Physics 1 & 2 for Engineers (PS 161) – Exam Formulas

Daniel E. Janusch

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1 Exam 1 Formulas – Ch. 1-3

$$v = v_0 + at \tag{1}$$

$$x = \frac{v_0 + v}{t} \tag{2}$$

$$x = v_0 t + \frac{a}{2} t^2 \tag{3}$$

$$v^2 = v_0^2 + 2ax \tag{4}$$

$$\text{vector stuff: dot, cross, angle, magnitude} \tag{5}$$

2 Exam 2 Formulas – Ch. 4-5

$$a_c = \frac{v^2}{r} \tag{6}$$

$$f_s = \mu_s N \tag{7}$$

$$f_k = \mu_k N \tag{8}$$

$$a_\parallel = g(\sin\theta - \mu_k \cos\theta) \quad \text{box sliding down slope} \tag{9}$$

$$F = ma \tag{10}$$

3 Exam 3 Formulas – Ch. 6-8

$$W = \int_{x_1}^{x_2} \vec{F} \cdot \mathrm{d}\vec{s} = W_{\text{cons}} + W_{\text{nc}} = \Delta K = \left(\frac{1}{2}mv^2 \quad \text{or} \quad \frac{p^2}{2m}\right)\Bigg|_{x_1}^{x_2} \tag{11}$$

$$W_F^{\text{cons}} = -\Delta U_F \tag{12}$$

$$U_{\text{grav}} = mgy \qquad U_{\text{el}} = \frac{1}{2}kx^2 \tag{13}$$

$$J = \int_{t_1}^{t_2} F(t)\,\mathrm{d}t = \Delta p = mv\Big|_{t_1}^{t_2} = F_{\text{av}}\Delta t \tag{14}$$

$$F = -\vec{\nabla}U = m\dot{\vec{v}} \tag{15}$$

$$P_{\text{av}} = \frac{W}{\Delta t} \qquad P = \dot{W} = \vec{F} \cdot \vec{v} \tag{16}$$

$$\vec{p} = m\vec{v} \tag{17}$$

$$x_{\text{cm}} = \frac{\sum mx}{\sum m} \qquad \vec{v}_{\text{cm}} = \frac{\sum \vec{p}}{\sum m} \tag{18}$$

$$\Delta W = -\Delta U \tag{19}$$

$$v_{Af}, v_{Bf} = \frac{p_{Ai} + 2p_{Bi} - m_B v_{Ai}}{m_A + m_B}, \frac{p_{Bi} + 2p_{Ai} - m_A v_{Bi}}{m_A + m_B} \quad \text{(elastic)} \tag{20}$$

4 Exam 4 Formulas – Ch. 9-11

$$s = r\theta \qquad v = r\omega \qquad a = r\alpha \tag{21}$$

$$\omega = \omega_0 + \alpha t \tag{22}$$

$$\theta = \omega_{\text{av}} t = \omega_0 t + \frac{\alpha}{2} t^2 \tag{23}$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta \tag{24}$$

$$a_{\text{rad}} = \frac{v^2}{r} = r\omega^2 \tag{25}$$

$$I = \sum_{i=1}^{N} m_i r_i^2 = \int r^2 \,\mathrm{d}m = \int r^2 \lambda(r) \mathrm{d}r \tag{26}$$

$$I = I_{\text{cm}} + md^2 \implies I_2 = I_1 + m\big(d_2^2 - d_1^2\big) \tag{27}$$

