounce [troy]

**Table 1. (Continued) Metric Conversion Factors**

Multiply	By	To Obtain
kilogram	2.204622	pound [avoirdupois]
kilogram	0.06852178	slug
kilogram	0.0009842064	ton [long]
kilogram	0.001102311	ton [short]
kilogram	0.001 <sup>a</sup>	ton [metric]
kilogram	0.001 <sup>a</sup>	tonne
kilogram	0.01968413	hundredweight [long]
kilogram	0.02204622	hundredweight [short]
kilogram/meter <sup>3</sup>	0.06242797	pound/foot <sup>3</sup>
kilogram/meter <sup>3</sup>	0.01002242	pound/gallon [U. K. liquid]
kilogram/meter <sup>3</sup>	0.008345406	pound/gallon [U. S. liquid]
ounce [avoirdupois]	28.34952	gram (g)
ounce [avoirdupois]	0.02834952	kilogram (kg)
ounce [troy]	31.10348	gram (g)
ounce [troy]	0.03110348	kilogram (kg)
pound [avoirdupois]	0.4535924	kilogram (kg)
pound/foot <sup>3</sup>	16.01846	kilogram/meter <sup>3</sup> (kg/m <sup>3</sup> )
pound/inch <sup>3</sup>	27.67990	gram/centimeter <sup>3</sup> (g/cm <sup>3</sup> )
pound/gal [U. S. liquid]	119.8264	kilogram/meter <sup>3</sup> (kg/m <sup>3</sup> )
pound/gal [U. K. liquid]	99.77633	kilogram/meter <sup>3</sup> (kg/m <sup>3</sup> )
slug	14.59390	kilogram (kg)
ton [long 2240 lb]	1016.047	kilogram (kg)
ton [short 2000 lb]	907.1847	kilogram (kg)
ton [metric]	1000. <sup>a</sup>	kilogram (kg)
ton [Metric]	0.9842	ton[long 2240 lb]
ton [Metric]	1.1023	ton[short 2000 lb]
tonne	1000. <sup>a</sup>	kilogram (kg)
<b>Force and Force/Length</b>		
dyne	0.00001 <sup>a</sup>	newton (N)
kilogram-force	9.806650 <sup>a</sup>	newton (N)
kilopond	9.806650 <sup>a</sup>	newton (N)
newton	0.1019716	kilogram-force
newton	0.1019716	kilopond
newton	0.2248089	pound-force
newton	100,000. <sup>a</sup>	dyne
newton	7.23301	poundal
newton	3.596942	ounce-force
newton/meter	0.005710148	pound/inch
newton/meter	0.06852178	pound/foot
ounce-force	0.2780139	newton (N)
pound-force	4.448222	newton (N)
poundal	0.1382550	newton (N)
pound/inch	175.1268	newton/meter (N/m)
pound/foot	14.59390	newton/meter (N/m)



**Table 1. (Continued) Metric Conversion Factors**

Multiply	By	To Obtain
Bending Moment or Torque		
dyne-centimeter	0.0000001 <sup>a</sup>	newton-meter (N · m)
kilogram-meter	9.806650 <sup>a</sup>	newton-meter (N · m)
ounce-inch	7.061552	newton-millimeter
ounce-inch	0.007061552	newton-meter (N · m)
newton-meter	0.7375621	pound-foot
newton-meter	10,000,000. <sup>a</sup>	dyne-centimeter
newton-meter	0.1019716	kilogram-meter
newton-meter	141.6119	ounce-inch
newton-millimeter	0.1416119	ounce-inch
pound-foot	1.355818	newton-meter (N · m)
Moment Of Inertia and Section Modulus		
moment of inertia [kg · m <sup>2</sup> ]	23.73036	pound-foot <sup>2</sup>
moment of inertia [kg · m <sup>2</sup> ]	3417.171	pound-inch <sup>2</sup>
moment of inertia [lb · ft <sup>2</sup> ]	0.04214011	kilogram-meter <sup>2</sup> (kg · m <sup>2</sup> )
moment of inertia [lb · inch <sup>2</sup> ]	0.0002926397	kilogram-meter <sup>2</sup> (kg · m <sup>2</sup> )
moment of section [foot <sup>4</sup> ]	0.008630975	meter <sup>4</sup> (m <sup>4</sup> )
moment of section [inch <sup>4</sup> ]	41.62314	centimeter <sup>4</sup>
moment of section [meter <sup>4</sup> ]	115.8618	foot <sup>4</sup>
moment of section [centimeter <sup>4</sup> ]	0.02402510	inch <sup>4</sup>
section modulus [foot <sup>3</sup> ]	0.02831685	meter <sup>3</sup> (m <sup>3</sup> )
section modulus [inch <sup>3</sup> ]	0.00001638706	meter <sup>3</sup> (m <sup>3</sup> )
section modulus [meter <sup>3</sup> ]	35.31466	foot <sup>3</sup>
section modulus [meter <sup>3</sup> ]	61,023.76	inch <sup>3</sup>
Momentum		
kilogram-meter/second	7.233011	pound-foot/second
kilogram-meter/second	86.79614	pound-inch/second
pound-foot/second	0.1382550	kilogram-meter/second (kg · m/s)
pound-inch/second	0.01152125	kilogram-meter/second (kg · m/s)
Pressure and Stress		
atmosphere [14.6959 lb/inch <sup>2</sup> ]	101,325.	pascal (Pa)
bar	100,000. <sup>a</sup>	pascal (Pa)
bar	14.50377	pound/inch <sup>2</sup>
bar	100,000. <sup>a</sup>	newton/meter <sup>2</sup> (N/m <sup>2</sup> )
hectobar	0.6474898	ton [long]/inch <sup>2</sup>
kilogram/centimeter <sup>2</sup>	14.22334	pound/inch <sup>2</sup>
kilogram/meter <sup>2</sup>	9.806650 <sup>a</sup>	newton/meter <sup>2</sup> (N/m <sup>2</sup> )
kilogram/meter <sup>2</sup>	9.806650 <sup>a</sup>	pascal (Pa)
kilogram/meter <sup>2</sup>	0.2048161	pound/foot <sup>2</sup>
kilonewton/meter <sup>2</sup>	0.1450377	pound/inch <sup>2</sup>
newton/centimeter <sup>2</sup>	1.450377	pound/inch <sup>2</sup>
newton/meter <sup>2</sup>	0.00001 <sup>a</sup>	bar
newton/meter <sup>2</sup>	1.0 <sup>a</sup>	pascal (Pa)

**Table 1. (Continued) Metric Conversion Factors**

Multiply	By	To Obtain
newton/meter <sup>2</sup>	0.0001450377	pound/inch <sup>2</sup>
newton/meter <sup>2</sup>	0.1019716	kilogram/meter <sup>2</sup>
newton/millimeter <sup>2</sup>	145.0377	pound/inch <sup>2</sup>
pascal	0.0000986923	atmosphere
pascal	0.00001 <sup>a</sup>	bar
pascal	0.1019716	kilogram/meter <sup>2</sup>
pascal	1.0 <sup>a</sup>	newton/meter <sup>2</sup> (N/m <sup>2</sup> )
pascal	0.02088543	pound/foot <sup>2</sup>
pascal	0.0001450377	pound/inch <sup>2</sup>
pound/foot <sup>2</sup>	4.882429	kilogram/meter <sup>2</sup>
pound/foot <sup>2</sup>	47.88026	pascal (Pa)
pound/inch <sup>2</sup>	0.06894757	bar
pound/inch <sup>2</sup>	0.07030697	kilogram/centimeter <sup>2</sup>
pound/inch <sup>2</sup>	0.6894757	newton/centimeter <sup>2</sup>
pound/inch <sup>2</sup>	6.894757	kilonewton/meter <sup>2</sup>
pound/inch <sup>2</sup>	6894.757	newton/meter <sup>2</sup> (N/m <sup>2</sup> )
pound/inch <sup>2</sup>	0.006894757	newton/millimeter <sup>2</sup> (N/mm <sup>2</sup> )
pound/inch <sup>2</sup>	6894.757	pascal (Pa)
ton [long]/inch <sup>2</sup>	1.544426	hectobar
<b>Energy and Work</b>		
Btu [International Table]	1055.056	joule (J)
Btu [mean]	1055.87	joule (J)
calorie [mean]	4.19002	joule (J)
foot-pound	1.355818	joule (J)
foot-poundal	0.04214011	joule (J)
joule	0.0009478170	Btu [International Table]
joule	0.0009470863	Btu [mean]
joule	0.2386623	calorie [mean]
joule	0.7375621	foot-pound
joule	23.73036	foot-poundal
joule	0.9998180	joule [International U. S.]
joule	0.9999830	joule [U. S. legal, 1948]
joule [International U. S.]	1.000182	joule (J)
joule [U. S. legal, 1948]	1.000017	joule (J)
joule	.0002777778	watt-hour
watt-hour	3600. <sup>a</sup>	joule (J)
<b>Power</b>		
Btu [International Table]/hour	0.2930711	watt (W)
foot-pound/hour	0.0003766161	watt (W)
foot-pound/minute	0.02259697	watt (W)
horsepower [550 ft-lb/s]	0.7456999	kilowatt (kW)
horsepower [550 ft-lb/s]	745.6999	watt (W)
horsepower [electric]	746. <sup>a</sup>	watt (W)
horsepower [metric]	735.499	watt (W)
horsepower [U. K.]	745.70	watt (W)
kilowatt	1.341022	horsepower [550 ft-lb/s]

**Table 1. (Continued) Metric Conversion Factors**

Multiply	By	To Obtain
watt	2655.224	foot-pound/hour
watt	44.25372	foot-pound/minute
watt	0.001341022	horsepower [550 ft-lb/s]
watt	0.001340483	horsepower [electric]
watt	0.001359621	horsepower [metric]
watt	0.001341022	horsepower [U. K.]
watt	3.412141	Btu [International Table]/hour
Viscosity		
centipoise	0.001 <sup>a</sup>	pascal-second (Pa · s)
centistoke	0.000001 <sup>a</sup>	meter <sup>2</sup> /second (m <sup>2</sup> /s)
meter <sup>2</sup> /second	1,000,000. <sup>a</sup>	centistoke
meter <sup>2</sup> /second	10,000. <sup>a</sup>	stoke
pascal-second	1000. <sup>a</sup>	centipoise
pascal-second	10. <sup>a</sup>	poise
poise	0.1 <sup>a</sup>	pascal-second (Pa · s)
stoke	0.0001 <sup>a</sup>	meter <sup>2</sup> /second (m <sup>2</sup> /s)
Temperature		
To Convert From	To	Use Formula
temperature Celsius, $t_C$	temperature Kelvin, $t_K$	$t_K = t_C + 273.15$
temperature Fahrenheit, $t_F$	temperature Kelvin, $t_K$	$t_K = (t_F + 459.67)/1.8$
temperature Celsius, $t_C$	temperature Fahrenheit, $t_F$	$t_F = 1.8 t_C + 32$
temperature Fahrenheit, $t_F$	temperature Celsius, $t_C$	$t_C = (t_F - 32)/1.8$
temperature Kelvin, $t_K$	temperature Celsius, $t_C$	$t_C = t_K - 273.15$
temperature Kelvin, $t_K$	temperature Fahrenheit, $t_F$	$t_F = 1.8 t_K - 459.67$
temperature Kelvin, $t_K$	temperature Rankine, $t_R$	$t_R = 9/5 t_K$
temperature Rankine, $t_R$	temperature Kelvin, $t_K$	$t_K = 5/9 t_R$

<sup>a</sup>The figure is exact.

Symbols of SI units, multiples and sub-multiples are given in parentheses in the right-hand column

### Metric and English Equivalents

**Use of Conversion Tables.**—On this and following pages, tables are given that permit conversion from English to metric units and vice versa over a wide range of values. Where the desired value cannot be obtained directly from these tables, a simple addition of two or more values taken directly from the table will suffice as shown in the following examples:

*Example 1:* Find the millimeter equivalent of 0.4476 inch.

.4	in	=	10.16000 mm
.04	in	=	1.01600 mm
.007	in	=	.17780 mm
<u>.0006</u>	in	=	<u>.01524 mm</u>
.4476	in	=	11.36904 mm

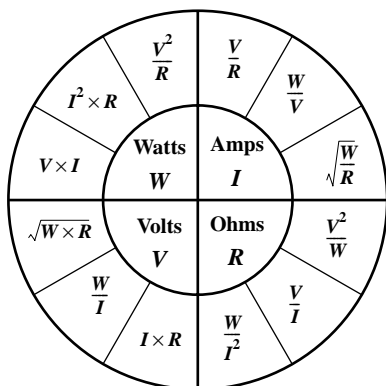
*Example 2:* Find the inch equivalent of 84.9 mm.

80.	mm	=	3.14961 in.
4.	mm	=	0.15748 in.
<u>0.9</u>	mm	=	<u>0.03543 in.</u>
84.9	mm	=	3.34252 in.

## Miscellaneous Conversion Factors (English Units)

Multiply	By	To Obtain
atmospheres	29.92	inches of mercury (32 deg. F.)
atmospheres	14.70	pounds/inch <sup>2</sup>
British thermal units/hour	12.96	foot-pounds/minute
circular mils	0.7854	square mils
feet of water (60 deg. F.)	0.8843	inches of mercury (60 deg. F.)
feet of water (60 deg. F.)	0.4331	pounds/inch <sup>2</sup>
feet/minute	0.01136	miles/hour
foot-pounds/second	0.07716	British thermal units/minute
gallons (U.S.) of water (60 deg. F.)	8.337	pounds of water (60 deg. F.)
gallons (U.S.)/second	8.021	feet <sup>3</sup> /minute
inches of mercury (32 deg. F.)	0.03342	atmospheres
inches of mercury (60 deg. F.)	1.131	feet of water (60 deg. F.)
inches of mercury (60 deg. F.)	0.4898	pounds/inch <sup>2</sup>
inches of water (60 deg. F.)	0.03609	pounds/inch <sup>2</sup>
knots (International)	1.151	miles (statute)/hour
miles/hour	88	feet/minute
miles (statute)/hour	0.8690	knots (International)
ounces (avoirdupois)	0.9115	ounces (troy)
ounces (troy)	1.097	ounces (avoirdupois)
ounces (troy)	0.06857	pounds (avoirdupois)
pounds (avoirdupois)	14.58	ounces (troy)
pounds of water (60 deg. F.)	0.01603	feet <sup>3</sup>
pounds of water (60 deg. F.)	0.1199	gallons (U.S.)
pounds/inch <sup>2</sup>	0.06805	atmospheres
pounds/inch <sup>2</sup>	2.309	feet of water (60 deg. F.)
pounds/inch <sup>2</sup>	2.042	inches of mercury (60 deg. F.)
pounds/inch <sup>2</sup>	27.71	inches of water (60 deg. F.)
square mils	1.273	circular mils

**Ohm's Law.**—The following figure represents basic electrical relationships. This chart has been formatted in such a way that each variable has been related to the other three variables. This figure is simply for reference.



