

# APPENDIX I

## SI AND ENGLISH UNITS AND CONVERSION FACTORS

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The International System of Units (Système International d'Unités, or SI) recognizes seven basic units from which all others are derived. They are:

<i>No.</i>	<i>Quantity</i>	<i>Name of Unit</i>	<i>Symbol</i>
1	length	meter	m
2	mass	kilogram	kg
3	time	second	s
4	electric current	ampere	A
5	temperature	kelvin	K
6	luminous intensity	candela	cd
7	amount of substance	mole	mol

Multiples of units are designated by the following names:

<i>Amount</i>	<i>Prefix</i>	<i>Symbol</i>	<i>Amount</i>	<i>Prefix</i>	<i>Symbol</i>
10 <sup>1</sup>	deca	da	10 <sup>-1</sup>	deci	d
10 <sup>2</sup>	hecto	h	10 <sup>-2</sup>	centi	c
10 <sup>3</sup>	kilo	k	10 <sup>-3</sup>	milli	m
10 <sup>6</sup>	mega	M	10 <sup>-6</sup>	micro	μ
10 <sup>9</sup>	giga	G	10 <sup>-9</sup>	nano	n

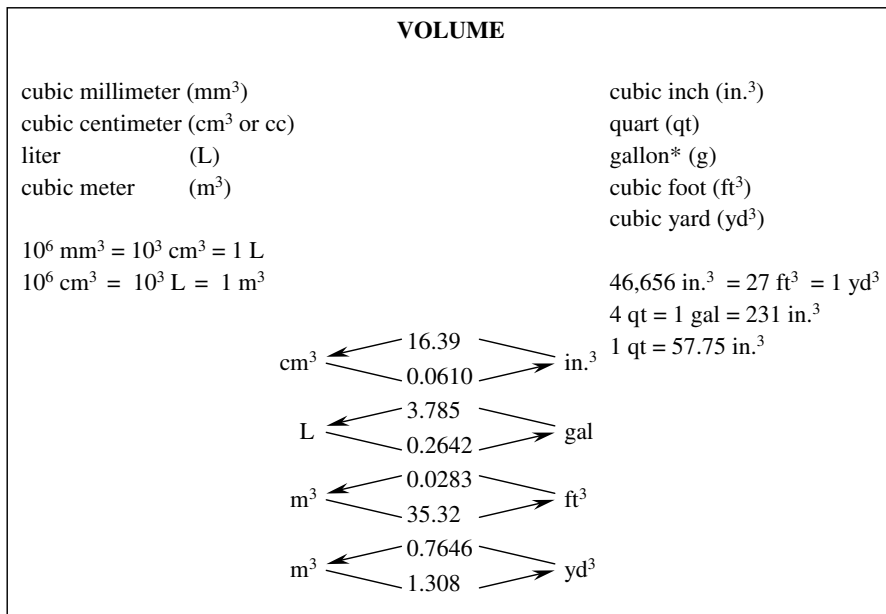
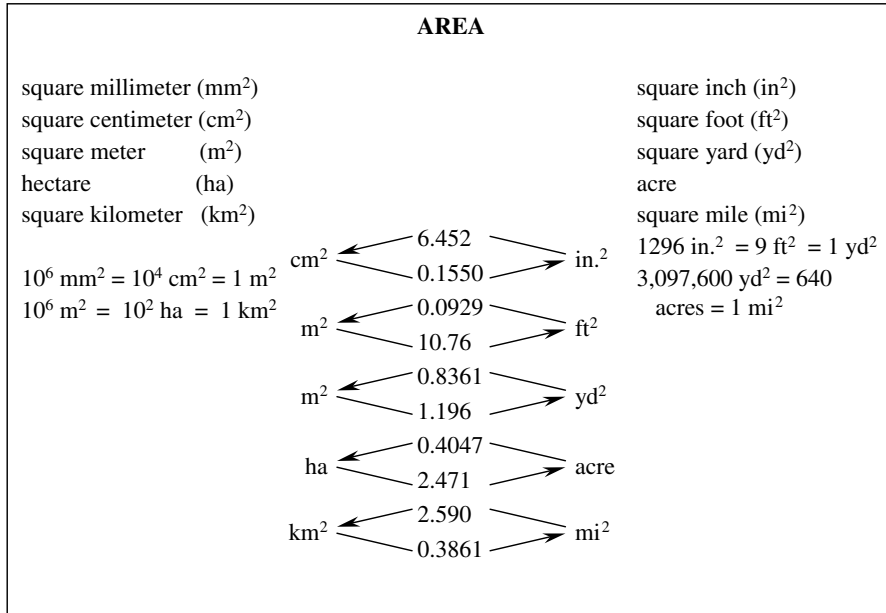
This appendix presents the SI and English (imperial) units, which are used in various areas of transportation engineering, and their conversion factors. Some metric units and factors that are not listed in the SI but are commonly used and remain internationally recognized are also included. Examples are the units of centimeter (10<sup>-2</sup> m), hour (3.6 × 10<sup>3</sup> s) and kilowatt-hour (3.6 MJ) and multiples of 10, 10<sup>2</sup>, 10<sup>-1</sup>, and 10<sup>-2</sup>.

For more extensive coverage of units, the following book is suggested:  
Cardarelli, Francois. *Scientific Unit Conversion*. New York: Springer-Verlag, 2003.

