The greek alphabet الحروف اليونانية

Alpha	A	α	Nu	N	ν
Beta	B	β	Xi	Ξ	ξ
Gamma	Γ	γ	Omicron	O	o
Delta	Δ	δ	Pi	Π	π
Epsilon	E	ε	Rho	P	ρ
Zeta	Z	ζ	Sigma	Σ	σ
Eta	H	η	Tau	T	τ
Theta	Θ	θ	Upsilon	Y	υ
Iota	I	ι	Phi	Φ	ϕ
Kappa	K	κ	Chi	X	χ
Lambda	Λ	λ	Psi	Ψ	ψ
Mu	M	μ	Omega	Ω	ω

SI Prefixed (Multipliers)

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{24}	yotta-	Y	10^{-24}	yocto-	y
10^{21}	zeta-	Z	10^{-21}	zepto-	z
10^{18}	exa-	E	10^{-18}	atto-	a
10^{15}	peta-	P	10^{-15}	**femto-**	**f**
10^{12}	**tera-**	**T**	10^{-12}	**pico-**	**p**
10^{9}	**giga-**	**G**	10^{-9}	**nano-**	**n**
10^{6}	**mega-**	**M**	10^{-6}	**micro-**	$\boldsymbol{\mu}$
10^{3}	**kilo-**	**k**	10^{-3}	**milli-**	**m**
10^{2}	hecta-	h	10^{-2}	**centi-**	**c**
10^{1}	deca-	da	10^{-1}	deci-	d

1.13:

For each quantity listed, indicate dimensions using mass as a primary dimension, and give typical SI and English units:

(a) Power

$$[\dot{W}] = \left[\frac{E}{t}\right] = \left[\frac{Fd}{t}\right] = \left[\frac{mad}{t}\right] = \frac{M \cdot L \cdot t^{-2} \cdot L}{t}$$

$[\dot{W}] = ML^2 t^{-3}$; SI : $kg \cdot m^2 \cdot s^{-3}$

EE : $lb_m \cdot ft^2 \cdot s^{-3}$

(b) Pressure

$$[P] = \left[\frac{F}{A}\right] = \left[\frac{ma}{A}\right] = ML \cdot t^{-2} \cdot L^{-2} = ML^{-1}t^{-2}$$

SI : $kg \cdot m^{-1} \cdot s^{-2}$

EE : $lb_m \cdot ft^{-1} \cdot s^{-2}$

(c) Modulus of elasticity

$$[E] = \left[\frac{\sigma}{\varepsilon}\right] = \left[\frac{F L_0}{A \Delta L}\right] = M\cancel{L}\, t^{-2} \cdot L \cdot L^{-2} \cdot \cancel{L^{-1}} = ML^{-1}t^{-2}$$

SI : $kg \cdot m^{-1} \cdot s^{-2}$

EE : $lb_m \cdot ft^{-1} \cdot s^{-2}$

(d) Angular velocity

$$[\omega] = \left[\frac{rad}{t}\right] = t^{-1}$$

SI : s^{-1}

EE : s^{-1}

(e) Energy

$$[E] = [Fd] = MLt^{-2} \cdot L = ML^2t^{-2}$$

SI : $kg \cdot m^2 \cdot s^{-2}$
EE : $lb_m \cdot ft^2 \cdot s^{-2}$

(f) Moment of a force

$$[M] = [Fd] = ML^2t^{-2}$$

SI : $kg \cdot m^2 \cdot s^{-2}$
EE : $lb_m \cdot ft^2 \cdot s^{-2}$

(g) Momentum

$$[P] = [mV] = MLt^{-1}$$

SI : $kg \cdot m \cdot s^{-1}$
EE : $lb_m \cdot ft \cdot s^{-1}$

(h) Shear stress

$$[\tau] = [P] = ML^{-1}t^{-2}$$

SI : $kg \cdot m^{-1} \cdot s^{-2}$
EE : $lb_m \cdot ft^{-1} \cdot s^{-2}$

(i) Strain

$$[\varepsilon] = \left[\frac{\Delta L}{L_0}\right] = \frac{L}{L} = 1$$

Dimensionless

(j) Angular momentum

$$[H] = [P d] = [m v d] = M L t^{-1} L = M L^2 t^{-1}$$

SI : $kg \cdot m^2 \cdot s^{-1}$

EE : $lb_m \cdot ft^2 \cdot s^{-1}$

1.17:

