

30. DIMENSIONAL UNITS

30.1 SI System Basic Units

The SI (International System) system of units comprises the basic units

m (meter) for length
 kg (kilogram) for mass
 s (second) for time
 k (Kelvin) for thermodynamic temperature

30.2 Prefixes And Prefix Symbols

Name	Power to Ten	Prefix	Prefix symbol
Decimal multiples			
tenfold	10 ¹	deca	da
hundredfold	10 ²	hecto	h
thousandfold	10 ³	kilo	k
millionfold	10 ⁶	mega	M
milliardfold	10 ⁹	giga	G
billionfold	10 ¹²	tera	T
Decimal fractions			
tenth	10 ⁻¹	deci	d
hundredth	10 ⁻²	centi	c
thousandth	10 ⁻³	milli	m
millionth	10 ⁻⁶	micro	μ
milliardth	10 ⁻⁹	nano	n
billionth	10 ⁻¹²	pico	p
billiardth	10 ⁻¹⁵	femto	f
trillionth	10 ⁻¹⁸	atto	a

Table 12 : Prefixes And Symbols

The prefix symbols shown in Table 12 above should be placed directly before the unit symbol, without any space between them.

30.3 Conversion Factors

Acceleration

$$1 \text{ m/s}^2 = \text{ft/s}^2 \times 0.3048 \qquad \text{ft/s}^2 = \text{m/s}^2 \times 3.281$$

$$\text{Gravitational acceleration} = 9.81 \text{ m/s}^2 = 32.2 \text{ ft/s}^2$$

Angle

$$\begin{aligned} \text{radians} &= \text{degree} \times 0.0174533 & \text{degree} &= \text{radians} \times 57.29575 \\ \text{minute} &= \text{degree} \times 0.0166667 & \text{degree} &= \text{minute} \times 60 \\ \text{second} &= \text{degree} \times 0.0002778 & \text{degree} &= \text{second} \times 3600 \end{aligned}$$

Area

$$\begin{aligned} \text{m}^2 &= \text{ft}^2 \times 0.0929 & \text{ft}^2 &= \text{m}^2 \times 10.7639 \\ \text{mm}^2 &= \text{in}^2 \times 645.16 & \text{in}^2 &= \text{mm}^2 \times 0.00155 \end{aligned}$$

Bending Moment

$$\text{Nm} = \text{lbf ft} \times 1.35582 \qquad \text{lbf ft} = \text{Nm} \times 0.7376$$

Density

$$\begin{aligned} \text{kg/m}^3 &= \text{lb/ft}^3 \times 16.02 & \text{lb/ft}^3 &= \text{kg/m}^3 \times 0.0624 \\ \text{kg/m}^3 &= \text{tonne/m}^3 \times 1000 & \text{tonne/m}^3 &= \text{kg/m}^3 \times 0.001 \end{aligned}$$

$$\text{Density of dry air} = 1.2 \text{ kg/m}^3 = 0.075 \text{ lb/ft}^3 \text{ at } 20^\circ\text{C}$$

$$\text{Density of water} = 1 \text{ kg/litre} = 1000 \text{ kg/m}^3 = 1 \text{ tonne/m}^3$$

Energy

$$\begin{aligned} \text{MJ} &= \text{kwhr} \times 3.6 & \text{kwhr} &= \text{MJ} \times 0.2778 \\ \text{kJ} &= \text{BTU} \times 1.0551 & \text{BTU} &= \text{kJ} \times 0.9478 \\ \text{J} &= \text{cal} \times 4.187 & \text{cal} &= \text{J} \times 0.2388 \end{aligned}$$

Enthalpy

kJ/kg	= BTU/lb x 2.326	BTU/lb	= kJ/kg x 0.43
kJ/kg	= kcal/kg x 4.1868	kcal/kg	= kJ/kg x 0.239

Force

N (Newton)	= kgm/s ²
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1 Newton is equal to the force required to impart an acceleration of 1m/s² to body of mass 1 kg.

N	= lb (force) x 4.4483	lb (force)	= N x 0.2248
N	= kg (force) x 9.807	kg (force)	= N x 0.102

Length

1 micron = 10⁻³mm = 10⁻⁶m = 1 mm

mm	= in. x 25.4	in	= mm x 0.03937
mm	= ft x 304.8	ft	= mm x 0.00328
m	= ft x 0.3048	ft	= m x 3.2808
km	= mile x 1.609	mile	= km x 0.6215
m	= yd x 0.9144	yd	= m x 1.0936

Mass

kg	= lb x 0.4536	lb	= kg x 2.2046
tonne	= ton x 1.01605	ton	= tonne x 0.9842
tonne	= kg x 0.001	kg	= tonne x 1000
lb	= oz x 0.0625	oz	= lb x 16

