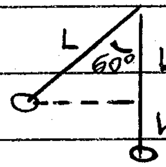
PHY 2048 Test II – 27 March 2017

Solutions — V. II —

① ⓐ


3 $L = 2.20\ m \rightarrow h = L - L\cos 60 = L/2$

$\Rightarrow$ $\boxed{h = 1.10\ m}$

4 ⓑ $E_{bottom} = E_{top} \Rightarrow \frac{1}{2} m_B v^2 = m_B g h \Rightarrow v = \sqrt{2gh}$

$\Rightarrow$ $\boxed{v = 4.64\ m/s}$

8 ⓒ momentum conserv $\rightarrow m_A v_A + m_B v_B = m_B v$ (1)

elastic collision $\rightarrow v_B - v_A = -v$ (2)

Eq (1) + $m_A \times$ Eq (2) $\rightarrow (m_A + m_B) v_B = (m_B - m_A) v$

$m_A = 0.80\ kg,\ m_B = 1.20\ kg \Rightarrow$ $\boxed{v_B = 0.2 v = 0.93\ m/s}$

$\rightarrow$ $\boxed{v_A = v + v_B = 5.57\ m/s}$

5 ⓓ Energy conserv $\rightarrow m_A g h_A = \frac{1}{2} m_A v_A^2 \Rightarrow h_A = v_A^2/2g = 1.584\ m$

$\rightarrow h_A = L - L\cos\theta \Rightarrow \cos\theta = (L - h_A)/L = 0.280$

$\rightarrow$ $\boxed{\theta = 74°}$

② ⓐ $m = 0.14\ kg,\ r = 0.15\ m,\ v = 5.0\ m/s$

4 $\Rightarrow$ $\boxed{L_m = m v r = 0.105\ kg\text{-}m^2/s}$

6 ⓑ Ang mom. conserv $\Rightarrow L_t + L_m = 0 \Rightarrow I\omega = -L_m$

$I = 0.120\ kg\text{-}m^2 \Rightarrow$ $\boxed{\omega = -L_m/I = -0.875\ rad/s}$

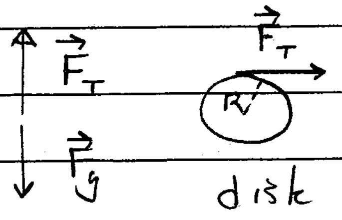
$\rightarrow$ rotates opposite way mouse runs

5 ⓒ $K_{total} = \frac{1}{2} m v^2 + \frac{1}{2} I\omega^2 = 1.75\ J + 0.046\ J \rightarrow$ $\boxed{K_{tot} = 1.80\ J}$

5 ⓓ 4 revs $\longrightarrow \Delta\theta = 4(2\pi) = 8\pi$ rads $\rightarrow \Delta\theta = |\omega| t$

$\rightarrow$ $\boxed{t = \Delta\theta / |\omega| = 28.7\ sec}$

3 (a) 8/



block: $ma = F_g - F_T = mg - F_T$ (1)

disk: $I\alpha = F_T R \Rightarrow F_T = I\alpha/R$ (2)

no slipping condition $\rightarrow \alpha = a/R$ (3)

substitute eqs (2) and (3) into eq (1)

$\rightarrow ma = mg - Ia/R^2 \Rightarrow a = mg/(m + I/R^2)$

$I = 0.16$ kg-m², $m = 0.50$ kg, $R = 0.20$ m $\rightarrow$ $\boxed{a = 1.09\ m/s^2}$

(b) 5/ 3 revs $\rightarrow \Delta\Theta = 3(2\pi) = 6\pi$ radians, $\alpha = a/R = 5.444\ rad/s^2$

$\Delta\Theta = \frac{1}{2}\alpha t^2 \Rightarrow t = \sqrt{2(\Delta\Theta)/\alpha} \rightarrow \boxed{t = 2.63\ sec}$

(c) 3/ Energy conserv $\Rightarrow K_{tot} = mgh = mg[3(2\pi R)] = (6\pi)mgR$

$\rightarrow \boxed{K_{tot} = 18.5\ J}$

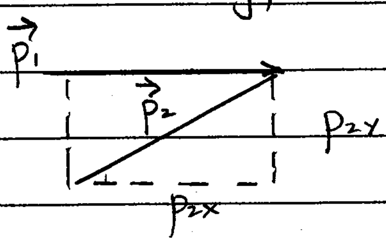
(d) 4/ $K_{trans} = \frac{1}{2}mV^2$ and $K_{rot} = \frac{1}{2}I\omega^2 = \frac{1}{2}I(V/R)^2 = \frac{1}{2}(I/R^2)V^2$

$\Rightarrow \boxed{\frac{K_{trans}}{K_{tot}} = \frac{m}{m + I/R^2} = \frac{1}{9}}$ $\boxed{\frac{K_{rot}}{K_{tot}} = \frac{I/R^2}{m + I/R^2} = \frac{8}{9}}$

4 (a) 4/ $M_1 = 1750$ kg, $V_1 = 10.0$ m/s $\Rightarrow \boxed{p_1 = M_1 V_1 = 1.75 \times 10^4\ kg\text{-}m/s}$

$M_2 = 2500$ kg, $V_2 = 6.0$ m/s $\Rightarrow \boxed{p_2 = M_2 V_2 = 1.50 \times 10^4\ kg\text{-}m/s}$

(b) 5/



$P_x = p_1 + p_2 \cos 36.9$, $P_y = p_2 \sin 36.9$

$\rightarrow \boxed{P_x = 2.95 \times 10^4\ kg\text{-}m/s}$ $\boxed{P_y = 9.01 \times 10^3\ kg\text{-}m/s}$

(c) 6/ Momentum conserv $\Rightarrow \vec{P}_{fin} = \vec{P}_{in}$

$P_{in} = \sqrt{P_x^2 + P_y^2} = 3.084 \times 10^4$ kg-m/s $\Rightarrow V_f = P_{in}/(M_1 + M_2)$

$\rightarrow \boxed{V_f = 7.26\ m/s}$ $\tan\phi = P_y/P_x = 0.3053 \rightarrow \boxed{\phi = 17.0°}$

(d) 5/ $K_{in} = \frac{1}{2}M_1 V_1^2 + \frac{1}{2}M_2 V_2^2 = 1.325 \times 10^5$ J

$K_{fin} = \frac{1}{2}(M_1 + M_2)V_f^2 = 1.119 \times 10^5$ J

$\boxed{K_{lost} = K_{in} - K_{fin} = 2.06 \times 10^4\ J}$