Recitation Week 8

Ch.8 #73

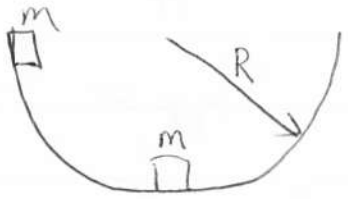
$1000 \frac{\text{rounds}}{\text{min}} \cdot \frac{1\,\text{min}}{60\,\text{s}} = 16.67 \frac{\text{rounds}}{\text{s}}$

$m = 7.45\,\text{g} \cdot \frac{1\,\text{kg}}{1000\,\text{g}} = 7.45 \times 10^{-3}\,\text{kg}$

$v = 293\,\text{m/s}$

$F = mv \cdot 16.67 \frac{\text{rounds}}{\text{s}} = 7.45 \times 10^{-3} \cdot 293 \cdot 16.67 = \boxed{36.4\,\text{N}}$

Ch.8 #78



Initial Energy $= mgR$

v at collision $\Rightarrow \frac{1}{2}mv^2 = mgR$

$v^2 = 2gR$

$v = \sqrt{2gR}$

Conservation of momentum during collision.

$P_o = mv = P_f = (m+m)v_f$

$mv = (m+m)v_f$

$v_f = v/2 = \frac{\sqrt{2gR}}{2}$

Conservation of energy for height

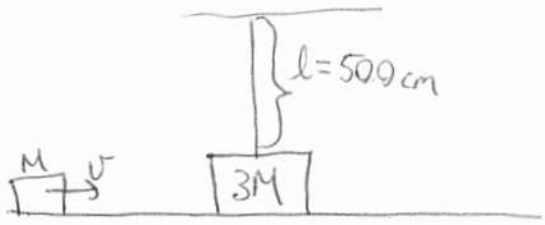
$(m+m)gh = \frac{2}{2}mv_f^2$

$2mgh = m\left(\frac{\sqrt{2gR}}{2}\right)^2$

$2gh = \frac{2gR}{4}$

$\boxed{h = \frac{1}{4}R}$

Ch.8 #79



$v = 5.0\ m/s$

Elastic collision, E conserved

$E_0 = \frac{1}{2}Mv^2 = \frac{1}{2}M(5)^2 = 12.5M$

$P_0 = Mv = 5M$

$E_f = \frac{1}{2}Mv_1^2 + \frac{1}{2}(3M)v_2^2 = 12.5M$

$P_f = Mv_1 + 3Mv_2 = 5M$

$v_1 = 5 - 3v_2$

$E_f = \frac{1}{2}M(5-3v_2)^2 + \frac{3}{2}Mv_2^2 = 12.5M$

$= \frac{1}{2}M(25 - 30v_2 + 9v_2^2) + \frac{3}{2}Mv_2^2 = 12.5M$

$12.5M - 15Mv_2 + \frac{9}{2}Mv_2^2 + \frac{3}{2}Mv_2^2 = 12.5M$

$6Mv_2^2 - 15Mv_2 = 0$

$6v_2 - 15 = 0$

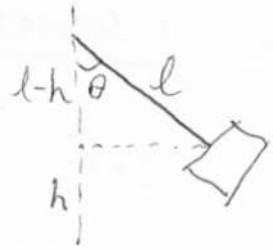
$v_2 = \frac{15}{6}\ m/s = 2.5\ m/s$ $\qquad v_1 = 5 - 3v_2 = 5 - 7.5 = -2.5\ m/s$

Heavy block conserves energy as it rises.