*Key to variables:*  
 V = Voltage (Volts)  
 R = Resistance (Ohms)  
 I = Current (Amps)  
 W = Power (Watts)

Circular Model of Electrical Relations

**Binary Multiples.**—The International Electrotechnical Commission has assigned the following prefixes to represent exponential binary multiples. This avoids confusion with standard SI decimal prefixes when representing powers of 2, as in bits and bytes.

Symbol	Name	Binary Power	Symbol	Name	Binary Power
Ki	kibi	2 <sup>10</sup>	Ti	tebi	2 <sup>40</sup>
Mi	mebi	2 <sup>20</sup>	Pi	pebi	2 <sup>50</sup>
Gi	gibi	2 <sup>30</sup>	Ei	exbi	2 <sup>60</sup>

*Example 1:* 2 Ki = 2 × 2<sup>10</sup> = 2 × 1,024 = 2,048. This does *not* equal 2 K = 2 × 10<sup>3</sup> = 2,000.

*Example 2:* 1 mebibyte = 1 × 2<sup>20</sup> = 1,048,576 bytes. Again this does *not* equal 1 megabyte = 1 × 10<sup>6</sup> = 1,000,000 bytes, a value that is often confused with 1,048,576 bytes.

**Linear Measure**

- 1 kilometer = 0.6214 mile
- 1 meter = 39.37 inches = 3.2808 feet = 1.0936 yards
- 1 centimeter = 0.3937 inch
- 1 millimeter = 0.03937 inch
- 1 mile = 1.609 kilometers
- 1 yard = 0.9144 meter
- 1 foot = 0.3048 meter = 304.8 millimeters
- 1 inch = 2.54 centimeters = 25.4 millimeters

**Table 2. Inch to Millimeters and Millimeters to Inch Conversion Table**

Inches To Millimeters							
in.	mm	in.	mm	in.	mm	in.	mm
10	254.00000	1	25.40000	0.1	2.54000	.01	0.25400
20	508.00000	2	50.80000	0.2	5.08000	.02	0.50800
30	762.00000	3	76.20000	0.3	7.62000	.03	0.76200
40	1,016.00000	4	101.60000	0.4	10.16000	.04	1.01600
50	1,270.00000	5	127.00000	0.5	12.70000	.05	1.27000
60	1,524.00000	6	152.40000	0.6	15.24000	.06	1.52400
70	1,778.00000	7	177.80000	0.7	17.78000	.07	1.77800
80	2,032.00000	8	203.20000	0.8	20.32000	.08	2.03200
90	2,286.00000	9	228.60000	0.9	22.86000	.09	2.28600
100	2,540.00000	10	254.00000	1.0	25.40000	.10	2.54000
Millimeters To Inches							
mm	in.	mm	in.	mm	in.	mm	in.
100	3.93701	10	0.39370	1	0.03937	0.1	0.00394
200	7.87402	20	0.78740	2	0.07874	0.2	0.00787
300	11.81102	30	1.18110	3	0.11811	0.3	0.01181
400	15.74803	40	1.57480	4	0.15748	0.4	0.01575
500	19.68504	50	1.96850	5	0.19685	0.5	0.01969
600	23.62205	60	2.36220	6	0.23622	0.6	0.02362
700	27.55906	70	2.75591	7	0.27559	0.7	0.02756
800	31.49606	80	3.14961	8	0.31496	0.8	0.03150
900	35.43307	90	3.54331	9	0.35433	0.9	0.03543
1,000	39.37008	100	3.93701	10	0.39370	1.0	0.03937

For inches to centimeters, shift decimal point in mm column one place to left and read centimeters, thus:

40 in. = 1016 mm = 101.6 cm

For centimeters to inches, shift decimal point of centimeter value one place to right and enter mm column, thus:

70 cm = 700 mm = 27.55906 inches

**Decimals of an Inch to Millimeters**  
(Based on 1 inch = 25.4 millimeters, exactly)

Inches	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
	Millimeters									
0.000	...	0.0254	0.0508	0.0762	0.1016	0.1270	0.1524	0.1778	0.2032	0.2286
0.010	0.2540	0.2794	0.3048	0.3302	0.3556	0.3810	0.4064	0.4318	0.4572	0.4826
0.020	0.5080	0.5334	0.5588	0.5842	0.6096	0.6350	0.6604	0.6858	0.7112	0.7366
0.030	0.7620	0.7874	0.8128	0.8382	0.8636	0.8890	0.9144	0.9398	0.9652	0.9906
0.040	1.0160	1.0414	1.0668	1.0922	1.1176	1.1430	1.1684	1.1938	1.2192	1.2446
0.050	1.2700	1.2954	1.3208	1.3462	1.3716	1.3970	1.4224	1.4478	1.4732	1.4986
0.060	1.5240	1.5494	1.5748	1.6002	1.6256	1.6510	1.6764	1.7018	1.7272	1.7526
0.070	1.7780	1.8034	1.8288	1.8542	1.8796	1.9050	1.9304	1.9558	1.9812	2.0066
0.080	2.0320	2.0574	2.0828	2.1082	2.1336	2.1590	2.1844	2.2098	2.2352	2.2606
0.090	2.2860	2.3114	2.3368	2.3622	2.3876	2.4130	2.4384	2.4638	2.4892	2.5146
0.100	2.5400	2.5654	2.5908	2.6162	2.6416	2.6670	2.6924	2.7178	2.7432	2.7686
0.110	2.7940	2.8194	2.8448	2.8702	2.8956	2.9210	2.9464	2.9718	2.9972	3.0226
0.120	3.0480	3.0734	3.0988	3.1242	3.1496	3.1750	3.2004	3.2258	3.2512	3.2766
0.130	3.3020	3.3274	3.3528	3.3782	3.4036	3.4290	3.4544	3.4798	3.5052	3.5306
0.140	3.5560	3.5814	3.6068	3.6322	3.6576	3.6830	3.7084	3.7338	3.7592	3.7846
0.150	3.8100	3.8354	3.8608	3.8862	3.9116	3.9370	3.9624	3.9878	4.0132	4.0386
0.160	4.0640	4.0894	4.1148	4.1402	4.1656	4.1910	4.2164	4.2418	4.2672	4.2926
0.170	4.3180	4.3434	4.3688	4.3942	4.4196	4.4450	4.4704	4.4958	4.5212	4.5466
0.180	4.5720	4.5974	4.6228	4.6482	4.6736	4.6990	4.7244	4.7498	4.7752	4.8006
0.190	4.8260	4.8514	4.8768	4.9022	4.9276	4.9530	4.9784	5.0038	5.0292	5.0546
0.200	5.0800	5.1054	5.1308	5.1562	5.1816	5.2070	5.2324	5.2578	5.2832	5.3086
0.210	5.3340	5.3594	5.3848	5.4102	5.4356	5.4610	5.4864	5.5118	5.5372	5.5626
0.220	5.5880	5.6134	5.6388	5.6642	5.6896	5.7150	5.7404	5.7658	5.7912	5.8166
0.230	5.8420	5.8674	5.8928	5.9182	5.9436	5.9690	5.9944	6.0198	6.0452	6.0706
0.240	6.0960	6.1214	6.1468	6.1722	6.1976	6.2230	6.2484	6.2738	6.2992	6.3246
0.250	6.3500	6.3754	6.4008	6.4262	6.4516	6.4770	6.5024	6.5278	6.5532	6.5786
0.260	6.6040	6.6294	6.6548	6.6802	6.7056	6.7310	6.7564	6.7818	6.8072	6.8326
0.270	6.8580	6.8834	6.9088	6.9342	6.9596	6.9850	7.0104	7.0358	7.0612	7.0866
0.280	7.1120	7.1374	7.1628	7.1882	7.2136	7.2390	7.2644	7.2898	7.3152	7.3406
0.290	7.3660	7.3914	7.4168	7.4422	7.4676	7.4930	7.5184	7.5438	7.5692	7.5946
0.300	7.6200	7.6454	7.6708	7.6962	7.7216	7.7470	7.7724	7.7978	7.8232	7.8486
0.310	7.8740	7.8994	7.9248	7.9502	7.9756	8.0010	8.0264	8.0518	8.0772	8.1026
0.320	8.1280	8.1534	8.1788	8.2042	8.2296	8.2550	8.2804	8.3058	8.3312	8.3566
0.330	8.3820	8.4074	8.4328	8.4582	8.4836	8.5090	8.5344	8.5598	8.5852	8.6106
0.340	8.6360	8.6614	8.6868	8.7122	8.7376	8.7630	8.7884	8.8138	8.8392	8.8646
0.350	8.8900	8.9154	8.9408	8.9662	8.9916	9.0170	9.0424	9.0678	9.0932	9.1186
0.360	9.1440	9.1694	9.1948	9.2202	9.2456	9.2710	9.2964	9.3218	9.3472	9.3726
0.370	9.3980	9.4234	9.4488	9.4742	9.4996	9.5250	9.5504	9.5758	9.6012	9.6266
0.380	9.6520	9.6774	9.7028	9.7282	9.7536	9.7790	9.8044	9.8298	9.8552	9.8806
0.390	9.9060	9.9314	9.9568	9.9822	10.0076	10.0330	10.0584	10.0838	10.1092	10.1346
0.400	10.1600	10.1854	10.2108	10.2362	10.2616	10.2870	10.3124	10.3378	10.3632	10.3886
0.410	10.4140	10.4394	10.4648	10.4902	10.5156	10.5410	10.5664	10.5918	10.6172	10.6426
0.420	10.6680	10.6934	10.7188	10.7442	10.7696	10.7950	10.8204	10.8458	10.8712	10.8966
0.430	10.9220	10.9474	10.9728	10.9982	11.0236	11.0490	11.0744	11.0998	11.1252	11.1506
0.440	11.1760	11.2014	11.2268	11.2522	11.2776	11.3030	11.3284	11.3538	11.3792	11.4046
0.450	11.4300	11.4554	11.4808	11.5062	11.5316	11.5570	11.5824	11.6078	11.6332	11.6586
0.460	11.6840	11.7094	11.7348	11.7602	11.7856	11.8110	11.8364	11.8618	11.8872	11.9126
0.470	11.9380	11.9634	11.9888	12.0142	12.0396	12.0650	12.0904	12.1158	12.1412	12.1666
0.480	12.1920	12.2174	12.2428	12.2682	12.2936	12.3190	12.3444	12.3698	12.3952	12.4206
0.490	12.4460	12.4714	12.4968	12.5222	12.5476	12.5730	12.5984	12.6238	12.6492	12.6746
0.500	12.7000	12.7254	12.7508	12.7762	12.8016	12.8270	12.8524	12.8778	12.9032	12.9286