Mass per unit length

kg/m	= lb/ft x 1.4882	lb/ft	= kg/m x 0.672
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Modulus of Elasticity & Stress

MPa	= tonf/in ² x 15.444	tonf/in ²	= MPa x 0.06475
MPa	= psi x 0.0069	psi	= MPa x 145
MPa	= N/mm ²		

Moment of Inertia

kg m ²	= lb.ft ² x 0.04215	lb.ft ²	= kgm ² x 23.7248
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Power

kw	= hp x 0.7457	hp	= kw x 1.341
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Fan absorbed power = (0.1 x m³/s x Pa) 4 Fan efficiency in %

Pressure

$$1\text{Pa (Pascal)} = 1 \frac{\text{N}}{\text{m}^2} = 1 \frac{\text{kg}}{\text{ms}^2}$$

Absolute pressure is the pressure compared with zero pressure in empty space.

Atmospheric pressure can be expressed in various units and is equal to 1.013 bar, 1013.25 mbar, 101325 Pa, 760 Torr, 29.92 in.Hg, 14.696 psi, 407 in.w.g.

in w.g.	= Pa x 0.004	Pa	= in w.g. x 249
in w.g.	= kPa x 4.016	kPa	= in w.g. x 0.249
in w.g.	= psi x 27.7	psi	= in w.g. x 0.0361
in w.g.	= mbar x 0.402	mbar	= in w.g. x 2.49
in w.g.	= mm w.g. x 0.03937	mm w.g.	= in w.g. x 25.4
kPa	= psi x 6.895	psi	= kPa x 0.145
kPa	= mm w.g. x 0.00981	mm w.g.	= kPa x 101.94
mm w.g.	= psi x 704.2	psi	= mm w.g. x 0.00142
mm Hg (Torr)	= Pa x 0.0075	Pa	= mm Hg x 133.33
mm Hg	= in w.g. x 13.6	in w.g.	= mm Hg x 0.07353
in Hg	= kPa x 0.2953	kPa	= in Hg x 3.3864
in Hg	= psi x 2.0367	psi	= in Hg x 0.491
Pa	= mbar x 100	mbar	= Pa x 0.01
Pa	= mm w.g. x 9.81	mm w.g.	= Pa x 0.102

Rotational Speed

rpm	= rev/s x 60	rev/s	= rpm x 0.01667
rpm	= rad/s x 9.551	rad/s	= rpm x 0.1047

Specific Volume

m ³ /kg	= ft ³ /lb x 0.06243	ft ³ /lb	= m ³ /kg x 16.0185
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Specific volume for dry air = 0.833 m³/kg @ 20°C

Specific volume for water = 0.001 m³/kg

Temperature

°C	= (°F - 32) x ⁵ / ₉	°F	= (°C x ⁹ / ₅) + 32
°K (Kelvin)	= °C + 273.15	°C	= °K - 273.15
°R (Rankine)	= °F + 459.6	°F	= °R - 459.6
°K	= °R x ⁵ / ₉	°R	= °K x ⁹ / ₅

°K (Kelvin) and °R (Rankine) are absolute temperatures. At the absolute zero temperature of -459.6°F or -273.15°C, there is no molecular movement within a body.

Water boils at 100°C (212°F) and freezes at 0°C (32°F)

Did you know that -40°C = -40°F?

Torque

Nm	= lb.ft x 1.35582	lb.ft	= Nm x 0.7376
Nm	= lb.in x 0.113	lb.in	= Nm x 8.85

Torque in Nm = $\frac{\text{kw(output)} \times 9560}{\text{rpm}}$ where 9560 = $\frac{60 \times 1000}{2\pi}$

Velocity

ft/s	= m/s x 3.281	m/s	= ft/s x 0.3048
ft/min	= m/s x 196.85	m/s	= ft/min x 0.00508
m/min	= m/s x 60	m/s	= m/min x 0.01667
km/hr	= m/s x 3.6	m/s	= km/hr x 0.2778
m/s	= mph x 0.44704	mph	= m/s x 2.2369
km/hr	= mph x 1.609	mph	= km/hr x 0.621

Velocity Pressure

Velocity pressure in Pa = 0.5rv², where r = density, kg/m³; v = velocity, m/s

Volume

m ³	= ft ³ x 0.02832	ft ³	= m ³ x 35.3147
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Volume Flowrate

cfm	= m ³ /hr x 0.5886	m ³ /hr	= cfm x 1.699
cfm	= m ³ /min x 35.31	m ³ /min	= cfm x 0.02832
cfm	= m ³ /s x 2118.6	m ³ /s	= cfm x 0.000472
cfm	= l/s x 2.1186	l/s	= cfm x 0.472
cfm	= l/min x 0.0353	l/min	= cfm x 28.32