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 (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

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

OpenStax Ch. 1 Equations

Percent uncertainty:

If a measurement = value ± uncertainty, percent uncertainty = (uncertainty/value) × 100 %.

OpenStax Ch. 2 Equations

Motion:

$\bar{v} = \Delta x/\Delta t$, $\Delta x = x - x_0$, 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:

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

For free fall on Earth, using an upward y-axis, with $g = 9.80$ m/s^2 downward:

$\bar{v}_y = \frac{1}{2}(v_{0y} + v_y)$, $v_y = v_{0y} - gt$, $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$, $v_y^2 = v_{0y}^2 - 2g\Delta y$.

OpenStax Ch. 3 Equations

Vectors

Written $\vec{V}$ or **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 **B** reversed.

Projectiles

$a_x = 0$, $v_x = v_{0x}$, $x = x_0 + v_{0x}t$. For a horizontal x-axis.
$a_y = -g$, $v_y = v_{0y} - gt$, $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$. For an upward y-axis.
$R = (v_0^2/g)\sin 2\theta_0$, (Range for level ground only.)

Relative Motion

$\vec{V}_{\text{BS}} = \vec{V}_{\text{BW}} + \vec{V}_{\text{WS}}$, B=Boat, S=Shore, W=Water. BS means "boat relative to shore", etc.

OpenStax Ch. 4 Equations

Newton's First Law:

$\vec{a} = 0$ unless $\vec{F}_{\text{net}} \neq 0$.

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.

Newton's Third Law:

$\vec{F}_{\text{A on B}} = -\vec{F}_{\text{B on A}}$.

Gravitational force (weight) near Earth:

$F_g = mg$, downward.

Gravitational force components on inclines:

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

OpenStax Ch. 5 Equations

Normal force N

N is the force acting perpendicular to a surface, on the object acted on by friction.

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

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

Chapter 6 Equations

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.

Gravitation:

$F = Gm_1 m_2/r^2$; $g = GM/r^2$, where $G = 6.67 \times 10^{-11}$ Nm^2/kg^2;

Orbits:

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

Chapter 7 Equations

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.