**Decimals of an Inch to Millimeters (Continued)**  
(Based on 1 inch = 25.4 millimeters, exactly)

Inches	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
	Millimeters									
0.510	12.9540	12.9794	13.0048	13.0302	13.0556	13.0810	13.1064	13.1318	13.1572	13.1826
0.520	13.2080	13.2334	13.2588	13.2842	13.3096	13.3350	13.3604	13.3858	13.4112	13.4366
0.530	13.4620	13.4874	13.5128	13.5382	13.5636	13.5890	13.6144	13.6398	13.6652	13.6906
0.540	13.7160	13.7414	13.7668	13.7922	13.8176	13.8430	13.8684	13.8938	13.9192	13.9446
0.550	13.9700	13.9954	14.0208	14.0462	14.0716	14.0970	14.1224	14.1478	14.1732	14.1986
0.560	14.2240	14.2494	14.2748	14.3002	14.3256	14.3510	14.3764	14.4018	14.4272	14.4526
0.570	14.4780	14.5034	14.5288	14.5542	14.5796	14.6050	14.6304	14.6558	14.6812	14.7066
0.580	14.7320	14.7574	14.7828	14.8082	14.8336	14.8590	14.8844	14.9098	14.9352	14.9606
0.590	14.9860	15.0114	15.0368	15.0622	15.0876	15.1130	15.1384	15.1638	15.1892	15.2146
0.600	15.2400	15.2654	15.2908	15.3162	15.3416	15.3670	15.3924	15.4178	15.4432	15.4686
0.610	15.4940	15.5194	15.5448	15.5702	15.5956	15.6210	15.6464	15.6718	15.6972	15.7226
0.620	15.7480	15.7734	15.7988	15.8242	15.8496	15.8750	15.9004	15.9258	15.9512	15.9766
0.630	16.0020	16.0274	16.0528	16.0782	16.1036	16.1290	16.1544	16.1798	16.2052	16.2306
0.640	16.2560	16.2814	16.3068	16.3322	16.3576	16.3830	16.4084	16.4338	16.4592	16.4846
0.650	16.5100	16.5354	16.5608	16.5862	16.6116	16.6370	16.6624	16.6878	16.7132	16.7386
0.660	16.7640	16.7894	16.8148	16.8402	16.8656	16.8910	16.9164	16.9418	16.9672	16.9926
0.670	17.0180	17.0434	17.0688	17.0942	17.1196	17.1450	17.1704	17.1958	17.2212	17.2466
0.680	17.2720	17.2974	17.3228	17.3482	17.3736	17.3990	17.4244	17.4498	17.4752	17.5006
0.690	17.5260	17.5514	17.5768	17.6022	17.6276	17.6530	17.6784	17.7038	17.7292	17.7546
0.700	17.7800	17.8054	17.8308	17.8562	17.8816	17.9070	17.9324	17.9578	17.9832	18.0086
0.710	18.0340	18.0594	18.0848	18.1102	18.1356	18.1610	18.1864	18.2118	18.2372	18.2626
0.720	18.2880	18.3134	18.3388	18.3642	18.3896	18.4150	18.4404	18.4658	18.4912	18.5166
0.730	18.5420	18.5674	18.5928	18.6182	18.6436	18.6690	18.6944	18.7198	18.7452	18.7706
0.740	18.7960	18.8214	18.8468	18.8722	18.8976	18.9230	18.9484	18.9738	18.9992	19.0246
0.750	19.0500	19.0754	19.1008	19.1262	19.1516	19.1770	19.2024	19.2278	19.2532	19.2786
0.760	19.3040	19.3294	19.3548	19.3802	19.4056	19.4310	19.4564	19.4818	19.5072	19.5326
0.770	19.5580	19.5834	19.6088	19.6342	19.6596	19.6850	19.7104	19.7358	19.7612	19.7866
0.780	19.8120	19.8374	19.8628	19.8882	19.9136	19.9390	19.9644	19.9898	20.0152	20.0406
0.790	20.0660	20.0914	20.1168	20.1422	20.1676	20.1930	20.2184	20.2438	20.2692	20.2946
0.800	20.3200	20.3454	20.3708	20.3962	20.4216	20.4470	20.4724	20.4978	20.5232	20.5486
0.810	20.5740	20.5994	20.6248	20.6502	20.6756	20.7010	20.7264	20.7518	20.7772	20.8026
0.820	20.8280	20.8534	20.8788	20.9042	20.9296	20.9550	20.9804	21.0058	21.0312	21.0566
0.830	21.0820	21.1074	21.1328	21.1582	21.1836	21.2090	21.2344	21.2598	21.2852	21.3106
0.840	21.3360	21.3614	21.3868	21.4122	21.4376	21.4630	21.4884	21.5138	21.5392	21.5646
0.850	21.5900	21.6154	21.6408	21.6662	21.6916	21.7170	21.7424	21.7678	21.7932	21.8186
0.860	21.8440	21.8694	21.8948	21.9202	21.9456	21.9710	21.9964	22.0218	22.0472	22.0726
0.870	22.0980	22.1234	22.1488	22.1742	22.1996	22.2250	22.2504	22.2758	22.3012	22.3266
0.880	22.3520	22.3774	22.4028	22.4282	22.4536	22.4790	22.5044	22.5298	22.5552	22.5806
0.890	22.6060	22.6314	22.6568	22.6822	22.7076	22.7330	22.7584	22.7838	22.8092	22.8346
0.900	22.8600	22.8854	22.9108	22.9362	22.9616	22.9870	23.0124	23.0378	23.0632	23.0886
0.910	23.1140	23.1394	23.1648	23.1902	23.2156	23.2410	23.2664	23.2918	23.3172	23.3426
0.920	23.3680	23.3934	23.4188	23.4442	23.4696	23.4950	23.5204	23.5458	23.5712	23.5966
0.930	23.6220	23.6474	23.6728	23.6982	23.7236	23.7490	23.7744	23.7998	23.8252	23.8506
0.940	23.8760	23.9014	23.9268	23.9522	23.9776	24.0030	24.0284	24.0538	24.0792	24.1046
0.950	24.1300	24.1554	24.1808	24.2062	24.2316	24.2570	24.2824	24.3078	24.3332	24.3586
0.960	24.3840	24.4094	24.4348	24.4602	24.4856	24.5110	24.5364	24.5618	24.5872	24.6126
0.970	24.6380	24.6634	24.6888	24.7142	24.7396	24.7650	24.7904	24.8158	24.8412	24.8666
0.980	24.8920	24.9174	24.9428	24.9682	24.9936	25.0190	25.0444	25.0698	25.0952	25.1206
0.990	25.1460	25.1714	25.1968	25.2222	25.2476	25.2730	25.2984	25.3238	25.3492	25.3746
1.000	25.4000	...	...	...	...	...	...	...	...	...

Use previous table to obtain whole inch equivalents to add to decimal equivalents above. All values given in this table are exact; figures to the right of the last place figures are all zeros.

**Millimeters to Inches**  
(Based on 1 inch = 25.4 millimeters, exactly)

Millimeters	0	1	2	3	4	5	6	7	8	9
	Inches									
0	...	0.03937	0.07874	0.11811	0.15748	0.19685	0.23622	0.27559	0.31496	0.35433
10	0.39370	0.43307	0.47244	0.51181	0.55118	0.59055	0.62992	0.66929	0.70866	0.74803
20	0.78740	0.82677	0.86614	0.90551	0.94488	0.98425	1.02362	1.06299	1.10236	1.14173
30	1.18110	1.22047	1.25984	1.29921	1.33858	1.37795	1.41732	1.45669	1.49606	1.53543
40	1.57480	1.61417	1.65354	1.69291	1.73228	1.77165	1.81102	1.85039	1.88976	1.92913
50	1.96850	2.00787	2.04724	2.08661	2.12598	2.16535	2.20472	2.24409	2.28346	2.32283
60	2.36220	2.40157	2.44094	2.48031	2.51969	2.55906	2.59843	2.63780	2.67717	2.71654
70	2.75591	2.79528	2.83465	2.87402	2.91339	2.95276	2.99213	3.03150	3.07087	3.11024
80	3.14961	3.18898	3.22835	3.26772	3.30709	3.34646	3.38583	3.42520	3.46457	3.50394
90	3.54331	3.58268	3.62205	3.66142	3.70079	3.74016	3.77953	3.81890	3.85827	3.89764
100	3.93701	3.97638	4.01575	4.05512	4.09449	4.13386	4.17323	4.21260	4.25197	4.29134
110	4.33071	4.37008	4.40945	4.44882	4.48819	4.52756	4.56693	4.60630	4.64567	4.68504
120	4.72441	4.76378	4.80315	4.84252	4.88189	4.92126	4.96063	5.00000	5.03937	5.07874
130	5.11811	5.15748	5.19685	5.23622	5.27559	5.31496	5.35433	5.39370	5.43307	5.47244
140	5.51181	5.55118	5.59055	5.62992	5.66929	5.70866	5.74803	5.78740	5.82677	5.86614
150	5.90551	5.94488	5.98425	6.02362	6.06299	6.10236	6.14173	6.18110	6.22047	6.25984
160	6.29921	6.33858	6.37795	6.41732	6.45669	6.49606	6.53543	6.57480	6.61417	6.65354
170	6.69291	6.73228	6.77165	6.81102	6.85039	6.88976	6.92913	6.96850	7.00787	7.04724
180	7.08661	7.12598	7.16535	7.20472	7.24409	7.28346	7.32283	7.36220	7.40157	7.44094
190	7.48031	7.51969	7.55906	7.59843	7.63780	7.67717	7.71654	7.75591	7.79528	7.83465
200	7.87402	7.91339	7.95276	7.99213	8.03150	8.07087	8.11024	8.14961	8.18898	8.22835
210	8.26772	8.30709	8.34646	8.38583	8.42520	8.46457	8.50394	8.54331	8.58268	8.62205
220	8.66142	8.70079	8.74016	8.77953	8.81890	8.85827	8.89764	8.93701	8.97638	9.01575
230	9.05512	9.09449	9.13386	9.17323	9.21260	9.25197	9.29134	9.33071	9.37008	9.40945
240	9.44882	9.48819	9.52756	9.56693	9.60630	9.64567	9.68504	9.72441	9.76378	9.80315
250	9.84252	9.88189	9.92126	9.96063	10.00000	10.0394	10.0787	10.1181	10.1575	10.1969
260	10.2362	10.2756	10.3150	10.3543	10.3937	10.4331	10.4724	10.5118	10.5512	10.5906
270	10.6299	10.6693	10.7087	10.7480	10.7874	10.8268	10.8661	10.9055	10.9449	10.9843
280	11.0236	11.0630	11.1024	11.1417	11.1811	11.2205	11.2598	11.2992	11.3386	11.3780
290	11.4173	11.4567	11.4961	11.5354	11.5748	11.6142	11.6535	11.6929	11.7323	11.7717
300	11.8110	11.8504	11.8898	11.9291	11.9685	12.0079	12.0472	12.0866	12.1260	12.1654
310	12.2047	12.2441	12.2835	12.3228	12.3622	12.4016	12.4409	12.4803	12.5197	12.5591
320	12.5984	12.6378	12.6772	12.7165	12.7559	12.7953	12.8346	12.8740	12.9134	12.9528
330	12.9921	13.0315	13.0709	13.1102	13.1496	13.1890	13.2283	13.2677	13.3071	13.3465
340	13.3858	13.4252	13.4646	13.5039	13.5433	13.5827	13.6220	13.6614	13.7008	13.7402
350	13.7795	13.8189	13.8583	13.8976	13.9370	13.9764	14.0157	14.0551	14.0945	14.1339
360	14.1732	14.2126	14.2520	14.2913	14.3307	14.3701	14.4094	14.4488	14.4882	14.5276
370	14.5669	14.6063	14.6457	14.6850	14.7244	14.7638	14.8031	14.8425	14.8819	14.9213
380	14.9606	15.0000	15.0394	15.0787	15.1181	15.1575	15.1969	15.2362	15.2756	15.3150
390	15.3543	15.3937	15.4331	15.4724	15.5118	15.5512	15.5906	15.6299	15.6693	15.7087
400	15.7480	15.7874	15.8268	15.8661	15.9055	15.9449	15.9843	16.0236	16.0630	16.1024
410	16.1417	16.1811	16.2205	16.2598	16.2992	16.3386	16.3780	16.4173	16.4567	16.4961
420	16.5354	16.5748	16.6142	16.6535	16.6929	16.7323	16.7717	16.8110	16.8504	16.8898
430	16.9291	16.9685	17.0079	17.0472	17.0866	17.1260	17.1654	17.2047	17.2441	17.2835
440	17.3228	17.3622	17.4016	17.4409	17.4803	17.5197	17.5591	17.5984	17.6378	17.6772
450	17.7165	17.7559	17.7953	17.8346	17.8740	17.9134	17.9528	17.9921	18.0315	18.0709
460	18.1102	18.1496	18.1890	18.2283	18.2677	18.3071	18.3465	18.3858	18.4252	18.4646
470	18.5039	18.5433	18.5827	18.6220	18.6614	18.7008	18.7402	18.7795	18.8189	18.8583
480	18.8976	18.9370	18.9764	19.0157	19.0551	19.0945	19.1339	19.1732	19.2126	19.2520
490	19.2913	19.3307	19.3701	19.4094	19.4488	19.4882	19.5276	19.5669	19.6063	19.6457





**Fractional Inch — Millimeter and Foot — Millimeter Conversion Tables**  
**(Based on 1 inch = 25.4 millimeters, exactly)**

Fractional Inch to Millimeters							
in.	mm	in.	mm	in.	mm	in.	mm
$\frac{1}{64}$	0.397	$\frac{17}{64}$	6.747	$\frac{33}{64}$	13.097	$\frac{49}{64}$	19.447
$\frac{1}{32}$	0.794	$\frac{9}{32}$	7.144	$\frac{17}{32}$	13.494	$\frac{25}{32}$	19.844
$\frac{3}{64}$	1.191	$\frac{19}{64}$	7.541	$\frac{35}{64}$	13.891	$\frac{51}{64}$	20.241
$\frac{1}{16}$	1.588	$\frac{5}{16}$	7.938	$\frac{9}{16}$	14.288	$\frac{13}{16}$	20.638
$\frac{5}{64}$	1.984	$\frac{21}{64}$	8.334	$\frac{37}{64}$	14.684	$\frac{53}{64}$	21.034
$\frac{3}{32}$	2.381	$\frac{11}{32}$	8.731	$\frac{19}{32}$	15.081	$\frac{27}{32}$	21.431
$\frac{7}{64}$	2.778	$\frac{23}{64}$	9.128	$\frac{39}{64}$	15.478	$\frac{55}{64}$	21.828
$\frac{1}{8}$	3.175	$\frac{3}{8}$	9.525	$\frac{5}{8}$	15.875	$\frac{7}{8}$	22.225
$\frac{9}{64}$	3.572	$\frac{25}{64}$	9.922	$\frac{41}{64}$	16.272	$\frac{57}{64}$	22.622
$\frac{5}{32}$	3.969	$\frac{13}{32}$	10.319	$\frac{21}{32}$	16.669	$\frac{29}{32}$	23.019
$\frac{11}{64}$	4.366	$\frac{27}{64}$	10.716	$\frac{43}{64}$	17.066	$\frac{59}{64}$	23.416
$\frac{3}{16}$	4.762	$\frac{7}{16}$	11.112	$\frac{11}{16}$	17.462	$\frac{15}{16}$	23.812
$\frac{13}{64}$	5.159	$\frac{29}{64}$	11.509	$\frac{45}{64}$	17.859	$\frac{61}{64}$	24.209
$\frac{7}{32}$	5.556	$\frac{15}{32}$	11.906	$\frac{23}{32}$	18.256	$\frac{31}{32}$	24.606
$\frac{15}{64}$	5.953	$\frac{31}{64}$	12.303	$\frac{47}{64}$	18.653	$\frac{63}{64}$	25.003
$\frac{1}{4}$	6.350	$\frac{1}{2}$	12.700	$\frac{3}{4}$	19.050	1	25.400

Inches to Millimeters							
in.	mm	in.	mm	in.	mm	in.	mm
1	25.4	3	76.2	5	127.0	7	177.8
2	50.8	4	101.6	6	152.4	8	203.2
9	228.6	10	254.0	11	279.4	12	304.8

Feet to Millimeters							
ft	mm	ft	mm	ft	mm	ft	mm
100	30,480	10	3,048	1	304.8	0.1	30.48
200	60,960	20	6,096	2	609.6	0.2	60.96
300	91,440	30	9,144	3	914.4	0.3	91.44
400	121,920	40	12,192	4	1,219.2	0.4	121.92
500	152,400	50	15,240	5	1,524.0	0.5	152.400
600	182,880	60	18,288	6	1,828.8	0.6	182.88
700	213,360	70	21,336	7	2,133.6	0.7	213.36
800	243,840	80	24,384	8	2,438.4	0.8	243.84
900	274,320	90	27,432	9	2,743.2	0.9	274.32
1,000	304,800	100	30,480	10	3,048.0	1.0	304.80
						0.10	30.480

*Example 1:* Find millimeter equivalent of 293 feet,  $5\frac{47}{64}$  inches.

