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}.
atto, femto, pico, nano, micro, milli, centi, kilo, mega, giga, tera, peta.

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

Trig summary

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

OpenStax Ch. 2: 1D Kinematics

$\bar{v} = \Delta x/\Delta t$, $\Delta x = x - x_0$, slope of $x(t)$ curve $= v(t)$.
$\bar{a} = \Delta v/\Delta t$, $\Delta v = v - v_0$, slope of $v(t)$ curve $= a(t)$.
Quadratic eqn.: $ax^2 + bx + c = 0$.
Solution: $x = \left[-b \pm \sqrt{b^2 - 4ac}\,\right]/(2a)$.

For constant acceleration in one-dimension:

$\bar{v} = \frac{1}{2}(v_0 + v)$, $v = v_0 + at$, $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2a(x - x_0)$.

OpenStax Ch. 3: 2D & 3D Motion

Vectors written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).

$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = V_y/V_x$. 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.

OpenStax Chs. 4 & 5: Newton's Laws & Friction

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.

Gravitational force ($F_g = mg$) components on inclines:

$F_{g\parallel} = mg\sin\theta$, $F_{g\perp} = mg\cos\theta$, for incline at angle θ to horizontal.

Friction magnitude (opposes the relative motion of two surfaces):

$f_s \le \mu_s N$ (static friction). $f_k = \mu_k N$ (kinetic or sliding friction).

OpenStax Ch. 6: Circular Motion

Centripetal Acceleration:

$a_c = v^2/r = \omega^2 r$, towards the center of the circle. Use ω in rad/sec!

Circular motion:

speed $v = 2\pi r/T = 2\pi r f$, frequency $f = 1/T$, where T is the period of one revolution.
speed $v = \omega r$, angular speed $\omega = 2\pi f = 2\pi/T$, ω is in rad/sec.

OpenStax Ch. 7: Work & Energy

Work & Kinetic & Potential Energies: $F_{\text{gravity},y} = -mg$, $F_{\text{spring}} = -kx$.

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

Conservation or Transformation of Energy:

Work-KE theorem:

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

General energy-transformation law:

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

Power:

$P_{\text{ave}} = W/t$, or use P_{ave} = energy/time.

OpenStax Ch. 8: Momentum

Momentum & Impulse:

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

Conservation of Momentum:

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

1D elastic collision–conservation of energy:

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

OpenStax Ch. 9: Rotational Motion

Rotational coordinates:

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

Linear coordinates vs. rotation coordinates and radius:

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

Constant angular acceleration:

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

Torque & Dynamics:

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

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

OpenStax Ch. 10: Static Equilibrium

$\Sigma F_x = \Sigma F_y = \Sigma F_z = 0$, $\Sigma\tau = 0$, $\tau = rF\sin\theta = r_\perp F = rF_\perp$, τ=torque around a chosen axis.

OpenStax Ch. 11: Static Fluids

Density:

$\rho = m/V$, SG=ρ/ρ_{H_2O}, $\rho_{H_2O} = 1000\ \text{kg/m}^3 = 1.00\ \text{g/cm}^3$ (at 4°C).

Static Fluids:

$P = F/A$, $P_2 = P_1 + \rho gh$, $\Delta P = \rho gh$, $P = P_{\text{atm.}} + P_G$, $B = \rho gV$ or $F_B = \rho gV$.

Pressure Units:

1 Pa = 1 N/m^2, 1 bar = 10^5 Pa = 100 kPa, 1 mm-Hg = 133.3 Pa.

1.00 atm = 101.3 kPa = 1.013 bar = 760 torr = 760 mm-Hg =14.7 lb/in^2.