SI PREFIX	SI SYMBOL	SI UNIT CONVERSION FACTOR (STANDARD FORM)	FACTOR (POWER)	FACTOR LANGUAGE
yotta	Y	1 yottametre = 1 000 000 000 000 000 000 000 000 metres	10^{24}	septillion
zetta	Z	1 zettametre = 1 000 000 000 000 000 000 000 metres	10^{21}	sextillion
exa	E	1 exametre = 1 000 000 000 000 000 000 metres	10^{18}	quintillion
peta	P	1 petametre = 1 000 000 000 000 000 metres	10^{15}	quadrillion
tera	T	1 terametre = 1 000 000 000 000 metres	10^{12}	trillion
giga	G	1 gigametre = 1 000 000 000 metres	10^{9}	billion
mega	M	1 megametre = 1 000 000 metres	10^{6}	million
kilo	k	1 kilometre = 1 000 metres	10^{3}	thousand
hecto	h	1 hectometre = 100 metres	10^{2}	hundred
deca	da	1 decametre = 10 metres	10^{1}	ten
		1 metre = 1 metre	$\mathbf{10^{0}}$	**one**
deci	d	1 decimetre = 0.1 metres	10^{-1}	tenth
centi	c	1 centimetre = 0.01 metres	10^{-2}	hundredth
milli	m	1 millimetre = 0.001 metres	10^{-3}	thousandth
micro	µ	1 micrometre = 0.000 001 metres	10^{-6}	millionth
nano	n	1 nanometre = 0.000 000 001 metres	10^{-9}	billionth
pico	p	1 picometre = 0.000 000 000 001 metres	10^{-12}	trillionth
femto	f	1 femtometre = 0.000 000 000 000 001 metres	10^{-15}	quadrillionth
atto	a	1 attometre = 0.000 000 000 000 000 001 metres	10^{-18}	quintillionth
zepto	z	1 zeptometre = 0.000 000 000 000 000 000 001 metres	10^{-21}	sextillionth
yocto	y	1 yoctometre = 0.000 000 000 000 000 000 000 001 metres	10^{-24}	septillionth

Magnitude and Direction of a vector

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2} \qquad \theta = Tan^{-1}\left(\frac{A_y}{A_x}\right)$$

Forces

$$\sum \vec{F} = m\vec{a} \qquad f_k = \mu_k F_N \qquad f_s = \mu_s F_N$$
$$F_g = mg \qquad \vec{F}_g = G\frac{m_1 m_2}{r^2}\hat{r} \qquad G = 6.67 \times 10^{-11} N\frac{m^2}{kg^2}$$

Uniform Circular Motion

$$\vec{R} = (RCos\theta)\hat{i} + (RSin\theta)\hat{j} \qquad \vec{v} = (-R\omega Sin\theta)\hat{i} + (R\omega Cos\theta)\hat{j} \qquad \vec{a} = (-R\omega^2 Cos\theta)\hat{i} + (-R\omega^2 Sin\theta)\hat{j}$$
$$\omega = \frac{d\theta}{dt} \qquad a_c = \frac{v^2}{R}$$

Kinematic Relationships

$$\vec{r} - \vec{r}_o = \int \vec{v}dt \qquad \vec{v} - \vec{v}_o = \int \vec{a}dt \qquad \vec{a} = \frac{d\vec{v}}{dt} \qquad \vec{v} = \frac{d\vec{r}}{dt}$$

Constant Acceleration Equations

$$x = x_o + v_{ox}t + \frac{1}{2}a_x t^2 \qquad v_x = v_{ox} + a_x t \qquad v_x^2 = v_{ox}^2 + 2a_x\Delta x$$
$$y = y_o + v_{oy}t + \frac{1}{2}a_y t^2 \qquad v_y = v_{oy} + a_y t \qquad v_y^2 = v_{oy}^2 + 2a_y\Delta y$$

Basic Integral and Derivative Forms

$$\int x^n dx = \frac{1}{n+1}x^{n+1} \qquad \frac{dx^n}{dx} = nx^{n-1}$$

Dot Product

$$\vec{A}\cdot\vec{B} = ABCos\theta$$
$$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$$

Energy and Momentum

$$P.E._{grav.} = mgh \quad P.E._{elast.} = \frac{1}{2}kx^2 \quad K.E. = \frac{1}{2}mv^2$$
$$E_{sys} = P.E. + K.E. \quad W = \int \vec{F} \cdot d\vec{r}$$

$$\vec{p} = m\vec{v} \qquad \vec{p}_f = \vec{p}_i$$

$$\Delta\vec{p} = \int \vec{F} dt$$
$$v_{1f} = \left(\frac{-2m_2}{m_1 + m_2}\right)v_{2i} + \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{1i}$$
$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right)v_{1i} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)v_{2i}$$