200 ft	=	60,960.	mm
90 ft	=	27,432.	mm
3 ft	=	914.4	mm
5 in.	=	127.0	mm
$\frac{47}{64}$ in.	=	18.653	mm
<hr/>			
293 ft $5\frac{47}{64}$ in.	=	89,452.053	mm

*Example 2:* Find millimeter equivalent of 71.86 feet.

70.	ft	=	21,336.	mm
1.	ft	=	304.8	mm
.80	ft	=	243.84	mm
.06	ft	=	18.288	mm
<hr/>				
71.86	ft	=	21,902.928	mm

**Microinches to Micrometers (microns)**  
**(Based on 1 microinch = 0.0254 micrometers, exactly)**

Micro-inches	0	1	2	3	4	5	6	7	8	9
	Micrometers (microns)									
0	...	0.025	0.051	0.076	0.102	0.127	0.152	0.178	0.203	0.229
10	0.254	0.279	0.305	0.330	0.356	0.381	0.406	0.432	0.457	0.483
20	0.508	0.533	0.559	0.584	0.610	0.635	0.660	0.686	0.711	0.737
30	0.762	0.787	0.813	0.838	0.864	0.889	0.914	0.940	0.965	0.991
40	1.016	1.041	1.067	1.092	1.118	1.143	1.168	1.194	1.219	1.245
50	1.270	1.295	1.321	1.346	1.372	1.397	1.422	1.448	1.473	1.499
60	1.524	1.549	1.575	1.600	1.626	1.651	1.676	1.702	1.727	1.753
70	1.778	1.803	1.829	1.854	1.880	1.905	1.930	1.956	1.981	2.007
80	2.032	2.057	2.083	2.108	2.134	2.159	2.184	2.210	2.235	2.261
90	2.286	2.311	2.337	2.362	2.388	2.413	2.438	2.464	2.489	2.515
100	2.540	2.565	2.591	2.616	2.642	2.667	2.692	2.718	2.743	2.769
110	2.794	2.819	2.845	2.870	2.896	2.921	2.946	2.972	2.997	3.023
120	3.048	3.073	3.099	3.124	3.150	3.175	3.200	3.226	3.251	3.277
130	3.302	3.327	3.353	3.378	3.404	3.429	3.454	3.480	3.505	3.531
140	3.556	3.581	3.607	3.632	3.658	3.683	3.708	3.734	3.759	3.785
150	3.810	3.835	3.861	3.886	3.912	3.937	3.962	3.988	4.013	4.039
160	4.064	4.089	4.115	4.140	4.166	4.191	4.216	4.242	4.267	4.293
170	4.318	4.343	4.369	4.394	4.420	4.445	4.470	4.496	4.521	4.547
180	4.572	4.597	4.623	4.648	4.674	4.699	4.724	4.750	4.775	4.801
190	4.826	4.851	4.877	4.902	4.928	4.953	4.978	5.004	5.029	5.055
200	5.080	5.105	5.131	5.156	5.182	5.207	5.232	5.258	5.283	5.309
210	5.334	5.359	5.385	5.410	5.436	5.461	5.486	5.512	5.537	5.563
220	5.588	5.613	5.639	5.664	5.690	5.715	5.740	5.766	5.791	5.817
230	5.842	5.867	5.893	5.918	5.944	5.969	5.994	6.020	6.045	6.071
240	6.096	6.121	6.147	6.172	6.198	6.223	6.248	6.274	6.299	6.325
250	6.350	6.375	6.401	6.426	6.452	6.477	6.502	6.528	6.553	6.579
260	6.604	6.629	6.655	6.680	6.706	6.731	6.756	6.782	6.807	6.833
270	6.858	6.883	6.909	6.934	6.960	6.985	7.010	7.036	7.061	7.087
280	7.112	7.137	7.163	7.188	7.214	7.239	7.264	7.290	7.315	7.341
290	7.366	7.391	7.417	7.442	7.468	7.493	7.518	7.544	7.569	7.595

The following short table permits conversion of microinches to micrometers for ranges higher than in the main table given above. Appropriate quantities chosen from both tables are simply added to obtain the higher converted value:

$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$
300	7.620	900	22.860	1500	38.100	2100	53.340	2700	68.580
600	15.240	1200	30.480	1800	45.720	2400	60.960	3000	76.200
<i>Example:</i> Convert 1375 $\mu\text{in.}$ to $\mu\text{m}$ :									
		From above table:	1200 $\mu\text{in.}$	=		30.480 $\mu\text{m}$			
		From main table:	175 $\mu\text{in.}$	=		4.445 $\mu\text{m}$			
			1375 $\mu\text{in.}$	=		34.925 $\mu\text{m}$			

**Micrometers (microns) to Microinches**  
**(Based on 1 microinch = 0.0254 micrometers, exactly)**

Micrometers Microns	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
	Microinches									
0	...	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.1	3.5
0.10	3.9	4.3	4.7	5.1	5.5	5.9	6.3	6.7	7.1	7.5
0.20	7.9	8.3	8.7	9.1	9.4	9.8	10.2	10.6	11.0	11.4
0.30	11.8	12.2	12.6	13.0	13.4	13.8	14.2	14.6	15.0	15.4
0.40	15.7	16.1	16.5	16.9	17.3	17.7	18.1	18.5	18.9	19.3
0.50	19.7	20.1	20.5	20.9	21.3	21.7	22.0	22.4	22.8	23.2
0.60	23.6	24.0	24.4	24.8	25.2	25.6	26.0	26.4	26.8	27.2
0.70	27.6	28.0	28.3	28.7	29.1	29.5	29.9	30.3	30.7	31.1
0.80	31.5	31.9	32.3	32.7	33.1	33.5	33.9	34.3	34.6	35.0
0.90	35.4	35.8	36.2	36.6	37.0	37.4	37.8	38.2	38.6	39.0
1.00	39.4	39.8	40.2	40.6	40.9	41.3	41.7	42.1	42.5	42.9
1.10	43.3	43.7	44.1	44.5	44.9	45.3	45.7	46.1	46.5	46.9
1.20	47.2	47.6	48.0	48.4	48.8	49.2	49.6	50.0	50.4	50.8
1.30	51.2	51.6	52.0	52.4	52.8	53.1	53.5	53.9	54.3	54.7
1.40	55.1	55.5	55.9	56.3	56.7	57.1	57.5	57.9	58.3	58.7
1.50	59.1	59.4	59.8	60.2	60.6	61.0	61.4	61.8	62.2	62.6
1.60	63.0	63.4	63.8	64.2	64.6	65.0	65.4	65.7	66.1	66.5
1.70	66.9	67.3	67.7	68.1	68.5	68.9	69.3	69.7	70.1	70.5
1.80	70.9	71.3	71.7	72.0	72.4	72.8	73.2	73.6	74.0	74.4
1.90	74.8	75.2	75.6	76.0	76.4	76.8	7.2	7.6	78.0	78.3
2.00	78.7	79.1	79.5	79.9	80.3	80.7	81.1	81.5	81.9	82.3
2.10	82.7	83.1	83.5	83.9	84.3	84.6	85.0	85.4	85.8	86.2
2.20	86.6	87.0	87.4	87.8	88.2	88.6	89.0	89.4	89.8	90.2
2.30	90.6	90.9	91.3	91.7	92.1	92.5	92.9	93.3	93.7	94.1
2.40	94.5	94.9	95.3	95.7	96.1	96.5	96.9	97.2	97.6	98.0
2.50	98.4	98.8	99.2	99.6	100.0	100.4	100.8	101.2	101.6	102.0
2.60	102.4	102.8	103.1	103.5	103.9	104.3	104.7	105.1	105.5	105.9
2.70	106.3	106.7	107.1	107.5	107.9	108.3	108.7	109.1	109.4	109.8
2.80	110.2	110.6	111.0	111.4	111.8	112.2	112.6	113.0	113.4	113.8
2.90	114.2	114.6	115.0	115.4	115.7	116.1	116.5	116.9	117.3	117.7
3.00	118.1	118.5	118.9	119.3	119.7	120.1	120.5	120.9	121.3	121.7
3.10	122.0	122.4	122.8	123.2	123.6	124.0	124.4	124.8	125.2	125.6
3.20	126.0	126.4	126.8	127.2	127.6	128.0	128.3	128.7	129.1	129.5
3.30	129.9	130.3	130.7	131.1	131.5	131.9	132.3	132.7	133.1	133.5
3.40	133.9	134.3	134.6	135.0	135.4	135.8	136.2	136.6	137.0	137.4
3.50	137.8	138.2	138.6	139.0	139.4	139.8	140.2	140.6	140.9	141.3
3.60	141.7	142.1	142.5	142.9	143.3	143.7	144.1	144.5	144.9	145.3
3.70	145.7	146.1	146.5	146.9	147.2	147.6	148.0	148.4	148.8	149.2
3.80	149.6	150.0	150.4	150.8	151.2	151.6	152.0	152.4	152.8	153.1
3.90	153.5	153.9	154.3	154.7	155.1	155.5	155.9	156.3	156.7	157.1
4.00	157.5	157.9	158.3	158.7	159.1	159.4	159.8	160.2	160.6	161.0
4.10	161.4	161.8	162.2	162.6	163.0	163.4	163.8	164.2	164.6	165.0
4.20	165.4	165.7	166.1	166.5	166.9	167.3	167.7	168.1	168.5	168.9
4.30	169.3	169.7	170.1	170.5	170.9	171.3	171.7	172.0	172.4	172.8
4.40	173.2	173.6	174.0	174.4	174.8	175.2	175.6	176.0	176.4	176.8
4.50	177.2	177.6	178.0	178.3	178.7	179.1	179.5	179.9	180.3	180.7
4.60	181.1	181.5	181.9	182.3	182.7	183.1	183.5	183.9	184.3	184.6
4.70	185.0	185.4	185.8	186.2	186.6	187.0	187.4	187.8	188.2	188.6
4.80	189.0	189.4	189.8	190.2	190.6	190.9	191.3	191.7	192.1	192.5
4.90	192.9	193.3	193.7	194.1	194.5	194.9	195.3	195.7	196.1	196.5
5.00	196.9	197.2	197.6	198.0	198.4	198.8	199.2	199.6	200.0	200.4

The table given below can be used with the preceding main table to obtain higher converted values, simply by adding appropriate quantities chosen from each table:

$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$	$\mu\text{m}$	$\mu\text{in.}$
10	393.7	20	787.4	30	1,181.1	40	1,574.8	50	1,968.5
15	590.6	25	984.3	35	1,378.0	45	1,771.7	55	2,165.4
<i>Example: Convert 23.55 <math>\mu\text{m}</math> to <math>\mu\text{in.}</math>:</i>									
		From above table:		20.00 $\mu\text{m}$		=		787.4 $\mu\text{in.}$	
		From main table:		3.55 $\mu\text{m}$		=		139.8 $\mu\text{in.}$	
				23.55 $\mu\text{m}$		=		927.2 $\mu\text{in.}$	

**Foot — Meter and Mile — Kilometer Conversion Tables**  
(Based on 1 foot = 0.3048 meter, exactly)

Feet to Meters (1 ft = 0.3048 m, exactly)									
feet	meters	feet	meters	feet	meters	feet	meters	feet	meters
100	30.480	10	3.048	1	0.305	0.1	0.030	0.01	0.003
200	60.960	20	6.096	2	0.610	0.2	0.061	0.02	0.006
300	91.440	30	9.144	3	0.914	0.3	0.091	0.03	0.009
400	121.920	40	12.192	4	1.219	0.4	0.122	0.04	0.012
500	152.400	50	15.240	5	1.524	0.5	0.152	0.05	0.015
600	182.880	60	18.288	6	1.829	0.6	0.183	0.06	0.018
700	213.360	70	21.336	7	2.134	0.7	0.213	0.07	0.021
800	243.840	80	24.384	8	2.438	0.8	0.244	0.08	0.024
1,000	304.800	100	30.480	10	3.048	1.0	0.305	0.10	0.030

Meters to Feet (1 m = 3.280840 ft)									
meters	feet	meters	feet	meters	feet	meters	feet	meters	feet
100	328.084	10	32.808	1	3.281	0.1	0.328	0.01	0.033
200	656.168	20	65.617	2	6.562	0.2	0.656	0.02	0.066
300	984.252	30	98.425	3	9.843	0.3	0.984	0.03	0.098
400	1,312.336	40	131.234	4	13.123	0.4	1.312	0.04	0.131
500	1,640.420	50	164.042	5	16.404	0.5	1.640	0.05	0.164
600	1,968.504	60	196.850	6	19.685	0.6	1.969	0.06	0.197
700	2,296.588	70	229.659	7	22.966	0.7	2.297	0.07	0.230
800	2,624.672	80	262.467	8	26.247	0.8	2.625	0.08	0.262
900	2,952.756	90	295.276	9	29.528	0.9	2.953	0.09	0.295
1,000	3,280.840	100	328.084	10	32.808	1.0	3.281	0.10	0.328

Miles to Kilometers (1 mile = 1.609344 km, exactly)									
miles	km	miles	km	miles	km	miles	km	miles	km
1,000	1,609.34	100	160.93	10	16.09	1	1.61	0.1	0.16
2,000	3,218.69	200	321.87	20	32.19	2	3.22	0.2	0.32
3,000	4,828.03	300	482.80	30	48.28	3	4.83	0.3	0.48
4,000	6,437.38	400	643.74	40	64.37	4	6.44	0.4	0.64
5,000	8,046.72	500	804.67	50	80.47	5	8.05	0.5	0.80
6,000	9,656.06	600	965.61	60	96.56	6	9.66	0.6	0.97
7,000	11,265.41	700	1,126.54	70	112.65	7	11.27	0.7	1.13
8,000	12,874.75	800	1,287.48	80	128.75	8	12.87	0.8	1.29
9,000	14,484.10	900	1,448.41	90	144.84	9	14.48	0.9	1.45
10,000	16,093.44	1,000	1,609.34	100	160.93	10	16.09	1.0	1.61

