Formulas and Constants

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

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

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

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

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

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

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

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

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

$$\vec{F}_{\text{net}} = m\vec{a} \qquad F_{\text{grav}} = \frac{Gm_1 m_2}{r^2} \qquad f_k = \mu_k F_N \qquad f_s \leq \mu_s F_N$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$PV = nRT = Nk_BT \qquad KE = \frac{1}{2}mv_{\text{rms}}^2 = \frac{3}{2}k_BT \qquad U = \frac{3}{2}Nk_BT = \frac{3}{2}nRT$$

$$\Delta U = Q - W \qquad W_{\text{constant P}} = P\Delta V = P(V_f - V_i) \qquad W_{\text{adiabatic}} = \frac{3}{2}nR(T_i - T_f)$$

$$W = Q_H - Q_C \qquad e = \frac{W}{Q_H} = 1 - \frac{Q_C}{Q_H} \qquad \left(\frac{Q_C}{Q_H}\right)_{\text{Carnot}} = \frac{T_C}{T_H} \qquad e_{\text{Carnot}} = 1 - \frac{T_C}{T_H}$$