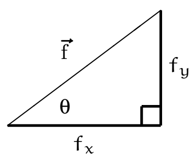
Formula sheet

$$g = 9.81\,\mathrm{m/s^2}$$

$$0 = ax^2 + bx^2 + c \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Generic vector $\vec{f}$:



$$f_y = |\vec{f}|\sin\theta$$
$$f_x = |\vec{f}|\cos\theta$$
$$\tan\theta = f_y/f_x$$
$$|\vec{f}| = \sqrt{f_x^2 + f_y^2}$$

motion with constant acceleration:

$$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2$$
$$v_f = v_i + a_x t$$
$$v_{xf}^2 = v_{xi}^2 + 2a_x\Delta x$$

Quantity	Unit	equivalent to
force	N	kg·m/s^2
energy	J	kg·m^2/s^2 = N·m
power	W	J/s=m^2·kg/s^3

Projectile motion:

$$\text{Range over level ground} = R = \frac{v_i^2 \sin 2\theta_i}{g}$$

$$\text{max height from origin} = H = \frac{v_i^2 \sin^2\theta_i}{2g}$$

$$y(x) = (\tan\theta_o)\,x - \frac{gx^2}{2v_o^2\cos^2\theta_o}$$

Isolated systems: $\vec{p}$, $E = K + PE$, L are all conserved.
Static equilibrium: $\sum F = 0$ and $\sum \tau = 0$ about any axis.
Elastic collision: KE and p are both conserved.
Inelastic collision: only p is conserved, not KE.

Force:

$$\Sigma\vec{F} = \vec{F}_{\text{net}} = m\vec{a} \qquad \Sigma F_x = ma_x \qquad \Sigma F_y = ma_y$$
$$\vec{F}_{12} = -\vec{F}_{21}$$
$$F_{\text{gravity}} = mg = \text{weight} \qquad F_{\text{spring}} = -k\Delta x$$
$$\text{friction}\begin{cases} f_s & \leqslant \mu_s n \\ f_k & = \mu_k n \end{cases}$$

Work-Energy:

$$W = F_{||}\Delta x = F\Delta x\cos\theta \qquad P = F_{||}v = Fv\cos\theta \quad \text{power}$$
$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$
$$\Delta K = K_f - K_i = W = -\Delta PE$$
$$PE_g(y) = mgy \qquad PE_s(x) = \frac{1}{2}kx^2$$
$$K_i + PE_i = K_f + PE_f + W_{\text{ext}}$$

Momentum, etc.:

$$\vec{p} = m\vec{v} \qquad \Delta p = p_f - p_i = F_{\text{avg}}\Delta t \qquad (\Delta p = 0 \text{ for isolated system})$$
$$x_{\text{com}} = \frac{1}{M_{\text{tot}}}\sum_{i=1}^{n} m_i x_i = \frac{m_1x_1 + m_2x_2 + \ldots m_nx_n}{m_1 + m_2 + \ldots m_n}$$
$$v_{\text{com}} = \frac{1}{M_{\text{tot}}}\sum_{i=1}^{n} m_i v_i = \frac{m_1v_1 + m_2v_2 + \ldots m_nv_n}{m_1 + m_2 + \ldots m_n}$$
$$\sum F_{\text{ext}} = M_{\text{tot}}a_{\text{com}} = \frac{\Delta p}{\Delta t}$$
$$p_{\text{tot}} = M_{\text{tot}}v_{\text{com}}$$

Rotation: we use radians

$$s = \Delta x = \theta r \qquad \omega = \frac{\Delta\theta}{\Delta t} = \frac{v}{r} \qquad \alpha = \frac{\Delta\omega}{\Delta t}$$
$$a_t = \alpha r \quad \text{tangential} \qquad a_r = a_{\text{centr}} = \frac{v^2}{r} = \omega^2 r \quad \text{radial}$$
$$x \to \theta \qquad v \to \omega \qquad a \to \alpha \qquad \text{convert linear to rotation eqns}$$
$$I = \sum_i m_i r_i^2 = kmr^2 \qquad \text{property of a given shape}$$
$$I_z = I_{com} + md^2 \qquad \text{axis } z \text{ parallel, dist } d$$
$$\tau = rF\sin\theta_{rF} \qquad \sum\tau = I\alpha = \frac{\Delta L}{\Delta t}$$
$$L = rp\sin\theta = mvr\sin\theta = I\omega$$
$$K_{\text{rot}} = \frac{1}{2}I\omega^2 = \frac{L^2}{2I} \qquad K_{\text{tot}} = K_{\text{rot}} + K_{\text{transl}} = \frac{1}{2}Mv_{\text{cm}}^2 + \frac{1}{2}I_{\text{cm}}\omega^2$$
$$\Delta K = W = \tau\Delta\theta \qquad P = \frac{\Delta W}{\Delta t} = \tau\omega$$
$$T = \frac{2\pi r}{v} \quad \text{period of motion}$$