Engineering Units

Dimensional Analysis

Dimensions and Units

- SI Units
  - Base Dimensions
  - Named Derived Dimensions
  - Metric Prefixes
- English Unit Conversions
- Unit Conversions
- Dimensional Analysis

Base SI Units

- Meter
- Kilogram
- Second
- Degrees Kelvin
- Ampere
- Mole
- Candela

TABLE 2 Base Dimensions and their SI Units

QUANTITY	UNIT	SYMBOL
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	cd

Named Derived Units

TABLE 4 Derived Dimensions and SI Units with Specific Names

QUANTITY	SI UNIT	UNIT NAME	BASE UNITS
Frequency	Hz	hertz	s^{-1}
Force	N	newton	$kg \cdot m \cdot s^{-2}$
Pressure	Pa	pascal	$kg \cdot m^{-1} \cdot s^{-2}$
Stress	Pa	pascal	$kg \cdot m^{-1} \cdot s^{-2}$
Energy	J	joule	$kg \cdot m^{2} \cdot s^{-2}$
Work	J	joule	$kg \cdot m^{2} \cdot s^{-2}$
Heat	J	joule	$kg \cdot m^{2} \cdot s^{-2}$
Power	W	watt	$kg \cdot m^{2} \cdot s^{-3}$
Electric charge	C	coulomb	$A \cdot s$
Electric potential (voltage)	V	volt	$kg \cdot m^{2} \cdot s^{-3} \cdot A^{-1}$
Electric resistance	Ω	ohm	$kg \cdot m^{2} \cdot s^{-3} \cdot A^{-2}$
Magnetic flux	Wb	weber	$kg^{-1} \cdot m \cdot s^{-2} \cdot A^{-1}$
Luminous flux	lm	lumen	$cd \cdot sr$

Metric Prefixes

TABLE 6 Standard Prefixes for SI Units

MULTIPLE	EXPONENTIAL FORM	PREFIX	PREFIX SYMBOL
1,000,000,000,000	10^{12}	tera	T
1,000,000,000	10^{9}	giga	G
1,000,000	10^{6}	mega	M
1,000	10^{3}	kilo	k
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ
0.000 000 001	10^{-9}	nano	n
0.000 000 000 001	10^{-12}	pico	p

Metric-English Conversions

60 miles/h = 1 mile/min

Speed of light
- 186,000 miles/sec
- 3 * 10^8 meters/sec
- ~ 1 ft/nsec

Speed of sound (air)
- Mach 1 (sea level)
- 331.4 + 0.6T(ºC)
- 762 miles/hour
- ~ 1 ft/msec

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Airman Chris M. Valdez

TABLE 11 Some Common SI-to-English Unit Conversions

QUANTITY	UNIT CONVERSION
Acceleration	1 m/s^2 = 3.2808 ft/s^2
Area	1 m^2 = 10.7636 ft^2 = 1550 in^2
Density	1 kg/m^3 = 0.06243 lb_m/ft^3
Energy, work, heat	1055.06 J = 1 Btu = 252 cal
Force	1 N = 0.22481 lb_f
Length	1 m = 3.2808 ft = 39.370 in
	0.0254 m = 1 in(1)
Mass	1 kg = 2.20462 lb_m = 0.06852 slug
Power	1 W = 3.4121 Btu/h
	745.7 W = 1 hp
Pressure	1 kPa = 20.8855 lb_f/ft^2 = 0.14504 lb_f/in^2
Specific heat	1 kJ/kg · °C = 0.2388 Btu/lb_m · °F
Temperature	T(K) = T(°C) + 273.16 = T(°R)/1.8 = [T(°F) + 459.67]/1.8
Velocity	1 m/s = 2.2369 mi/h

(1) Exact conversion

Dimensional Analysis

- Unit Conversion
  - 1 mile/min = ? Mile/Hour
    1mile/min*60min/h = 60 mile/hour
  - 186000 mile/sec * 5280 ft/mile = 982080000 = 0.982 * 10^9 ft/sec ~ 1 ft/nsec (~2% error)
  - (762 mile/hour*5280 ft/mile)/(3600 sec/hour) = 1117.6 ft/sec ~ 1 ft/msec (~10% error)
- Validation of Calculations