Rotational Kinematics

$$\vec{\theta} - \vec{\theta}_o = \int \vec{\omega} dt \qquad \vec{\omega} - \vec{\omega}_o = \int \vec{\alpha} dt \qquad \vec{\omega} = \frac{d\vec{\theta}}{dt} \qquad \vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

Constant Angular Acceleration Equations

$$\vec{\theta} = \vec{\theta}_o + \vec{\omega}t + \frac{1}{2}\vec{\alpha}t^2 \qquad \vec{\omega} = \vec{\omega}_o + \vec{\alpha}t \qquad \omega^2 = \omega_o^2 + 2\alpha\Delta\theta$$

Cross Product

$$\vec{A} \times \vec{B} = (A_yB_z - A_zB_y)\hat{i} - (A_xB_z - A_zB_x)\hat{j} + (A_xB_y - A_yB_x)\hat{k}$$

Torque

$$\vec{\tau} = \vec{r} \times \vec{F} \qquad |\vec{\tau}| = rFSin\theta \qquad \sum \vec{\tau} = I\vec{\alpha}$$

Rotational Energy

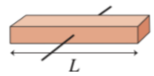
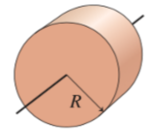
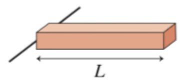
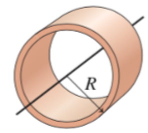
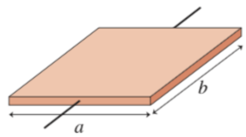
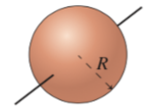
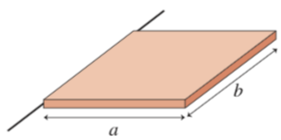
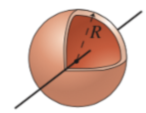
$$W = \vec{\tau} \cdot \vec{\theta} \qquad K.E._{rot} = \frac{1}{2}I\omega^2$$

Moment of Inertia and Center of Mass

$$I = \sum_i m_i r_i^2 \qquad I = \int r^2 dm$$
$$x_{cm} = \sum_i \frac{m_i x_i}{M} \qquad y_{cm} = \sum_i \frac{m_i y_i}{M} \qquad x_{cm} = \frac{1}{M}\int x dm \qquad y_{cm} = \frac{1}{M}\int y dm$$

Moment of Inertia for Select Objects

TABLE 12.2 Moments of inertia of objects with uniform density

Object and axis	Picture	I	Object and axis	Picture	I
Thin rod, about center		$\frac{1}{12}ML^2$	Cylinder or disk, about center		$\frac{1}{2}MR^2$
Thin rod, about end		$\frac{1}{3}ML^2$	Cylindrical hoop, about center		MR^2
Plane or slab, about center		$\frac{1}{12}Ma^2$	Solid sphere, about diameter		$\frac{2}{5}MR^2$
Plane or slab, about edge		$\frac{1}{3}Ma^2$	Spherical shell, about diameter		$\frac{2}{3}MR^2$

Mechanical Oscillations and Waves

$$f = \frac{1}{T} \qquad 2\pi f = \omega$$

Spring-mass oscillator

$$v_{max} = \sqrt{\frac{k}{m}}A \qquad \omega = \sqrt{\frac{k}{m}}$$

Simple Pendulum

$$\omega = \sqrt{\frac{g}{L}}$$

Waves on a String

$$\lambda_m = \frac{2L}{m} \quad m = 1, 2, 3, 4, \ldots$$
$$f_m = \frac{v}{\lambda_m} = m\frac{v}{2L} \quad m = 1, 2, 3, 4, \ldots$$
$$v = \sqrt{\frac{T}{\mu}} \quad \mu = \frac{mass}{Length}$$

Air Columns

Open - Open and Closed - Closed

$$\lambda_m = \frac{2L}{m} \quad m = 1, 2, 3, 4, \ldots$$
$$f_m = \frac{v_s}{\lambda_m} = m\frac{v_s}{2L} \quad m = 1, 2, 3, 4, \ldots$$

Open - Closed

$$\lambda_m = \frac{4L}{m} \quad m = 1, 3, 5, 7, \ldots$$
$$f_m = \frac{v}{\lambda_m} = m\frac{v}{4L} \quad m = 1, 3, 5, 7, \ldots$$