Kilometers to Miles (1 km = 0.6213712 mile)									
km	miles	km	miles	km	miles	km	miles	km	miles
1,000	621.37	100	62.14	10	6.21	1	0.62	0.1	0.06
2,000	1,242.74	200	124.27	20	12.43	2	1.24	0.2	0.12
3,000	1,864.11	300	186.41	30	18.64	3	1.86	0.3	0.19
4,000	2,485.48	400	248.55	40	24.85	4	2.49	0.4	0.25
5,000	3,106.86	500	310.69	50	31.07	5	3.11	0.5	0.31
6,000	3,728.23	600	372.82	60	37.28	6	3.73	0.6	0.37
7,000	4,349.60	700	434.96	70	43.50	7	4.35	0.7	0.43
8,000	4,970.97	800	497.10	80	49.71	8	4.97	0.8	0.50
9,000	5,592.34	900	559.23	90	55.92	9	5.59	0.9	0.56
10,000	6,213.71	1,000	621.37	100	62.14	10	6.21	1.0	0.62

**Square Measure**

*1 square kilometer* = 0.3861 square mile = 247.1 acres

*1 hectare* = 2.471 acres = 107,639 square feet

*1 are* = 0.0247 acre = 1076.4 square feet

*1 square meter* = 10.764 square feet = 1.196 square yards

*1 square centimeter* = 0.155 square inch

*1 square millimeter* = 0.00155 square inch

*1 square mile* = 2.5899 square kilometers

*1 acre* = 0.4047 hectare = 40.47 ares

*1 square yard* = 0.836 square meter

*1 square foot* = 0.0929 square meter = 929 square centimeters

*1 square inch* = 6.452 square centimeters = 645.2 square millimeters

**Square Inch — Square Centimeter and Square Foot — Square Meter  
Conversion Tables  
(Based on 1 inch = 2.54 centimeters, exactly)**

Square Inches to Square Centimeters (1 in. <sup>2</sup> = 6.4516 cm <sup>2</sup> , exactly)							
in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>
100	645.16	10	64.52	1	6.45	0.1	0.65
200	1,290.32	20	129.03	2	12.90	0.2	1.29
300	1,935.48	30	193.55	3	19.35	0.3	1.94
400	2,580.64	40	258.06	4	25.81	0.4	2.58
500	3,225.80	50	322.58	5	32.26	0.5	3.23
600	30,870.96	60	387.10	6	38.71	0.6	3.87
700	4,516.12	70	451.61	7	45.16	0.7	4.52
800	5,161.28	80	516.13	8	51.61	0.8	5.16
900	5,806.44	90	580.64	9	58.06	0.9	5.81
1,000	6,451.60	100	645.16	10	64.52	1.0	6.45

Square Centimeters to Square Inches (1 cm <sup>2</sup> = 0.1550003 in. <sup>2</sup> )							
cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>	cm <sup>2</sup>	in. <sup>2</sup>
100	15.500	10	1.550	1	0.155	0.1	0.016
200	31.000	20	3.100	2	0.310	0.2	0.031
300	46.500	30	4.650	3	0.465	0.3	0.047
400	62.000	40	6.200	4	0.620	0.4	0.062
500	77.500	50	7.750	5	0.750	0.5	0.078
600	93.000	60	9.300	6	0.930	0.6	0.093
700	108.500	70	10.850	7	1.085	0.7	0.109
800	124.000	80	12.400	8	1.240	0.8	0.124
900	139.500	90	13.950	9	1.395	0.9	0.140
1,000	155.000	100	15.500	10	1.550	1.0	0.155

Square Feet to Square Meters (1 ft <sup>2</sup> = 0.09290304 m <sup>2</sup> , exactly)							
ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>
1,000	92.903	100	9.290	10	0.929	1	0.093
2,000	185.806	200	18.581	20	1.858	2	0.186
3,000	278.709	300	27.871	30	2.787	3	0.279
4,000	371.612	400	37.161	40	3.716	4	0.372
5,000	464.515	500	46.452	50	4.645	5	0.465
6,000	557.418	600	55.742	60	5.574	6	0.557
7,000	650.321	700	65.032	70	6.503	7	0.650
8,000	743.224	800	74.322	80	7.432	8	0.743
9,000	836.127	900	83.613	90	8.361	9	0.836
10,000	929.030	1,000	92.903	100	9.290	10	0.929

Square Meters to Square Feet (1 m <sup>2</sup> = 10.76391 ft <sup>2</sup> )							
m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>	m <sup>2</sup>	ft <sup>2</sup>
100	1,076.39	10	107.64	1	10.76	0.1	1.08
200	2,152.78	20	215.28	2	21.53	0.2	2.15
300	3,229.17	30	322.92	3	32.29	0.3	3.23
400	4,305.56	40	430.56	4	43.06	0.4	4.31
500	5,381.95	50	538.20	5	53.82	0.5	5.38
600	6,458.35	60	645.83	6	64.58	0.6	6.46
700	7,534.74	70	753.47	7	75.35	0.7	7.53
800	8,611.13	80	861.11	8	86.11	0.8	8.61
900	9,687.52	90	968.75	9	96.88	0.9	9.69
1,000	10,763.91	100	1,076.39	10	107.64	1.0	10.76

### Cubic Measure

*1 cubic meter* = 35.315 cubic feet = 1.308 cubic yards.

*1 cubic meter* = 264.2 U.S. gallons.

*1 cubic centimeter* = 0.061 cubic inch.

*1 liter (cubic decimeter)* = 0.0353 cubic foot = 61.023 cubic inches.

*1 liter* = 0.2642 U.S. gallon = 1.0567 U.S. quarts.

*1 cubic yard* = 0.7646 cubic meter.

*1 cubic foot* = 0.02832 cubic meter = 28.317 liters.

*1 cubic inch* = 16.38706 cubic centimeters.

*1 U.S. gallon* = 3.785 liters.

*1 U.S. quart* = 0.946 liter.

### Cubic Inch — Cubic Centimeter and Cubic Foot — Cubic Meter Conversion Tables (Based on 1 inch = 2.54 centimeters, exactly)

Cubic Inches to Cubic Centimeters (1 in. <sup>3</sup> = 16.38706 cm <sup>3</sup> )									
in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>
100	1,638.71	10	163.87	1	16.39	0.1	1.64	0.01	0.16
200	3,277.41	20	327.74	2	32.77	0.2	3.28	0.02	0.33
300	4,916.12	30	491.61	3	49.16	0.3	4.92	0.03	0.49
400	6,554.82	40	655.48	4	65.55	0.4	6.55	0.04	0.66
500	8,193.53	50	819.35	5	81.94	0.5	8.19	0.05	0.82
600	9,832.24	60	983.22	6	98.32	0.6	9.83	0.06	0.98
700	11,470.94	70	1,147.09	7	114.71	0.7	11.47	0.07	1.15
800	13,109.65	80	1,310.96	8	131.10	0.8	13.11	0.08	1.31
900	14,748.35	90	1,474.84	9	147.48	0.9	14.75	0.09	1.47
1,000	16,387.06	100	1,638.71	10	163.87	1.0	16.39	0.10	1.64
Cubic Centimeters to Cubic Inches (1 cm <sup>3</sup> = 0.06102376 in. <sup>3</sup> )									
cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>	cm <sup>3</sup>	in. <sup>3</sup>
1,000	61.024	100	6.102	10	0.610	1	0.061	0.1	0.006
2,000	122.048	200	12.205	20	1.220	2	0.122	0.2	0.012
3,000	183.071	300	18.307	30	1.831	3	0.183	0.3	0.018
4,000	244.095	400	24.410	40	2.441	4	0.244	0.4	0.024
5,000	305.119	500	30.512	50	3.051	5	0.305	0.5	0.031
6,000	366.143	600	36.614	60	3.661	6	0.366	0.6	0.037
7,000	427.166	700	42.717	70	4.272	7	0.427	0.7	0.043
8,000	488.190	800	48.819	80	4.882	8	0.488	0.8	0.049
9,000	549.214	900	54.921	90	5.492	9	0.549	0.9	0.055
10,000	610.238	1,000	61.024	100	6.102	10	0.610	1.0	0.061
Cubic Feet to Cubic Meters (1 ft <sup>3</sup> = 0.02831685 m <sup>3</sup> )									
ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>
1,000	28.317	100	2.832	10	0.283	1	0.028	0.1	0.003
2,000	56.634	200	5.663	20	0.566	2	0.057	0.2	0.006
3,000	84.951	300	8.495	30	0.850	3	0.085	0.3	0.008
4,000	113.267	400	11.327	40	1.133	4	0.113	0.4	0.011
5,000	141.584	500	14.158	50	1.416	5	0.142	0.5	0.014
6,000	169.901	600	16.990	60	1.699	6	0.170	0.6	0.017
7,000	198.218	700	19.822	70	1.982	7	0.198	0.7	0.020
8,000	226.535	800	22.653	80	2.265	8	0.227	0.8	0.023
9,000	254.852	900	25.485	90	2.549	9	0.255	0.9	0.025
10,000	283.168	1,000	28.317	100	2.832	10	0.283	1.0	0.028
Cubic Meters to Cubic Feet (1 m <sup>3</sup> = 35.31466 ft <sup>3</sup> )									
m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>	m <sup>3</sup>	ft <sup>3</sup>
100	3,531.47	10	353.15	1	35.31	0.1	3.53	0.01	0.35
200	7,062.93	20	706.29	2	70.63	0.2	7.06	0.02	0.71
300	10,594.40	30	1,059.44	3	105.94	0.3	10.59	0.03	1.06
400	14,125.86	40	4,412.59	4	141.26	0.4	14.13	0.04	1.41
500	17,657.33	50	1,756.73	5	176.57	0.5	17.66	0.05	1.77
600	21,188.80	60	2,118.88	6	211.89	0.6	21.19	0.06	2.12
700	24,720.26	70	2,472.03	7	247.20	0.7	24.72	0.07	2.47
800	28,251.73	80	2,825.17	8	282.52	0.8	28.25	0.08	2.83
900	31,783.19	90	3,178.32	9	317.83	0.9	31.78	0.09	3.18
1,000	35,314.66	100	3,531.47	10	353.15	1.0	35.311	0.10	3.53

## Acre—Hectare and U.K. Gallon—Liter Conversion Tables

Acres to Hectares (1 acre = 0.4046856 hectare)										
acres	0	10	20	30	40	50	60	70	80	90
	hectares									
0	...	4.047	8.094	12.141	16.187	20.234	24.281	28.328	32.375	36.422
100	40.469	44.515	48.562	52.609	56.656	60.703	64.750	68.797	72.843	76.890
200	80.937	84.984	89.031	93.078	97.125	101.171	105.218	109.265	113.312	117.359
300	121.406	125.453	129.499	133.546	137.593	141.640	145.687	149.734	153.781	157.827
400	161.874	165.921	169.968	174.015	178.062	182.109	186.156	190.202	194.249	198.296
500	202.343	206.390	240.437	214.483	218.530	222.577	226.624	230.671	234.718	238.765
600	242.811	246.858	250.905	254.952	258.999	263.046	267.092	271.139	275.186	279.233
700	283.280	287.327	291.374	295.420	299.467	303.514	307.561	311.608	315.655	319.702
800	323.748	327.795	331.842	335.889	339.936	343.983	348.030	352.076	356.123	360.170
900	364.217	368.264	372.311	376.358	380.404	384.451	388.498	392.545	396.592	400.639
1000	404.686	...	...	...	...	...	...	...	...	...
Hectares to Acres (1 hectare = 2.471054 acres)										
hectares	0	10	20	30	40	50	60	70	80	90
	acres									
0	...	24.71	49.42	74.13	98.84	123.55	148.26	172.97	197.68	222.39
100	247.11	271.82	296.53	321.24	345.95	370.66	395.37	420.08	444.79	469.50
200	494.21	518.92	543.63	568.34	593.05	617.76	642.47	667.18	691.90	716.61
300	741.32	766.03	790.74	815.45	840.16	864.87	889.58	914.29	939.00	963.71
400	988.42	1013.13	1037.84	1062.55	1087.26	1111.97	1136.68	1161.40	1186.11	1210.82
500	1235.53	1260.24	1284.95	1309.66	1334.37	1359.08	1383.79	1408.50	1433.21	1457.92
600	1482.63	1507.34	1532.05	1556.76	1581.47	1606.19	1630.90	1655.61	1680.32	1705.03
700	1729.74	1754.45	1779.16	1803.87	1828.58	1853.29	1878.00	1902.71	1927.42	1952.13
800	1976.84	2001.55	2026.26	2050.97	2075.69	2100.40	2125.11	2149.82	2174.53	2199.24
900	2223.95	2248.66	2273.37	2298.08	2322.79	2347.50	2372.21	2396.92	2421.63	2446.34
1000	2471.05	...	...	...	...	...	...	...	...	...
U.K. Gallons to Liters (1 U.K. gallon = 4.546092 liters)										
Imp. gals	0	1	2	3	4	5	6	7	8	9
	liters									
0	...	4.546	9.092	13.638	18.184	22.730	27.277	31.823	36.369	40.915
10	45.461	50.007	54.553	59.099	63.645	68.191	72.737	77.284	81.830	86.376
20	90.922	95.468	100.014	104.560	109.106	113.652	118.198	122.744	127.291	131.837
30	136.383	140.929	145.475	150.021	154.567	159.113	163.659	168.205	172.751	177.298
40	181.844	186.390	190.936	195.482	200.028	204.574	209.120	213.666	218.212	222.759
50	227.305	231.851	236.397	240.943	245.489	250.035	254.581	259.127	263.673	268.219
60	272.766	277.312	281.858	286.404	290.950	295.496	300.042	304.588	309.134	313.680
70	318.226	322.773	327.319	331.865	336.411	340.957	345.503	350.049	354.595	359.141
80	363.687	368.233	372.780	377.326	381.872	386.418	390.964	395.510	400.056	404.602
90	409.148	413.694	418.240	422.787	427.333	431.879	436.425	440.971	445.517	450.063
100	454.609	459.155	463.701	468.247	472.794	477.340	481.886	486.432	490.978	495.524
Liters to U.K. Gallons (1 liter = 0.2199692 U.K. gallons)										
liters	0	1	2	3	4	5	6	7	8	9
	Imperial gallons									
0	...	0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.739	3.959	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.699	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.218	11.438	11.658	11.878	12.098	12.318	12.538	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777
100	21.997	22.217	22.437	22.657	22.877	23.097	23.317	23.537	23.757	23.977