Units and conversion factors within and between the two systems of measures are presented here for each dimension in a separate box. The format followed for each dimension is shown in the first box:

<b>DIMENSION</b>	
<i>SI unit (symbol)</i>	<i>English unit (symbol)</i>
<i>Conversion factors</i>	
(for conversion in the direction of the arrow, multiply by the number provided)	

<b>LENGTH</b>		
millimeter (mm) centimeter (cm) meter (m) kilometer (km)	inch (in. ") foot (ft. ') yard (yd) mile (mi)	
$10^3 \text{ mm} = 10^2 \text{ cm} = 1 \text{ m}$ $10^3 \text{ m} = 1 \text{ km}$	$36 \text{ in.} = 3 \text{ ft} = 1 \text{ yd}$ $5280 \text{ ft} = 1760 \text{ yd} = 1 \text{ mi}$	
mm	$\begin{array}{ccc} & 25.40 & \\ \swarrow & & \searrow \\ & 0.0394 & \\ \swarrow & & \searrow \\ & 0.3048 & \\ \swarrow & & \searrow \\ & 3.281 & \\ \swarrow & & \searrow \\ & 0.9144 & \\ \swarrow & & \searrow \\ & 1.094 & \\ \swarrow & & \searrow \\ & 1.609 & \\ \swarrow & & \searrow \\ & 0.6214 & \end{array}$	in.
m	$\begin{array}{ccc} & 0.3048 & \\ \swarrow & & \searrow \\ & 3.281 & \\ \swarrow & & \searrow \\ & 0.9144 & \\ \swarrow & & \searrow \\ & 1.094 & \\ \swarrow & & \searrow \\ & 1.609 & \\ \swarrow & & \searrow \\ & 0.6214 & \end{array}$	ft
m	$\begin{array}{ccc} & 0.9144 & \\ \swarrow & & \searrow \\ & 1.094 & \\ \swarrow & & \searrow \\ & 1.609 & \\ \swarrow & & \searrow \\ & 0.6214 & \end{array}$	yd
km	$\begin{array}{ccc} & 1.609 & \\ \swarrow & & \searrow \\ & 0.6214 & \\ \swarrow & & \searrow \\ & & \end{array}$	mi





**ACCELERATION**

meters per second squared (m/s <sup>2</sup> ) (km/h/s is not used)  $g = 9.807 \text{ m/s}^2$	feet per second squared (ft/s <sup>2</sup> ) miles per hour per second (mphs) $g = 32.18 \text{ ft/s}^2$ $1 \text{ mphs} = 1.467 \text{ ft/s}^2$
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m/s <sup>2</sup>	← 0.3048	→	ft/s <sup>2</sup>
	← 3.281	→	
m/s <sup>2</sup>	← 0.4470	→	mphs
	← 2.237	→	

**JERK**

meters per second cubed (m/s <sup>3</sup> )	feet per second cubed (ft/s <sup>3</sup> )
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Factors are the same as the corresponding ones for acceleration.

**FORCE, WEIGHT**

dyne (dyn) newton (N) kilonewton (kN) (metric) ton or tonne (t) (not in SI)  $10^8 \text{ dynes} = 10 \text{ N} = 1 \text{ kN}$ Force = mass × acceleration  $1 \text{ N} = 1 \text{ kg m/s}^2$	ounce (oz) pound force (lbf) 10 <sup>3</sup> pounds (kip) (short) ton force (tnf or s.tnf) $3200 \text{ oz} = 2000 \text{ lbf} = 1 \text{ tnf}$  $\text{Force} = \frac{\text{weight} \times \text{acceleration}}{\text{gravity const. } (g_c)}$ $g_c = 32.18 \frac{\text{lbm} \cdot \text{ft}}{\text{lbf} \cdot \text{s}^2}$
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N	← 4.448	→	lbf
	← 0.2248	→	
kN	← 8.896	→	tnf
	← 0.1124	→	

**LINEAL MASS\***

kilograms per meter (kg/m)

pounds per yard (lb/yd)

$$\begin{array}{ccc} & 0.4960 & \\ \swarrow & & \searrow \\ \text{kg/m} & & \text{lb/yd} \\ \searrow & 2.016 & \swarrow \end{array}$$

\*Common use in transportation: mass of rails.

**PRESSURE\***

pascal (Pa)

kilogram force per square

meter (kgf/m<sup>2</sup>)1 kgf/m<sup>2</sup> = 9.807 Papounds force per square  
inch (lbf/in.<sup>2</sup>) (psi)pounds force per square  
foot (lbf/ft<sup>2</sup>)

$$\begin{array}{ccc} & 6,894.76 & \\ \swarrow & & \searrow \\ \text{Pa} & & \text{psi} \\ \searrow & 1.45 \times 10^{-4} & \swarrow \\ & & \\ & 47.88 & \\ \swarrow & & \searrow \\ \text{Pa} & & \text{lbf/ft}^2 \\ \searrow & 0.02089 & \swarrow \end{array}$$

\*Often used for area weight of vehicles.

**FUEL CONSUMPTION (C)  
AND EFFICIENCY (E)\***(C) liters per 100 kilometers  
(L/100 km)(C) joules per kilometer  
(J/km)

(E) kilometers per liter (km/L)

(C) gallons per mile  
(gpm, gal/mi)(C) British thermal units  
per mile (Btu/mi)(E) miles per gallon  
(mpg, mi/gal)

$$\begin{array}{ccc} & 0.4251 & \\ \swarrow & & \searrow \\ \text{m/s} & & \text{ft/s} \\ \searrow & 2.352 & \swarrow \\ & & \\ & 235.2 & \\ \swarrow & & \searrow \\ \text{km/h} & & \text{mph} \\ \searrow & 0.00425 & \swarrow \\ & & \\ & 0.6557 \times 10^3 & \\ \swarrow & & \searrow \\ \text{km/h} & & \text{mph} \\ \searrow & 1.525 \times 10^{-3} & \swarrow \end{array}$$

