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

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

Chapter 1 Equations
Percent error:
\[\text{percent error} = \frac{\text{error}}{\text{value}} \times 100\%\]

Chapter 2 Equations
Motion:
\[\vec{v} = \frac{\Delta \vec{x}}{\Delta t}, \quad \Delta \vec{x} = \vec{x} - \vec{x}_0, \quad \text{slope of } \Delta \vec{x}(t) \text{ curve} = \vec{v}(t)\]
\[\vec{a} = \frac{\Delta \vec{v}}{\Delta t}, \quad \Delta \vec{v} = \vec{v} - \vec{v}_0, \quad \text{slope of } \Delta \vec{v}(t) \text{ curve} = \vec{a}(t)\]

For constant acceleration in one-dimension:
\[\vec{v} = \frac{1}{2}(\vec{v}_0 + \vec{v}), \quad \vec{v} = \vec{v}_0 + \vec{a}t, \quad x = x_0 + v_0t + \frac{1}{2}at^2, \quad \vec{v}^2 = \vec{v}_0^2 + 2\vec{a}(x - x_0)\]

For free fall on Earth, using an upward y-axis, with \(g = 9.80 \text{ m/s}^2\) downward:
\[\vec{v}_y = \frac{1}{2}(v_{y0} + v_y), \quad \vec{v}_y = v_{y0} - gt, \quad \vec{y} = y_0 + v_{y0}t - \frac{1}{2}gt^2, \quad \vec{v}_y^2 = \vec{v}_{y0}^2 - 2g\Delta y\]

Chapter 3 Equations
Vectors
Written \(\vec{V}\) or \(\vec{v}\), described by magnitude=\(V\), direction=\(\theta\) or by components \((V_x, V_y)\).
\[V_x = V \cos \theta, \quad V_y = V \sin \theta, \quad V = \sqrt{V_x^2 + V_y^2}, \quad \tan \theta = \frac{V_y}{V_x}, \quad \theta \text{ is the angle from } \vec{V} \text{ to } x\text{-axis}\]
Addition: \(\vec{A} + \vec{B}\), head to tail. Subtraction: \(\vec{A} - \vec{B}\) is \(\vec{A} + (-\vec{B})\), \(-\vec{B}\) is \(\vec{B}\) reversed.

Projectiles
\[a_x = 0, \quad v_x = v_{x0}, \quad x = x_0 + v_{x0}t, \quad \text{For a horizontal } x\text{-axis}\]
\[a_y = -g, \quad v_y = v_{y0} - gt, \quad \vec{y} = y_0 + v_{y0}t - \frac{1}{2}gt^2, \quad \text{For an upward } y\text{-axis}\]
\[R = \frac{v_0^2}{g} \sin 2\theta_0, \quad \text{(For level ground only.)}\]

Relative Motion
\[\vec{V}_{BS} = \vec{V}_{BW} + \vec{V}_{WS}, \quad \text{B=Boat, S=Shore, W=Water}\]
BS means ”boat relative to shore”, etc.
Must be applied as a vector equation!

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