$\frac{1}{2}(3M)v_2^2 = (3M)gh$

$\frac{1}{2}(2.5)^2 = gh$

$h = 0.32\ m.$ $\qquad l = 50\ cm = 0.50\ m.$



$\cos\theta = \frac{l-h}{l}$

$\cos\theta = \frac{50-32}{50}$

$\theta = \cos^{-1}\left(\frac{18}{50}\right) = \boxed{68.8°}$

Ch.9 #11

a) $\omega = \alpha t$ $\quad \omega = 36.0 \text{ rad/s} \quad \alpha = 1.50 \text{ rad/s}^2$

$t = \frac{\omega}{\alpha} = \frac{36.0 \text{ rad/s}}{1.50 \text{ rad/s}^2} = 24 \text{ s.}$

b) $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = \frac{1}{2}(1.5)(24)^2 = 432 \text{ rad} \cdot \frac{1 \text{ rev}}{2\pi \text{ rad}} = \boxed{68.75 \text{ revs}}$

Ch.9 #15

a) $\omega_0 = 500 \text{ rpm}$

$t = 30 \text{ s} = 0.5 \text{ min.}$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

with constant $\alpha \Rightarrow \quad \theta = \theta_0 + \frac{1}{2}(\omega_f + \omega_0)t$

$\theta = \frac{1}{2}(\omega_f + 500)\,0.5$

$200 = \frac{1}{2}(\omega_f + 500)\,0.5$

$200 = \frac{1}{4}\omega_f + 125$

$\boxed{\omega_f = 300 \text{ rpm}}$

b) It went from 500 rpm to 300 rpm in 0.5 min.

$\omega_f = \omega_0 + \alpha t$

$300 = 500 + \alpha(0.5)$

$\frac{1}{2}\alpha = -200$

$\alpha = -400 \text{ rpm.}$

$0 = 500 + (-400)t$

$\boxed{t = 1.25 \text{ min.}}$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = 500(1.25) + \frac{1}{2}(-400)(1.25)^2$

$= 625 - 312.5$

$= \boxed{312.5 \text{ rotations}}$

Ch.9 #20

a) $R = 2.50\,m$.

$v = 25.0\,cm/s$

$= 0.25\,m/s$.

$v = \omega R = \omega(2.50)$

$0.25\,m/s = \omega(2.50\,m)$

$\omega = 0.1\,\frac{rad}{s} \cdot \frac{60\,s}{1\,min} \cdot \frac{1\,rot}{2\pi\,rad} = \boxed{0.95\,rpm}$

b) $a = \alpha R$

$\frac{1}{8}g = \alpha R$

$\alpha(2.5\,m) = \frac{1}{8}(9.8)\,m/s^2$

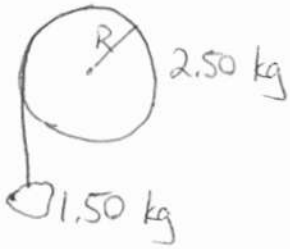
$\boxed{\alpha = 0.49\,rad/s^2}$

c) disk circumference $C = 2\pi R = 15.7\,m$.

$\theta = \frac{3.25\,m}{15.7\,m/rot} = 0.21\,rot \cdot \frac{2\pi\,rad}{1\,rot} = \boxed{1.3\,rad}$

$0.21\,rot \cdot \frac{360^\circ}{1\,rot} = \boxed{74.5^\circ}$

Ch.9 #49



a) $v = \omega R$ $\quad R = 0.20\,m$.

$\frac{1}{2}I\omega^2 = 4.5\,J$ $\quad I = \frac{1}{2}MR^2$

$\frac{1}{2}(0.05)\omega^2 = 4.5$ $\quad = 0.05$

$\omega^2 = 180$

$\omega = 13.4\,rad/s$

$v = 13.4(0.2) = 2.68\,m/s$

$E_s = \frac{1}{2}mv^2 = \frac{1}{2}(1.50)(2.68)^2 = 5.4\,J$

$E_{Tot} = 4.5 + 5.4 = 9.9\,J = mgh$

$h = \frac{9.9}{mg} = \frac{9.9}{1.5(9.8)} = \boxed{0.67\,m}$

b) fraction $= \frac{4.5}{9.9} = \boxed{0.45}$ or $\boxed{45\%}$