

Formulas and Constants

$$g = 9.80 \text{ m/s}^2 \quad G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$$

$$\rho_{\text{water}} = 1000 \text{ kg/m}^3 \quad P_{\text{atm}} = 1.013 \times 10^5 \text{ Pa} \quad \text{Pa} = \text{N/m}^2 \quad k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$R = 8.31 \text{ J/(mol K)} \quad \sigma = 5.67 \times 10^{-8} \text{ J/(s m}^2 \text{ K}^4) \quad N_A = 6.02 \times 10^{23} \quad 1 \text{ kcal} = 4186 \text{ J}$$

$$c_{\text{water}} = 4186 \text{ J/(kg C)} \quad c_{\text{ice}} = 2000 \text{ J/(kg C)} \quad L_{f,\text{water}} = 33.5 \times 10^4 \text{ J/kg} \quad L_{v,\text{water}} = 22.6 \times 10^5 \text{ J/kg}$$

$$\vec{A} + \vec{B} = \vec{C} \Rightarrow A_x + B_x = C_x \quad A_y + B_y = C_y$$

$$C_x = C \cos \theta \quad C_y = C \sin \theta \quad C = \sqrt{C_x^2 + C_y^2} \quad \theta = \arctan\left(\frac{C_y}{C_x}\right)$$

$$\Delta(\text{thing}) = \text{thing}_f - \text{thing}_i$$

$$C_{\text{circle}} = 2\pi R \quad A_{\text{disk}} = \pi R^2 \quad A_{\text{sphere}} = 4\pi R^2 \quad V_{\text{sphere}} = \frac{4}{3}\pi R^3$$

$$\bar{v} = \frac{\Delta x}{\Delta t} \quad v = v_0 + at \quad \Delta x = v_0 t + \frac{1}{2}at^2 \quad v^2 = v_0^2 + 2a\Delta x$$

$$\vec{F}_{\text{net}} = m\vec{a} \quad F_{\text{grav}} = \frac{Gm_1m_2}{r^2} \quad f_k = \mu_k F_N \quad f_s \leq \mu_s F_N$$

$$\text{weight} = mg \quad \vec{F}_{\text{cent}} = m\vec{a}_{\text{cent}} \quad a_{\text{cent}} = \frac{v^2}{r} \quad v = \frac{2\pi r}{T}$$

$$W = F\Delta x \cos \theta = F\Delta x_{\parallel} \quad \text{KE} = \frac{1}{2}mv^2 \quad \text{PE} = mgh \quad E = \text{KE} + \text{PE}$$

$$\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f \Leftrightarrow \Delta\text{KE} + \Delta\text{PE} = 0 \quad W = \Delta\text{KE}$$

$$W_{\text{non-cons}} = \Delta E = E_f - E_i \quad \text{average power} = \frac{\Delta E}{\Delta t}$$

$$\vec{p} = m\vec{v} \quad \text{impulse} = \vec{I} = \Delta\vec{p} = \vec{F}_{\text{ext}}\Delta t$$

$$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f} \Leftrightarrow \Delta\vec{p}_1 + \Delta\vec{p}_2 = 0$$

$$\theta = \frac{s}{r} \quad \bar{\omega} = \frac{\Delta\theta}{\Delta t} \quad \bar{\alpha} = \frac{\Delta\omega}{\Delta t} \quad \omega = \omega_0 + at \quad \Delta\theta = \omega_0 t + \frac{1}{2}at^2 \quad \omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$v_{\text{linear}} = v_T = r\omega \quad a_{\text{linear}} = a_T = r\alpha \quad a_c = r\omega^2 \quad a_{\text{total}} = \sqrt{a_T^2 + a_c^2}$$

$$I_{\text{point}} = mr^2 \quad I_{\text{rod,axis at center}} = \frac{1}{12}m\ell^2 \quad I_{\text{sphere,axis at center}} = \frac{2}{5}mR^2 \quad I_{\text{system}} = I_1 + I_2 + \dots$$

$$\text{torque} = \tau = F\ell \sin \theta = F\ell_{\perp} \quad \tau_{\text{net}} = I\alpha \quad \text{KE}_{\text{rot}} = \frac{1}{2}I\omega^2$$

$$L = I\omega \quad \tau_{\text{ext}} = \frac{\Delta L}{\Delta t} \quad \text{equilibrium: } \sum F = 0 \quad \text{and} \quad \sum \tau = 0$$

$$F = -kx \quad f = \frac{1}{T} \quad \omega = 2\pi f = \frac{2\pi}{T}$$

$$x(t) = A \cos(\omega t) \quad v_{\text{max}} = A\omega \quad a_{\text{max}} = A\omega^2 \quad \omega = \sqrt{\frac{k}{m}}$$

$$\text{PE}_{\text{spring}} = \frac{1}{2}kx^2 \quad E_{\text{tot}} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgh + \frac{1}{2}kx^2$$

$$\omega_{\text{simple pend}} = 2\pi f = \sqrt{\frac{g}{L}} \quad \omega_{\text{phys pend}} = 2\pi f = \sqrt{\frac{mgL}{I}}$$

$$\rho = \frac{m}{V} \quad P = \frac{F}{A} \quad P_2 = P_1 + \rho gh \quad F_B = W_{\text{displaced fluid}}$$

$$\text{mass flow rate} = \rho Av \quad \rho_1 A_1 v_1 = \rho_2 A_2 v_2 \quad (\text{if incompressible}): \quad A_1 v_1 = A_2 v_2$$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$T_F = \frac{9}{5}T_C + 32 \quad T_C = \frac{5}{9}(T_F - 32) \quad T_K = T_C + 273.15 \quad \Delta L = \alpha L_0 \Delta T$$

$$Q = mc\Delta T \quad Q = mL \quad \frac{Q}{t} = \frac{kA\Delta T}{L} \quad \frac{Q}{t} = e\sigma T^4 A$$

$$PV = nRT = Nk_B T \quad KE = \frac{1}{2}mv_{\text{rms}}^2 = \frac{3}{2}k_B T \quad U = \frac{3}{2}Nk_B T = \frac{3}{2}nRT$$

$$v_{\text{unbanked}} = \sqrt{\mu_s g r} \quad v_{\text{banked}} = \sqrt{r g \tan \theta} \quad v_{\text{orbit}} = \sqrt{\frac{GM_E}{r}}$$