

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

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1 Exam 1 Formulas – Ch. 1-3

$$v = v_0 + at \quad (1)$$

$$x = \frac{v_0 + v}{t} \quad (2)$$

$$x = v_0 t + \frac{a}{2} t^2 \quad (3)$$

$$v^2 = v_0^2 + 2ax \quad (4)$$

$$\text{vector stuff: dot, cross, angle, magnitude} \quad (5)$$

2 Exam 2 Formulas – Ch. 4-5

$$a_c = \frac{v^2}{r} \quad (6)$$

$$f_s = \mu_s N \quad (7)$$

$$f_k = \mu_k N \quad (8)$$

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

$$F = ma \quad (10)$$

3 Exam 3 Formulas – Ch. 6-8

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

$$W_F^{\text{cons}} = -\Delta U_F \quad (12)$$

$$U_{\text{grav}} = mgy \quad U_{\text{el}} = \frac{1}{2}kx^2 \quad (13)$$

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

$$F = -\vec{\nabla}U = m\vec{a} \quad (15)$$

$$P_{\text{av}} = \frac{W}{\Delta t} \quad P = \dot{W} = \vec{F} \cdot \vec{v} \quad (16)$$

$$\vec{p} = m\vec{v} \quad (17)$$

$$x_{\text{cm}} = \frac{\sum mx}{\sum m} \quad \vec{v}_{\text{cm}} = \frac{\sum \vec{p}}{\sum m} \quad (18)$$

$$\Delta W = -\Delta U \quad (19)$$

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

4 Exam 4 Formulas – Ch. 9-11

$$s = r\theta \quad v = r\omega \quad a = r\alpha \quad (21)$$

$$\omega = \omega_0 + \alpha t \quad (22)$$

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

$$\omega^2 = \omega_0^2 + 2\alpha\theta \quad (24)$$

$$a_{\text{rad}} = \frac{v^2}{r} = r\omega^2 \quad (25)$$

$$I = \sum_{i=1}^N m_i r_i^2 = \int r^2 dm = \int r^2 \lambda(r) dr \quad (26)$$

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

$$K_{\text{rot}} = \frac{1}{2} I \omega^2 \quad (28)$$

$$W = \Delta K_{\text{lin}} + \Delta K_{\text{rot}} \quad (29)$$

$$U_{\text{grav}} = mgy_{\text{cm}} \quad (30)$$

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

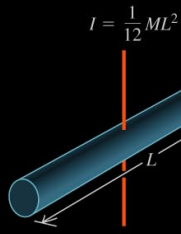
$$x_{\text{cg}} = x_{\text{cm}} \quad (\text{usually}) \quad (32)$$

$$\text{statics} \implies \sum F = \sum \tau = 0 \quad (33)$$

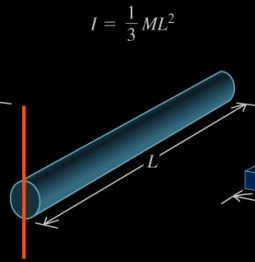
$$\text{rolling without slipping} \implies v_{\text{cm}} = r\omega \quad \wedge \quad a_{\text{cm}} = r\alpha \quad (34)$$

$$P = \tau\omega \quad (35)$$

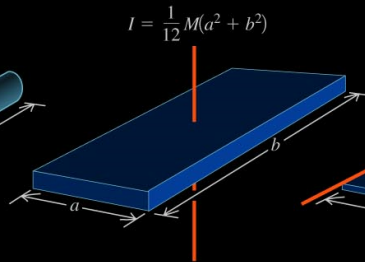
(a) Slender rod,
axis through center



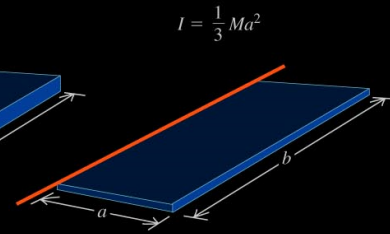
(b) Slender rod,
axis through one end



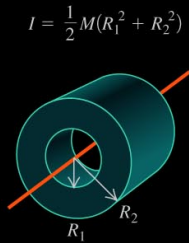
(c) Rectangular plate,
axis through center



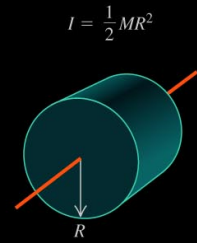
(d) Thin rectangular plate,
axis along edge



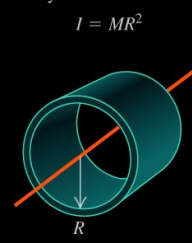
(e) Hollow cylinder



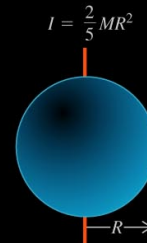
(f) Solid cylinder



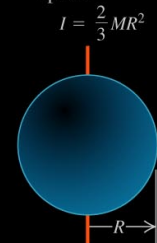
(g) Thin-walled hollow
cylinder



(h) Solid sphere



(i) Thin-walled hollow
sphere



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

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

5 Final Exam Formulas – Ch. 12-14

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

$$\lambda = \frac{m}{L} \quad \sigma = \frac{m}{A} \quad \rho = \frac{m}{V} \quad (39)$$

$$p = \rho gh = \frac{F_1}{A_1} = \frac{F_2}{A_2} \quad [\text{Pa}] \quad (40)$$

$$F_{\text{pressure}} = pA \quad (41)$$

$$F_{\text{buoyant}} = \rho gV \quad (42)$$

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

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

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

$$ME = p + \frac{1}{2}\rho v^2 + \rho gy \quad (46)$$

$$U_g = -\frac{GMm}{r} \quad (47)$$

$$F_g = -\frac{GMm}{r^2} \quad (48)$$

$$v_{\text{orbit}} = \sqrt{\frac{GM}{R}} \quad (49)$$

$$v_{\text{escape}} = v_{\text{orbit}}\sqrt{2} \quad (50)$$

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

$$R_S = \frac{2GM}{c^2} \quad (52)$$