**Cubic Foot—Liter and Gallon—Liter Conversion Tables**  
(Based on 1 liter = 1000 cubic centimeters)

Cubic Feet to Liters (1 ft <sup>3</sup> = 28.31685 liters)									
ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters
100	2,831.68	10	283.17	1	28.32	0.1	2.83	0.01	0.28
200	5,663.37	20	566.34	2	56.63	0.2	5.66	0.02	0.57
300	8,495.06	30	849.51	3	84.95	0.3	8.50	0.03	0.85
400	11,326.74	40	1,132.67	4	113.27	0.4	11.33	0.04	1.13
500	14,158.42	50	1,415.84	5	141.58	0.5	14.16	0.05	1.42
600	16,990.11	60	1,699.01	6	169.90	0.6	16.99	0.06	1.70
700	19,821.80	70	1,982.18	7	198.22	0.7	19.82	0.07	1.98
800	22,653.48	80	2,263.35	8	226.53	0.8	22.65	0.08	2.27
900	25,485.16	90	2,548.52	9	254.85	0.9	25.49	0.09	2.55
1,000	28,316.85	100	2,831.68	10	283.17	1.0	28.32	0.10	2.83
Liters to Cubic Feet (1 liter = 0.03531466 ft <sup>3</sup> )									
liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>	liters	ft <sup>3</sup>
1,000	35.315	100	3.531	10	0.353	1	0.035	0.1	0.004
2,000	70.629	200	7.063	20	0.706	2	0.071	0.2	0.007
3,000	105.944	300	10.594	30	1.059	3	0.106	0.3	0.011
4,000	141.259	400	14.126	40	1.413	4	0.141	0.4	0.014
5,000	176.573	500	17.657	50	1.766	5	0.177	0.5	0.018
6,000	211.888	600	21.189	60	2.119	6	0.212	0.6	0.021
7,000	247.203	700	24.720	70	2.472	7	0.247	0.7	0.025
8,000	282.517	800	28.252	80	2.825	8	0.283	0.8	0.028
9,000	317.832	900	31.783	90	3.178	9	0.318	0.9	0.032
10,000	353.147	1,000	35.315	100	3.531	10	0.353	1.0	0.035
U.S. Gallons to Liters (1 U.S. gallon = 3.785412 liters)									
gals	liters	gals	liters	gals	liters	gals	liters	gals	liters
1,000	3,785.41	100	378.54	10	37.85	1	3.79	0.1	0.38
2,000	7,570.82	200	757.08	20	75.71	2	7.57	0.2	0.76
3,000	11,356.24	300	1,135.62	30	113.56	3	11.36	0.3	1.14
4,000	15,141.65	400	1,514.16	40	151.42	4	15.14	0.4	1.51
5,000	18,927.06	500	1,892.71	50	189.27	5	18.93	0.5	1.89
6,000	22,712.47	600	2,271.25	60	227.12	6	22.71	0.6	2.27
7,000	26,497.88	700	2,649.79	70	264.98	7	26.50	0.7	2.65
8,000	30,283.30	800	3,028.33	80	302.83	8	30.28	0.8	3.03
9,000	34,068.71	900	3,406.87	90	340.69	9	34.07	0.9	3.41
10,000	37,854.12	1,000	3,785.41	100	378.54	10	37.85	1.0	3.79
Liters to U.S. Gallons (1 liter = 0.2641720 U.S. gallon)									
liters	gals	liters	gals	liters	gals	liters	gals	liters	gals
1,000	264.17	100	26.42	10	2.64	1	0.26	0.1	0.03
2,000	528.34	200	52.83	20	5.28	2	0.53	0.2	0.05
3,000	792.52	300	79.25	30	7.93	3	0.79	0.3	0.08
4,000	1,056.69	400	105.67	40	10.57	4	1.06	0.4	0.11
5,000	1,320.86	500	132.09	50	13.21	5	1.32	0.5	0.13
6,000	1,585.03	600	158.50	60	15.85	6	1.59	0.6	0.16
7,000	1,849.20	700	184.92	70	18.49	7	1.85	0.7	0.18
8,000	2,113.38	800	211.34	80	21.13	8	2.11	0.8	0.21
9,000	2,377.55	900	237.75	90	23.78	9	2.38	0.9	0.24
10,000	2,641.72	1,000	264.17	100	26.42	10	2.64	1.0	0.26



**Pound—Kilogram and Ounce—Gram Conversion Tables (Continued)**

Grams to Ounces (1 gram = 0.03527397 ounce)									
g	oz	g	oz	g	oz	g	oz	g	oz
100	3.527	10	0.353	1	0.035	0.1	0.004	0.01	0.000
200	7.055	20	0.705	2	0.071	0.2	0.007	0.02	0.001
300	10.582	30	1.058	3	0.106	0.3	0.011	0.03	0.001
400	14.110	40	1.411	4	0.141	0.4	0.014	0.04	0.001
500	17.637	50	1.764	5	0.176	0.5	0.018	0.05	0.002
600	21.164	60	2.116	6	0.212	0.6	0.021	0.06	0.002
700	24.692	70	2.469	7	0.247	0.7	0.025	0.07	0.002
800	28.219	80	2.822	8	0.282	0.8	0.028	0.08	0.003
900	31.747	90	3.175	9	0.317	0.9	0.032	0.09	0.003
1,000	35.274	100	3.527	10	0.353	1.0	0.035	0.10	0.004

**Pounds per Square Inch—Kilograms per Square Centimeter and Pounds per Square Foot—Kilograms per Square Meter Conversion Tables**

Pounds per Square Inch to Kilograms per Square Centimeter (1 lb/in. <sup>2</sup> = 0.07030697 kg/cm <sup>2</sup> )									
lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>
1,000	70.307	100	7.031	10	0.703	1	0.070	0.1	0.007
2,000	140.614	200	14.061	20	1.406	2	0.141	0.2	0.014
3,000	210.921	300	21.092	30	2.109	3	0.211	0.3	0.021
4,000	281.228	400	28.123	40	2.812	4	0.281	0.4	0.028
5,000	351.535	500	35.153	50	3.515	5	0.352	0.5	0.035
6,000	421.842	600	42.184	60	4.218	6	0.422	0.6	0.042
7,000	492.149	700	49.215	70	4.921	7	0.492	0.7	0.049
8,000	562.456	800	56.246	80	5.625	8	0.562	0.8	0.056
9,000	632.763	900	63.276	90	6.328	9	0.633	0.9	0.063
10,000	703.070	1,000	70.307	100	7.031	10	0.703	1.0	0.070

Kilogram per Square Centimeter to Pounds per Square Inch (1 kg/cm <sup>2</sup> = 14.22334 lb/in. <sup>2</sup> )									
kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>	kg/cm <sup>2</sup>	lb/in. <sup>2</sup>
100	1,422.33	10	142.23	1	14.22	0.1	1.42	0.01	0.14
200	2,844.67	20	284.47	2	28.45	0.2	2.84	0.02	0.28
300	4,267.00	30	426.70	3	42.67	0.3	4.27	0.03	0.43
400	5,689.34	40	568.93	4	56.89	0.4	5.69	0.04	0.57
500	7,111.67	50	711.17	5	71.12	0.5	7.11	0.05	0.71
600	8,534.00	60	853.40	6	85.34	0.6	8.53	0.06	0.85
700	9,956.34	70	995.63	7	99.56	0.7	9.96	0.07	1.00
800	11,378.67	80	1,137.87	8	113.79	0.8	11.38	0.08	1.14
900	12,801.01	90	1,280.10	9	128.01	0.9	12.80	0.09	1.28
1,000	14,223.34	100	1,422.33	10	142.23	1.0	14.22	0.10	1.42

Pounds per Square Foot to Kilograms per Square Meter (1 lb/ft <sup>2</sup> = 4.882429 kg/m <sup>2</sup> )									
lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>
1,000	4,882.43	100	488.24	10	48.82	1	4.88	0.1	0.49
2,000	9,764.86	200	976.49	20	97.65	2	9.76	0.2	0.98
3,000	14,647.29	300	1,464.73	30	146.47	3	14.65	0.3	1.46
4,000	19,529.72	400	1,952.97	40	195.30	4	19.53	0.4	1.95
5,000	24,412.14	500	2,441.21	50	244.12	5	24.41	0.5	2.44
6,000	29,294.57	600	2,929.46	60	292.95	6	29.29	0.6	2.93
7,000	34,177.00	700	3,417.70	70	341.77	7	34.18	0.7	3.42
8,000	39,059.43	800	3,905.94	80	390.59	8	39.06	0.8	3.91
9,000	43,941.86	900	4,394.19	90	439.42	9	43.94	0.9	4.39
10,000	48,824.28	10,000	4,882.43	100	488.24	10	48.82	1.0	4.88

**Pounds per Square Inch—Kilograms per Square Centimeter and Pounds per Square Foot—Kilograms per Square Meter Conversion Tables (Continued)**

Kilograms per Square Meter to Pounds per Square Foot (1 kg/m <sup>2</sup> = 0.2048161 lb/ft <sup>2</sup> )									
kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>	kg/m <sup>2</sup>	lb/ft <sup>2</sup>
1,000	204.82	100	20.48	10	2.05	1	0.20	0.1	0.02
2,000	409.63	200	40.96	20	4.10	2	0.41	0.2	0.04
3,000	614.45	300	61.44	30	6.14	3	0.61	0.3	0.06
4,000	819.26	400	81.93	40	8.19	4	0.82	0.4	0.08
5,000	1,024.08	500	102.41	50	10.24	5	1.02	0.5	0.10
6,000	1,228.90	600	122.89	60	12.29	6	1.23	0.6	0.12
7,000	1,433.71	700	143.37	70	14.34	7	1.43	0.7	0.14
8,000	1,638.53	800	163.85	80	16.39	8	1.64	0.8	0.16
9,000	1,843.34	900	184.33	90	18.43	9	1.84	0.9	0.18
10,000	2,048.16	1,000	204.82	100	20.48	10	2.05	1.0	0.20

**Pounds per Square Inch—Kilopascals Conversion Table**

Pounds per Square Inch to Kilopascals (1 lb/in <sup>2</sup> = 6.894757 kPa)										
lb/in. <sup>2</sup>	0	1	2	3	4	5	6	7	8	9
	kilopascals									
0	...	6.895	13.790	20.684	27.579	34.474	41.369	48.263	55.158	62.053
10	68.948	75.842	82.737	89.632	96.527	103.421	110.316	117.211	124.106	131.000
20	137.895	144.790	151.685	158.579	165.474	172.369	179.264	186.158	193.053	199.948
30	206.843	213.737	220.632	227.527	234.422	241.316	248.211	255.106	262.001	268.896
40	275.790	282.685	289.580	296.475	303.369	310.264	317.159	324.054	330.948	337.843
50	344.738	351.633	358.527	365.422	372.317	379.212	386.106	393.001	399.896	406.791
60	413.685	420.580	427.475	434.370	441.264	448.159	455.054	461.949	468.843	475.738
70	482.633	489.528	496.423	503.317	510.212	517.107	524.002	530.896	537.791	544.686
80	551.581	558.475	565.370	572.265	579.160	586.054	592.949	599.844	606.739	613.633
90	620.528	627.423	634.318	641.212	648.107	655.002	661.897	668.791	675.686	682.581
100	689.476	696.370	703.265	710.160	717.055	723.949	730.844	737.739	744.634	751.529
	Kilopascals to Pounds Per Square Inch (1 kPa = 0.1450377 lb/in <sup>2</sup> )									
kPa	0	1	2	3	4	5	6	7	8	9
	lb/in. <sup>2</sup>									
0	...	0.145	0.290	0.435	0.580	0.725	0.870	1.015	1.160	1.305
10	1.450	1.595	1.740	1.885	2.031	2.176	2.321	2.466	2.611	2.756
20	2.901	3.046	3.191	3.336	3.481	3.626	3.771	3.916	4.061	4.206
30	4.351	4.496	4.641	4.786	4.931	5.076	5.221	5.366	5.511	5.656
40	5.802	5.947	6.092	6.237	6.382	6.527	6.672	6.817	6.962	7.107
50	7.252	7.397	7.542	7.687	7.832	7.977	8.122	8.267	8.412	8.557
60	8.702	8.847	8.992	9.137	9.282	9.427	9.572	9.718	9.863	10.008
70	10.153	10.298	10.443	10.588	10.733	10.878	11.023	11.168	11.313	11.458
80	11.603	11.748	11.893	12.038	12.183	12.328	12.473	12.618	12.763	12.908
90	13.053	13.198	13.343	13.489	13.634	13.779	13.924	14.069	14.214	14.359
100	14.504	14.649	14.794	14.939	15.084	15.229	15.374	15.519	15.664	15.809

Note: 1 kilopascal = 1 kilonewton/meter<sup>2</sup>.

