Prefixes

a=10^{-18}, f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^3, M=10^6, G=10^9, T=10^{12}, P=10^{15}

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration)
$M_E = 5.98 \times 10^{24}$ kg (mass of Earth)
$m_e = 9.11 \times 10^{-31}$ kg (electron mass)
$c = 299792458$ m/s (speed of light)
$G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (Gravitational constant)
$R_E = 6380$ km (mean radius of Earth)
$m_p = 1.67 \times 10^{-27}$ kg (proton mass)

Units and Conversions

1 inch = 1 in = 2.54 cm (exactly)
1 mile = 5280 ft
1 m/s = 3.6 km/hour
1 acre = 43560 ft^2 = (1 mile)^2/640
1 foot = 1 ft = 12 in = 30.48 cm (exactly)
1 mile = 1609.344 m = 1.609344 km
1 ft/s = 0.6818 mile/hour
1 hectare = 10^4 m^2

Trig summary

$\sin\theta = \frac{\text{(opp)}}{\text{(hyp)}}$, $\cos\theta = \frac{\text{(adj)}}{\text{(hyp)}}$, $\tan\theta = \frac{\text{(opp)}}{\text{(adj)}}$, $\text{(opp)}^2 + \text{(adj)}^2 = \text{(hyp)}^2$.
$\sin\theta = \sin(180^\circ - \theta)$, $\cos\theta = \cos(-\theta)$, $\tan\theta = \tan(180^\circ + \theta)$, $\sin^2\theta + \cos^2\theta = 1$.

Acceleration Equations

$\bar{v} = \frac{\Delta x}{\Delta t}$, $\Delta x = x - x_0$, slope of $x(t)$ curve $= v(t)$.
$\bar{a} = \frac{\Delta v}{\Delta t}$, $\Delta v = v - v_0$, slope of $v(t)$ curve $= a(t)$.

For constant acceleration in one-dimension:
$\bar{v} = \frac{1}{2}(v_0 + v)$, $v = v_0 + at$, $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2a(x - x_0)$.

Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).
$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = \frac{V_y}{V_x}$. θ is the angle from $\vec{V}$ to x-axis.
Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Chapter 4 Equations

Newton's Second Law:
$\vec{F}_{\text{net}} = m\vec{a}$, means $\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$. $\vec{F}_{\text{net}} = \sum \vec{F}_i$, sum over all forces on a mass.

Friction (magnitude):
$f_s \le \mu_s N$ or $F_{\text{fr}} \le \mu_s F_N$ (static friction). $f_k = \mu_k N$ or $F_{\text{fr}} = \mu_k F_N$. (kinetic or sliding friction)

Gravitational force near Earth:
$F_G = mg$, downward.

Chapter 5 Equations

Centripetal Acceleration:
$a_R = \frac{v^2}{r}$, towards the center of the circle.

Circular motion:
speed $v = \frac{2\pi r}{T} = 2\pi r f$, frequency $f = \frac{1}{T}$, where T is the period of one revolution.

Gravitation:
$F = G\frac{m_1 m_2}{r^2}$; $g = \frac{GM}{r^2}$, where $G = 6.67 \times 10^{-11}$ Nm^2/kg^2;

Orbits:
$\frac{v^2}{r} = g = \frac{GM}{r^2}$; $v = \sqrt{\frac{GM}{r}}$. centripetal acceleration = free fall acceleration.

Chapter 6 Equations

Work & Kinetic & Potential Energies:

$W = Fd\cos\theta$, $\quad$ $\mathrm{KE} = \frac{1}{2}mv^2$, $\quad$ $\mathrm{PE}_{\mathrm{gravity}} = mgy$, $\quad$ $\mathrm{PE}_{\mathrm{spring}} = \frac{1}{2}kx^2$. $\quad$ $\theta =$ angle btwn $\vec{F}$ and $\vec{d}$.

Conservation or Transformation of Energy:

Work-KE theorem:

$\Delta\mathrm{KE} = W_{\mathrm{net}} =$ work of all forces.

General energy-conservation law:

$\Delta\mathrm{KE} + \Delta\mathrm{PE} = W_{\mathrm{NC}} =$ work of non-conservative forces.

Power:

$P_{\mathrm{ave}} = \frac{W}{t}$, $\quad$ or use $P_{\mathrm{ave}} = \frac{\mathrm{energy}}{\mathrm{time}}$.

Chapter 7 Equations

Momentum & Impulse:

momentum $\vec{p} = m\vec{v}$, $\quad$ impulse $\Delta\vec{p} = \vec{F}_{\mathrm{ave}}\,\Delta t$.

Conservation of Momentum:

(2-body collision): $\quad m_A\vec{v}_A + m_B\vec{v}_B = m_A\vec{v}_A^{\,'} + m_B\vec{v}_B^{\,'}$.

1D elastic collision–conservation of energy:

$\frac{1}{2}m_Av_A^2 + \frac{1}{2}m_Bv_B^2 = \frac{1}{2}m_Av_A^{'2} + \frac{1}{2}m_Bv_B^{'2}$, $\quad$ or $\quad$ $v_A - v_B = -(v_A' - v_B')$.

Center of Mass:

$x_{\mathrm{cm}} = \frac{m_1x_1+m_2x_2+\ldots}{m_1+m_2+\ldots}$, $\quad$ $v_{\mathrm{cm}} = \frac{m_1v_1+m_2v_2+\ldots}{m_1+m_2+\ldots}$.

Chapter 8 Equations

Rotational coordinates:

1 rev $= 2\pi$ radians $= 360°$, $\quad$ $\omega = 2\pi f$, $\quad$ $f = \frac{1}{T}$, $\quad$ $\bar{\omega} = \frac{\Delta\theta}{\Delta t}$, $\quad$ $\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$, $\quad$ $\Delta\theta = \bar{\omega}\Delta t$.

Linear coordinates vs. rotation coordinates and radius:

$l = \theta r$, $\quad$ $v = \omega r$, $\quad$ $a_{\tan} = \alpha r$, $\quad$ $a_R = \omega^2 r$, $\quad$ (must use radians in these).

Constant angular acceleration:

$\omega = \omega_0 + \alpha t$, $\quad$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$, $\quad$ $\bar{\omega} = \frac{1}{2}(\omega_0 + \omega)$, $\quad$ $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$.

Torque & Dynamics:

$\tau = rF\sin\theta$, $\quad$ $I = \Sigma mr^2$, $\quad$ $\tau_{\mathrm{net}} = I\alpha$, $\quad$ $L = I\omega$, $\quad$ $\Delta L = \tau_{\mathrm{net}}\Delta t$, $\quad$ $\mathrm{KE}_{\mathrm{rotation}} = \frac{1}{2}I\omega^2$.

Rotational Inertias about centers:

$I = MR^2$,	$I = \frac{1}{2}MR^2$,	$I = \frac{2}{5}MR^2$,	$I = \frac{1}{12}ML^2$.
hoop	solid cylinder	sphere	thin rod

Chapter 9 Equations

Static Equilibrium:

$\Sigma F_x = \Sigma F_y = \Sigma F_z = 0$, $\quad$ $\Sigma\tau = 0$, $\quad$ $\tau = rFsin\theta$.