Express the following in SI units:

(a) $7.5\ acre \cdot \text{ft}$

$1\ acre = 4047\ m^2$

$1\ \text{ft} = 0.3048\ m$

$$7.5\ \cancel{acre} \cdot \cancel{ft} * \frac{0.3048\ m}{1\ \cancel{ft}} * \frac{4047\ m^2}{1\ \cancel{acre}} = 9251.44\ m^3$$

(b) $190\ in^3/s$

$1\ in = 0.0254\ m$

$$\frac{190\ \cancel{in^3}}{1\ sec} * \frac{0.0254^3\ m^3}{1\ \cancel{in^3}} = 3.114 \times 10^{-3}\ m^3/s$$

(c) $5\ gpm$

$1\ gal = 0.003785\ m^3$

$$\frac{5\ \cancel{gal}}{1\ \cancel{min}} * \frac{0.003785\ m^3}{1\ \cancel{gal}} * \frac{1\ \cancel{min}}{60\ sec} = 3.154 \times 10^{-4}\ \frac{m^3}{sec}$$

(d) $5\ mph/s$

$1\ mile = 5280\ \text{ft}$

$1\ \text{ft} = 0.3048\ m$

$$\frac{5\ \cancel{mil}}{\cancel{hr}.S} * \frac{5280\ \cancel{ft}}{1\ \cancel{mil}} * \frac{0.3048\ m}{1\ \cancel{ft}} * \frac{1\ \cancel{hr}}{60*60\ S} = 2.2352\ m/S^2$$

1.27:

In chapter 9 we will study aerodynamics and learn that the drag force F_D on a body is given by

$$F_D = \frac{1}{2}\rho V^2 A C_D$$

Hence the drag depends on speed V, fluid density ρ, and body size (indicated by frontal area A) and shape (indicated by drag coefficient C_D). What are the dimensions of C_D?

Solution

$$C_D = \frac{F_D}{\frac{1}{2}\rho V^2 A}$$

$$[C_D] = \left[\frac{F_D}{\rho V^2 A}\right] = \left[\frac{ma}{\rho V^2 A}\right]$$

$$[C_D] = \left[\frac{\cancel{M} L t^{-2}}{\cancel{M} L^{-3} \cdot L^2 t^{-2} \cdot L^2}\right]$$

$$[C_D] = \left[\frac{\cancel{L} \cancel{t^{-2}}}{\cancel{L} \cancel{t^{-2}}}\right] = 1$$

Dimensionless

1.29:

An important equation in the theory of vibrations is

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = f(t)$$

where m (kg) is the mass and x (m) is the position at time t (s). For a dimensionally consistent equation, what are the dimensions of c, k, and f? What would be suitable units for c, k, and f in the SI and BG systems?

Solution

$$\left[m\frac{d^2x}{dt^2}\right] = [ma] = MLt^{-2}$$

$$\left[c\frac{dx}{dt}\right] = [cv] = [c]Lt^{-1}$$

$$[kx] = [k]L$$

* Dimensional Consistency dictate every term to have the same dimensions

$$[c]\cancel{L}t^{-1} = M\cancel{L}t^{-2} \Rightarrow [c] = \frac{Mt^{-2}}{t^{-1}} = Mt^{-1} \#$$

$$[k]\cancel{L} = M\cancel{L}t^{-2} \Rightarrow [k] = Mt^{-2} \#$$

$$[f] = MLt^{-2} \#$$

	SI	BG
c	$kg \cdot s^{-1}$	$slug \cdot s^{-1}$
k	$kg \cdot s^{-2}$	$slug \cdot s^{-2}$
f	$kg \cdot m \cdot s^{-2}$	$slug \cdot ft \cdot s^{-2}$