$$K_{\text{rot}} = \frac{1}{2} I\omega^2 \tag{28}$$

$$W = \Delta K_{\text{lin}} + \Delta K_{\text{rot}} \tag{29}$$

$$U_{\text{grav}} = mgy_{\text{cm}} \tag{30}$$

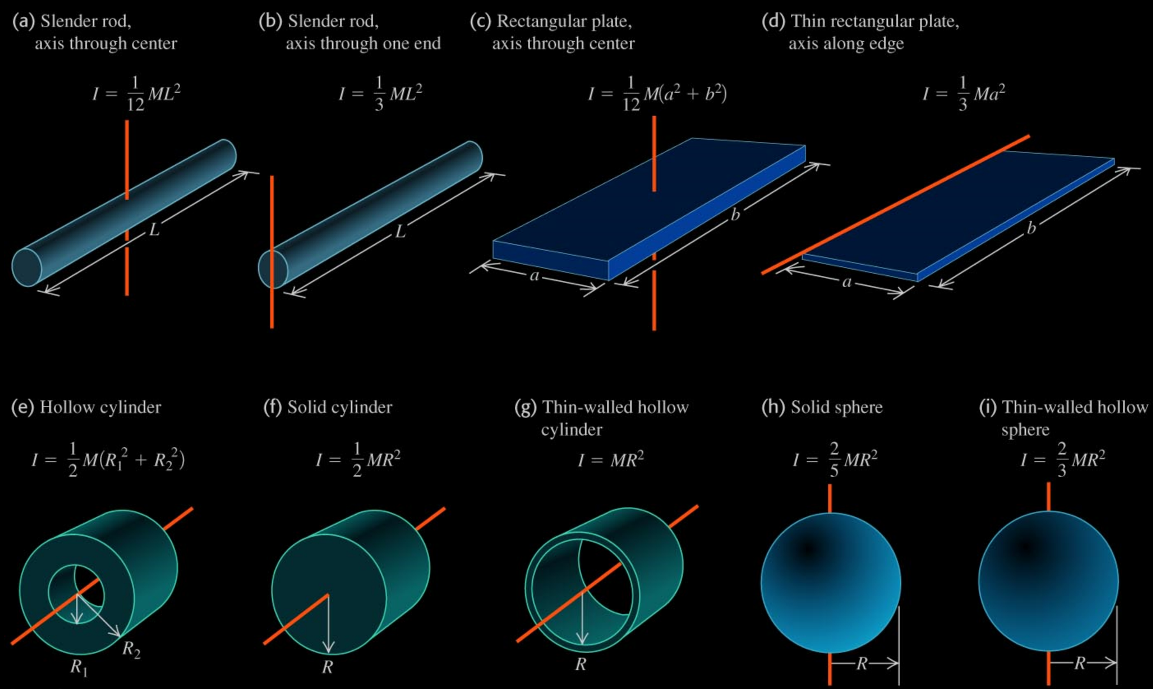
$$\tau = \vec{r} \times \vec{F} = F\ell = F_{\perp} r = rF\sin\theta = I\alpha = \dot{L} \tag{31}$$

$$x_{\text{cg}} = x_{\text{cm}} \quad \text{(usually)} \tag{32}$$

$$\text{statics} \implies \sum F = \sum \tau = 0 \tag{33}$$

$$\text{rolling without slipping} \implies v_{\text{cm}} = r\omega \quad \wedge \quad a_{\text{cm}} = r\alpha \tag{34}$$

$$P = \tau\omega \tag{35}$$



$$L = \vec{r} \times \vec{p} = mvr \sin\theta = mv\ell = I\omega \tag{36}$$

$$L_0 = L_1 \quad \text{(assuming no external torque)} \tag{37}$$

5 Final Exam Formulas – Ch. 12-14

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L_0} = \frac{FL_0}{A\Delta L} \quad [\text{Pa}] \tag{38}$$

$$\lambda = \frac{m}{L} \qquad \sigma = \frac{m}{A} \qquad \rho = \frac{m}{V} \tag{39}$$

$$p = \rho g h = \frac{F_1}{A_1} = \frac{F_1}{A_2} \quad [\text{Pa}] \tag{40}$$

$$F_{\text{pressure}} = pA \tag{41}$$

$$F_{\text{buoyant}} = \rho g V \tag{42}$$

$$R = Av \quad \text{(flow rate)} \tag{43}$$

$$\rho_1 R_1 = \rho_2 R_2 \quad \text{(mass flux)} \tag{44}$$

$$\rho_1 = \rho_2 \quad \text{(incompressible)} \tag{45}$$

$$ME = p + \frac{1}{2}\rho v^2 + \rho g y \tag{46}$$

$$U_g = -\frac{GMm}{r} \tag{47}$$

$$F_g = -\frac{GMm}{r^2} \tag{48}$$

$$v_{\text{orbit}} = \sqrt{\frac{GM}{R}} \tag{49}$$

$$v_{\text{escape}} = v_{\text{orbit}}\sqrt{2} \tag{50}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi r^{1.5}}{\sqrt{GM}} \tag{51}$$

$$R_S = \frac{2GM}{c^2} \tag{52}$$

Simple Harmonic Motion (SHM):

$$x(t) = A\cos(\omega t + \phi) \ni \omega^2 = \frac{k}{m} \tag{53}$$

$$\omega = 2\pi f \tag{54}$$

$$E = \frac{mv^2 + kx^2}{2} \tag{55}$$

$$v = \pm\omega\sqrt{A^2 - x^2} \tag{56}$$

$$\theta(t) = \theta_0 \cos(\omega t + \phi) \tag{57}$$

$$\text{Angular SHM: } \omega^2 = \frac{\kappa}{I} \ni \kappa = \text{torsion constant} \tag{58}$$

$$\text{Small } \theta \text{ Simple Pendulum: } \omega^2 = \frac{g}{L} \tag{59}$$

$$\text{Physical Pendulum: } \omega^2 = \frac{mgd}{I} \tag{60}$$