**Pounds per Cubic Inch—Grams per Cubic Centimeter and Pounds per Cubic Foot—Kilograms per Cubic Meter Conversion Tables**

Pounds per Cubic Inch to Grams per Cubic Centimeter (1 lb/in. <sup>3</sup> = 27.67990 g/cm <sup>3</sup> )									
lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>
100	2,767.99	10	276.80	1	27.68	0.1	2.77	0.01	0.28
200	5,535.98	20	553.60	2	55.36	0.2	5.54	0.02	0.55
300	8,303.97	30	830.40	3	83.04	0.3	8.30	0.03	0.83
400	11,071.96	40	1,107.20	4	110.72	0.4	11.07	0.04	1.11
500	13,839.95	50	1,384.00	5	138.40	0.5	13.84	0.05	1.38
600	16,607.94	60	1,660.79	6	166.08	0.6	16.61	0.06	1.66
700	19,375.93	70	1,937.59	7	193.76	0.7	19.38	0.07	1.94
800	22,143.92	80	2,214.39	8	221.44	0.8	22.14	0.08	2.21
900	24,911.91	90	2,491.19	9	249.12	0.9	24.91	0.09	2.49
1,000	27,679.90	100	2,767.99	10	276.80	1.0	27.68	0.10	2.77

Grams per Cubic Centimeter to Pounds per Cubic Inch (1 g/cm <sup>3</sup> = 0.03612730 lb/in. <sup>3</sup> )									
g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	lb/in. <sup>3</sup>
1,000	36.127	100	3.613	10	0.361	1	0.036	0.1	0.004
2,000	72.255	200	7.225	20	0.723	2	0.072	0.2	0.007
3,000	108.382	300	10.838	30	1.084	3	0.108	0.3	0.011
4,000	144.509	400	14.451	40	1.445	4	0.145	0.4	0.014
5,000	180.636	500	18.064	50	1.806	5	0.181	0.5	0.018
6,000	216.764	600	21.676	60	2.168	6	0.217	0.6	0.022
7,000	252.891	700	25.289	70	2.529	7	0.253	0.7	0.025
8,000	289.018	800	28.902	80	2.890	8	0.289	0.8	0.029
9,000	325.146	900	32.515	90	3.251	9	0.325	0.9	0.033
10,000	361.273	1,000	36.127	100	3.613	10	0.361	1.0	0.036

Pounds per Cubic Foot to Kilograms per Cubic Meter (1 lb/ft <sup>3</sup> = 16.01846 kg/m <sup>3</sup> )									
lb/ft <sup>3</sup>	lb/kg/m <sup>3</sup>	lb/ft <sup>3</sup>	lb/kg/m <sup>3</sup>	lb/ft <sup>3</sup>	lb/kg/m <sup>3</sup>	lb/ft <sup>3</sup>	lb/kg/m <sup>3</sup>	lb/ft <sup>3</sup>	lb/kg/m <sup>3</sup>
100	1,601.85	10	160.18	1	16.02	0.1	1.60	0.01	0.16
200	3,203.69	20	320.37	2	32.04	0.2	3.20	0.02	0.32
300	4,805.54	30	480.55	3	48.06	0.3	4.81	0.03	0.48
400	6,407.38	40	640.74	4	64.07	0.4	6.41	0.04	0.64
500	8,009.23	50	800.92	5	80.09	0.5	8.01	0.05	0.80
600	9,611.08	60	961.11	6	96.11	0.6	9.61	0.06	0.96
700	11,212.92	70	1,121.29	7	112.13	0.7	11.21	0.07	1.12
800	12,814.77	80	1,281.48	8	128.15	0.8	12.81	0.08	1.28
900	14,416.61	90	1,441.66	9	144.17	0.9	14.42	0.09	1.44
1,000	16,018.46	100	1,601.85	10	160.18	1.0	16.02	0.10	1.60

Kilograms per Cubic Meter to Pounds per Cubic Foot (1 kg/m <sup>3</sup> = 0.06242797 lb/ft <sup>3</sup> )									
kg/m <sup>3</sup>	lb/ft <sup>3</sup>	kg/m <sup>3</sup>	lb/ft <sup>3</sup>	kg/m <sup>3</sup>	lb/ft <sup>3</sup>	kg/m <sup>3</sup>	lb/ft <sup>3</sup>	kg/m <sup>3</sup>	lb/ft <sup>3</sup>
1,000	62.428	100	6.243	10	0.624	1	0.062	0.1	0.006
2,000	124.856	200	12.486	20	1.249	2	0.125	0.2	0.012
3,000	187.284	300	18.728	30	1.873	3	0.187	0.3	0.019
4,000	249.712	400	24.971	40	2.497	4	0.250	0.4	0.025
5,000	312.140	500	31.214	50	3.121	5	0.312	0.5	0.031
6,000	374.568	600	37.457	60	3.746	6	0.375	0.6	0.037
7,000	436.996	700	43.700	70	4.370	7	0.437	0.7	0.044
8,000	499.424	800	49.942	80	4.994	8	0.499	0.8	0.050
9,000	561.852	900	56.185	90	5.619	9	0.562	0.9	0.056
10,000	624.280	1,000	62.428	100	6.243	10	0.624	1.0	0.062

**Pounds-force to Newtons Conversion Table**

Pounds-Force to Newtons (1 pound-force = 4.448222 newtons.)										
lbf	0	1	2	3	4	5	6	7	8	9
	newtons									
0	...	4.448	8.896	13.345	17.793	22.241	26.689	31.138	35.586	40.034
10	44.482	48.930	53.379	57.827	62.275	66.723	71.172	75.620	80.068	84.516
20	88.964	93.413	97.861	102.309	106.757	111.206	115.654	120.102	124.550	128.998
30	133.447	137.895	142.343	146.791	151.240	155.688	160.136	164.584	169.032	173.481
40	177.929	182.377	186.825	191.274	195.722	200.170	204.618	209.066	213.515	217.963
50	222.411	226.859	231.308	235.756	240.204	244.652	249.100	253.549	257.997	262.445
60	266.893	271.342	275.790	280.238	284.686	289.134	293.583	298.031	302.479	306.927
70	311.376	315.824	320.272	324.720	329.168	333.617	338.065	342.513	346.961	351.410
80	355.858	360.306	364.754	369.202	373.651	378.099	382.547	386.995	391.444	395.892
90	400.340	404.788	409.236	413.685	418.133	422.581	427.029	431.478	435.926	440.374
100	444.822	449.270	453.719	458.167	462.615	467.063	471.512	475.960	480.408	484.856
Newtons to Pounds-Force (1 newton = 0.2248089 pound-force.)										
N	0	1	2	3	4	5	6	7	8	9
	pounds-force									
0	...	0.22481	0.44962	0.67443	0.89924	1.12404	1.34885	1.57366	1.79847	2.02328
10	2.24809	2.47290	2.69771	2.92252	3.14732	3.37213	3.59694	3.82175	4.04656	4.27137
20	4.49618	4.72099	4.94580	5.17060	5.39541	5.62022	5.84503	6.06984	6.29465	6.51946
30	6.74427	6.96908	7.19388	7.41869	7.64350	7.86831	8.09312	8.31793	8.54274	8.76755
40	8.99236	9.21716	9.44197	9.66678	9.89159	10.1164	10.3412	10.5660	10.7908	11.0156
50	11.2404	11.4653	11.6901	11.9149	12.1397	12.3645	12.5893	12.8141	13.0389	13.2637
60	13.4885	13.7133	13.9382	14.1630	14.3878	14.6126	14.8374	15.0622	15.2870	15.5118
70	15.7366	15.9614	16.1862	16.4110	16.6359	16.8607	17.0855	17.3103	17.5351	17.7599
80	17.9847	18.2095	18.4343	18.6591	18.8839	19.1088	19.3336	19.5584	19.7832	20.0080
90	20.2328	20.4576	20.6824	20.9072	21.1320	21.3568	21.5817	21.8065	22.0313	22.2561
100	22.4809	22.7057	22.9305	23.1553	23.3801	23.6049	23.8297	24.0546	24.2794	24.5042

**Pound-Inches to Newton-Meters Conversion Table**

Pound-Inches to Newton-Meters (1 pound-force-inch = 0.1129848 newton-meter)									
lbf-in.	N-m	lbf-in.	N-m	lbf-in.	N-m	lbf-in.	N-m	lbf-in.	N-m
100	11.298	10	1.130	1	0.113	0.1	0.011	0.01	0.001
200	22.597	20	2.260	2	0.226	0.2	0.023	0.02	0.002
300	33.895	30	3.390	3	0.339	0.3	0.034	0.03	0.003
400	45.194	40	4.519	4	0.452	0.4	0.045	0.04	0.005
500	56.492	50	5.649	5	0.565	0.5	0.056	0.05	0.006
600	67.791	60	6.779	6	0.678	0.6	0.068	0.06	0.007
700	79.089	70	7.909	7	0.791	0.7	0.079	0.07	0.008
800	90.388	80	9.039	8	0.904	0.8	0.090	0.08	0.009
900	101.686	90	10.169	9	1.017	0.9	0.102	0.09	0.010
1000	112.985	100	11.298	10	1.130	1.0	0.113	0.10	0.011

**Pound-Inches to Newton-Meters Conversion Table** (Continued)

Newton-Meters to Pound-Inches (1 newton meter = 8.850748 pound-force-inches)									
N-m	lbf-in.	N-m	lbf-in.	N-m	lbf-in.	N-m	lbf-in.	N-m	lbf-in.
100	885.07	10	88.51	1	8.85	0.1	0.89	0.01	0.09
200	1770.15	20	177.01	2	17.70	0.2	1.77	0.02	0.18
300	2655.22	30	265.52	3	26.55	0.3	2.66	0.03	0.27
400	3540.30	40	354.03	4	35.40	0.4	3.54	0.04	0.35
500	4425.37	50	442.54	5	44.25	0.5	4.43	0.05	0.44
600	5310.45	60	531.04	6	53.10	0.6	5.31	0.06	0.53
700	6195.52	40	619.55	7	61.96	0.7	6.20	0.07	0.62
800	7080.60	80	708.06	8	70.81	0.8	7.08	0.08	0.71
900	7965.67	90	796.57	9	79.66	0.9	7.97	0.09	0.80
1000	8850.75	100	885.07	10	88.51	1.0	8.85	0.10	0.89

**Power and Heat Equivalents**

*1 horsepower-hour* = 0.746 kilowatt-hour = 1,980,000 foot-pounds = 2545 Btu (British thermal units) = 2.64 pounds of water evaporated at 212°F = 17 pounds of water raised from 62° to 212°F.

*1 kilowatt-hour* = 100 watt-hours = 1.34 horsepower-hour = 2,655,200 foot-pounds = 3,600,000 joules = 3415 Btu = 3.54 pounds of water evaporated at 212°F = 22.8 pounds of water raised from 62° to 212°F.

*1 horsepower* = 746 watts = 0.746 kilowatt = 33,000 foot-pounds per minute = 550 foot-pounds per second = 2545 Btu per hour = 42.4 Btu per minute = 0.71 Btu per second = 2.64 lbs. of water evaporated per hour at 212°F.

*1 kilowatt* = 1000 watts = 1.34 horsepower = 2,654,200 foot-pounds per hour = 44,200 foot-pounds per minute = 737 foot-pounds per second = 3415 Btu per hour = 57 Btu per minute = 0.95 Btu per second = 3.54 pounds of water evaporated per hour at 212°F.

*1 watt* = 1 joule per second = 0.00134 horsepower = 0.001 kilowatt = 3.42 Btu per hour = 44.22 foot-pounds per minute = 0.74 foot-pounds per second = 0.0035 pound of water evaporated per hour at 212°F.

*1 Btu (British thermal unit)* = 1052 watt-seconds = 778 foot-pounds = 0.252 kilogram-calorie = 0.000292 kilowatt-hour = 0.000393, horsepower-hour = 0.00104 pound of water evaporated at 212°F.

*1 foot-pound* = 1.36 joules = 0.000000377 kilowatt-hour = 0.00129 Btu = 0.0000005 horsepower-hour.

*1 joule* = 1 watt-second = 0.00000078 kilowatt-hour = 0.00095 Btu = 0.74 foot-pound.

**British Thermal Unit — Foot-Pound and Horsepower — Kilowatt  
Conversion Tables**

British Thermal Units to Foot-Pounds (1 Btu = 778.26 ft-lb) <sup>a</sup>									
Btu	Ft-lb	Btu	Ft-lb	Btu	Ft-lb	Btu	Ft-lb	Btu	Ft-lb
100	77,826	10	7,783	1	778	0.1	78	0.01	8
200	155,652	20	15,565	2	1,557	0.2	156	0.02	16
300	233,478	30	23,348	3	2,335	0.3	233	0.03	23
400	311,304	40	31,130	4	3,113	0.4	311	0.04	31
500	389,130	50	38,913	5	3,891	0.5	389	0.05	39
600	466,956	60	46,696	6	4,670	0.6	467	0.06	47
700	544,782	70	54,478	7	5,448	0.7	545	0.07	54
800	622,608	80	62,261	8	6,226	0.8	623	0.08	62
900	700,434	90	70,043	9	7,004	0.9	700	0.09	70
1,000	778,260	100	77,826	10	7,783	1.0	778	0.10	78
Foot-Pounds to British Thermal Units (1 ft-lb = 0.00128492 Btu) <sup>a</sup>									
Ft-lb	Btu	Ft-lb	Btu	Ft-lb	Btu	Ft-lb	Btu	Ft-lb	Btu
10,000	12.849	1,000	1.285	100	0.128	10	0.013	1	0.001
20,000	25.698	2,000	2.570	200	0.257	20	0.026	2	0.003
30,000	38.548	3,000	3.855	300	0.385	30	0.039	3	0.004
40,000	51.397	4,000	5.140	400	0.514	40	0.051	4	0.005
50,000	64.246	5,000	6.425	500	0.642	50	0.064	5	0.006
60,000	77.095	6,000	7.710	600	0.771	60	0.077	6	0.008
70,000	89.944	7,000	8.994	700	0.899	70	0.090	7	0.009
80,000	102.794	8,000	10.279	800	1.028	80	0.103	8	0.010
90,000	115.643	9,000	11.564	900	1.156	90	0.116	9	0.012
100,000	128.492	10,000	12.849	1,000	1.285	100	0.128	10	0.013
Horsepower to Kilowatts (1 hp = 0.7456999 kW) <sup>b</sup>									
hp	kW	hp	kW	hp	kW	hp	kW	hp	kW
1,000	745.7	100	74.6	10	7.5	1	0.7	0.1	0.07
2,000	1,491.4	200	149.1	20	14.9	2	1.5	0.2	0.15
3,000	2,237.1	300	223.7	30	22.4	3	2.2	0.3	0.22
4,000	2,982.8	400	298.3	40	29.8	4	3.0	0.4	0.30
5,000	3,728.5	500	372.8	50	37.3	5	3.7	0.5	0.37
6,000	4,474.2	600	447.4	60	44.7	6	4.5	0.6	0.45
7,000	5,219.9	700	522.0	70	52.2	7	5.2	0.7	0.52
8,000	5,965.6	800	596.6	80	59.7	8	6.0	0.8	0.60
9,000	6,711.3	900	671.1	90	67.1	9	6.7	0.9	0.67
10,000	7,457.0	1,000	745.7	100	74.6	10	7.5	1.0	0.75
Kilowatts to Horsepower (1 kW = 1.341022 hp) <sup>b</sup>									
kW	hp	kW	hp	kW	hp	kW	hp	kW	hp
1,000	1,341.0	100	134.1	10	13.4	1	1.3	0.1	0.13
2,000	2,682.0	200	268.2	20	26.8	2	2.7	0.2	0.27
3,000	4,023.1	300	402.3	30	40.2	3	4.0	0.3	0.40
4,000	5,364.1	400	536.4	40	53.6	4	5.4	0.4	0.54
5,000	6,705.1	500	670.5	50	67.1	5	6.7	0.5	0.67
7,000	9,387.2	700	938.7	70	93.9	7	9.4	0.7	0.94
8,000	10,728.2	800	1,072.8	80	107.3	8	10.7	0.8	1.07
9,000	12,069.2	900	1,206.9	90	120.7	9	12.1	0.9	1.21
10,000	13,410.2	1,000	1,341.0	100	134.1	10	13.4	1.0	1.34

<sup>a</sup> Conversion factor defined by International Steam Table Conference, 1929.

<sup>b</sup> Based on 1 horsepower = 550 foot-pounds per second.



**British Thermal Unit — Kilojoule and Foot-Pound — Joule Conversion Tables**

British Thermal Units to Kilojoules (1 Btu = 1055.056 joules.)										
Btu	0	100	200	300	400	500	600	700	800	900
	kilojoules									
0	...	105.51	211.01	316.52	422.02	527.53	633.03	738.54	844.04	949.55
1000	1055.06	1160.56	1266.07	1371.57	1477.08	1582.58	1688.09	1793.60	1899.10	2004.61
2000	2110.11	2215.62	2321.12	2426.63	2532.13	2637.64	2743.15	2848.65	2954.16	3059.66
3000	3165.17	3270.67	3376.18	3481.68	3587.19	3692.70	3798.20	3903.71	4009.21	4114.72
4000	4220.22	4325.73	4431.24	4536.74	4642.25	4747.75	4853.26	4958.76	5064.27	5169.77
5000	5275.28	5380.79	5486.29	5591.80	5697.30	5802.81	5908.31	6013.82	6119.32	6224.83
6000	6330.34	6435.84	6541.35	6646.85	6752.36	6857.86	6963.37	7068.88	7174.38	7279.89
7000	7385.39	7490.90	7596.40	7701.91	7807.41	7912.92	8018.43	8123.93	8229.44	8334.94
8000	8440.45	8545.95	8651.46	8756.96	8862.47	8967.98	9073.48	9178.99	9284.49	9390.00
9000	9495.50	9601.01	9706.52	9812.02	9917.53	10023.0	10128.5	10234.0	10339.5	10445.1
10000	10550.6	...	...	...	...	...	...	...	...	...
Kilojoules to British Thermal Units (1 joule = 0.0009478170 Btu.)										
kJ	0	100	200	300	400	500	600	700	800	900
	British Thermal Units									
0	...	94.78	189.56	284.35	379.13	473.91	568.69	663.47	758.25	853.04
1000	947.82	1042.60	1137.38	1232.16	1326.94	1421.73	1516.51	1611.29	1706.07	1800.85
2000	1895.63	1990.42	2085.20	2179.98	2274.76	2369.54	2464.32	2559.11	2653.89	2748.67
3000	2843.45	2938.23	3033.01	3127.80	3222.58	3317.36	3412.14	3506.92	3601.70	3696.49
4000	3791.27	3886.05	3980.83	4075.61	4170.39	4265.18	4359.96	4454.74	4549.52	4644.30
5000	4739.08	4833.87	4928.65	5023.43	5118.21	5212.99	5307.78	5402.56	5497.34	5592.12
6000	5686.90	5781.68	5876.47	5971.25	6066.03	6160.81	6255.59	6350.37	6445.16	6539.94
7000	6634.72	6729.50	6824.28	6919.06	7013.85	7108.63	7203.41	7298.19	7392.97	7487.75
8000	7582.54	7677.32	7772.10	7866.88	7961.66	8056.44	8151.23	8246.01	8340.79	8435.57
9000	8530.35	8625.13	8719.92	8814.70	8909.48	9004.26	9099.04	9193.82	9288.61	9383.39
10000	9478.17	...	...	...	...	...	...	...	...	...
Foot-Pounds to Joules (1 foot-pound = 1.355818 joules)										
ft-lb	0	1	2	3	4	5	6	7	8	9
	joules									
0	...	1.356	2.712	4.067	5.423	6.779	8.135	9.491	10.847	12.202
10	13.558	14.914	16.270	17.626	18.981	20.337	21.693	23.049	24.405	25.761
20	27.116	28.472	29.828	31.184	32.540	33.895	35.251	36.607	37.963	39.319
30	40.675	42.030	43.386	44.742	46.098	47.454	48.809	50.165	51.521	52.877
40	54.233	55.589	56.944	58.300	59.656	61.012	62.368	63.723	65.079	66.435
50	67.791	69.147	70.503	71.858	73.214	74.570	75.926	77.282	78.637	79.993
60	81.349	82.705	84.061	85.417	86.772	88.128	89.484	90.840	92.196	93.551
70	94.907	96.263	97.619	98.975	100.331	101.686	103.042	104.398	105.754	107.110
80	108.465	109.821	111.177	112.533	113.889	115.245	116.600	117.956	119.312	120.668
90	122.024	123.379	124.735	126.091	127.447	128.803	130.159	131.514	132.870	134.226
100	135.582	136.938	138.293	139.649	141.005	142.361	143.717	145.073	146.428	147.784
Joules to Foot-Pounds (1 joule = 0.7375621 foot-pound)										
J	0	1	2	3	4	5	6	7	8	9
	foot-pounds									
0	...	0.7376	1.4751	2.2127	2.9502	3.6878	4.4254	5.1629	5.9005	6.6381
10	7.3756	8.1132	8.8507	9.5883	10.3259	11.0634	11.8010	12.5386	13.2761	14.0137
20	14.7512	15.4888	16.2264	16.9639	17.7015	18.4391	19.1766	19.9142	20.6517	21.3893
30	22.1269	22.8644	23.6020	24.3395	25.0771	25.8147	26.5522	27.2898	28.0274	28.7649
40	29.5025	30.2400	30.9776	31.7152	32.4527	33.1903	33.9279	34.6654	35.4030	36.1405
50	36.8781	37.6157	38.3532	39.0908	39.8284	40.5659	41.3035	42.0410	42.7786	43.5162
60	44.2537	44.9913	45.7289	46.4664	47.2040	47.9415	48.6791	49.4167	50.1542	50.8918
70	51.6293	52.3669	53.1045	53.8420	54.5796	55.3172	56.0547	56.7923	57.5298	58.2674
80	59.0050	59.7425	60.4801	61.2177	61.9552	62.6928	63.4303	64.1679	64.9055	65.6430
90	66.3806	67.1182	67.8557	68.5933	69.3308	70.0684	70.8060	71.5435	72.2811	73.0186
100	73.7562	74.4938	75.2313	75.9689	76.7065	77.4440	78.1816	78.9191	79.6567	80.3943

### Greek Letters and Standard Abbreviations

The Greek letters are frequently used in mathematical expressions and formulas. The Greek alphabet is given below.

A	$\alpha$	Alpha	H	$\eta$	Eta	N	$\nu$	Nu	T	$\tau$	Tau
B	$\beta$	Beta	$\Theta$	$\vartheta \theta$	Theta	$\Xi$	$\xi$	Xi	$\Upsilon$	$\upsilon$	Upsilon
$\Gamma$	$\gamma$	Gamma	I	$\iota$	Iota	O	$o$	Omicron	$\Phi$	$\phi$	Phi
$\Delta$	$\delta$	Delta	K	$\kappa$	Kappa	$\Pi$	$\pi$	Pi	X	$\chi$	Chi
E	$\epsilon$	Epsilon	$\Lambda$	$\lambda$	Lambda	R	$\rho$	Rho	$\Psi$	$\psi$	Psi
Z	$\zeta$	Zeta	M	$\mu$	Mu	$\Sigma$	$\sigma \varsigma$	Sigma	$\Omega$	$\omega$	Omega

### American National Standard Abbreviations for Scientific and Engineering Terms ANSI Y1.1-1972, (R 1984)

Absolute	abs	Decibel	dB
Alternating current	ac	Degree	deg or °
Ampere	amp	Degree Centigrade	°C
Ampere-hour	amp hr	Degree Fahrenheit	°F
Angstrom unit	Å	Degree Kelvin	K
Antilogarithm	antilog	Diameter	dia
Arithmetical average	aa	Direct current	dc
Atmosphere	atm	Dozen	doz
Atomic weight	at wt	Dram	dr
Avoirdupois	avdp	Efficiency	eff
Barometer	baro	Electric	elec
Board feet (feet board measure)	fbm	Electromotive force	emf
Boiler pressure	bopress	Elevation	el
Boiling point	bp	Engine	eng
Brinell hardness number	Bhn	Engineer	engr
British thermal unit	Btu or B	Engineering	enrg
Bushel	bu	Equation	eq
Calorie	cal	External	ext
Candle	cd	Fluid	fl
Center to center	c to c	Foot	ft
Centimeter	cm	Foot-candle	fc
Centimeter-gram-second (system)	cgs	Foot-Lambert	fL or fl
Chemical	chem	Foot per minute	fpm
Chemically pure	cp	Foot per second	fps
Circular	circ	Foot-pound	ft lb
Circular mil	cmil	Foot-pound-second (system)	fps
Coefficient	coef	Free on board	fob
Cologarithm	colog	Freezing point	fp
Concentrate	conc	Frequency	freq
Conductivity	condct	Fusion point	fnpt
Constant	const	Gallon	gal
Cord	cd	Gallon per minute	gpm
Cosecant	csc	Gallon per second	gps
Cosine	cos	Grain	gr
Cost, insurance, and freight	cif	Gram	g
Cotangent	ctn	Greatest common divisor	gcd
Counter electromotive force	cemf		
Cubic	cu	High pressure	hp
Cubic centimeter	cm <sup>3</sup> or cc	Horsepower	hp
Cubic foot	ft <sup>3</sup> or cu ft	Horsepower-hour	hp hr
Cubic feet per second	ft <sup>3</sup> or cfs	Hour	h or hr
Cubic inch	in <sup>3</sup> or cu in	Hyperbolic cosine	cosh
Cubic meter	m <sup>3</sup> or cu m	Hyperbolic sine	sinh
Cubic millimeter	mm <sup>3</sup> or cumm	Hyperbolic tangent	tanh
Cubic yard	yd <sup>3</sup> or cu yd	pound-force foot	lb <sub>f</sub> · ft or lb ft
Current density	cd	pound-force inch	lb <sub>f</sub> · in or lb in
Cylinder	cyl	Inch	in
Indicated horsepower-hour	iph	Inch per second	in/s or ips

**American National Standard Abbreviations for Scientific and Engineering Terms**  
*ANSI Y1.1-1972, (R 1984) (Continued)*

Intermediate pressure	ip	Inch-pound	in lb
Internal	intl	pound-force per square foot	lb <sub>f</sub> /ft <sup>2</sup> or psf
Kilovolt-ampere/hour	KVA-h or kVAh	pound-force per square inch	lb <sub>f</sub> /in <sup>2</sup> or psi
Kilowatt-hour meter	kwhm	pound per horsepower	lb/hp or php
Latitude	lat	Power factor	pf
Least common multiple	lcm	Quart	qt
Liquid	liq	Reactive volt-ampere meter	rva
Logarithm (common)	log	Revolution per minute	r/min or rpm
Logarithm (natural)	ln	Revolution per second	r/s or rps
Low pressure	lp	Root mean square	rms
Lumen per watt	lm/W or lpw	Round	rnd
Magnetomotive force	mmf	Secant	sec
Mathematics (ical)	math	Second	s or sec
Maximum	max	Sine	sin
Mean effective pressure	mep	Specific gravity	sp gr
Melting point	mp	Specific heat	sp ht
Meter	m	Square	sq
Meter-kilogram-second	mks	Square centimeter	cm <sup>2</sup> or sq cm
Microfarad	μF	Square foot	ft <sup>2</sup> or sq ft
Mile	mi	Square inch	in <sup>2</sup> or sq in
Mile per hour	mi/h or mph	Square kilometer	km <sup>2</sup> or sq km
Milliamper	m/A	Square root of mean square	rms
Minimum	min	Standard	std
Molecular weight	mol wt	Tangent	tan
Molecule	mo	Temperature	temp
National Electrical Code	NEC	Tensile strength	ts
Ounce	oz	Versed sine	vers
Ounce-inch	oz in	Volt	V
Pennyweight	dwt	Watt	W
Pint	pt	Watt-hour	Wh
Potential	pot	Week	wk
Potential difference	pd	Weight	wt
Pound	lb	Yard	yd

Alternative abbreviations conforming to the practice of the International Electrotechnical Commission.

Ampere	A	Kilovolt-ampere	kVA	Microfarad	μF	Milliamper	mA
Ampere-hour	Ah	Kilowatt	kW	Microwatt	μW	Volt	V
Coulomb	C			Milliamper	mA	Volt-ampere	VA
Farad	F	Kilowatthour	kWh	Millifarad	mF	Volt-coulomb	VC
Henry	H	Megawatt	MW	Millihenry	mH	Watt	W
Joule	J	Megohm	MΩ	Millivolt	mV	Watt-hour	Wh
Kilovolt	kV	Microampere	μA	Ohm	Ω	Volt	VA

Only the most commonly used terms have been included. These forms are recommended for those whose familiarity with the terms used makes possible a maximum of abbreviations. For others, less contracted combinations made up from this list may be used. For example, the list gives the abbreviation of the term "feet per second" as "fps." To some, however, ft per sec will be more easily understood.

Abbreviations should be used sparingly and only where their meaning will be clear. If there is any doubt, then spell out the term or unit of measurement.

The following points are good practice when preparing engineering documentation. Terms denoting units of measurement should be abbreviated in text only when preceded by the amounts indicated in numerals: "several inches," "one inch," "12 in." A sentence should not begin with a numeral followed by an abbreviation. The use of conventional signs for abbreviations in text should be avoided: use "lb," not "#" or "in," not".

Symbols for the chemical elements are listed in the table on page 363.