Chapter 11 EOC Probs. P19, P27, P32, P43, and P46

PHYS 1311 4-28-2018

Prob P19

$I = \frac{2}{5}MR^2$, $L = I\omega$ $\omega = \frac{2\pi}{T}$ $T = 1\,dy$

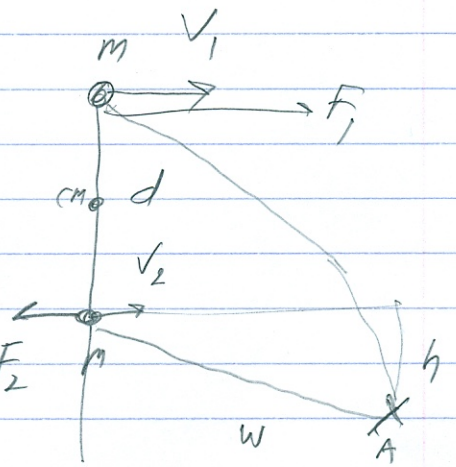
$T = 1\,dy \times \frac{24\,hrs}{1\,dy} \times \frac{60\,min}{1\,hr} \times \frac{60\,sec}{1\,min} = 86,400\,s$

$M_E = 6\times10^{24}\,kg$, $R = 6.4\times10^{6}\,m$

$L = \frac{2}{5}(6\times10^{24})(6.4\times10^{6})^2(2\pi/86,400) = 7.1\times10^{33}\,kg\frac{m^2}{s}$

P27

$m = 0.3\,kg$, $d = 1.5\,m$
$V_1 = 38\,m/s$, $V_2 = 60\,m/s$
$F_1 = 44\,N$, $F_2 = 26\,N$
$h = 0.3\,m$, $w = 0.7\,m$



a) $\vec{P}_{total}$

$\vec{P}_{total} = m\vec{V}_1 + m\vec{V}_2 = m(\vec{V}_1 + \vec{V}_2)$

$= m(\langle 38,0,0\rangle + \langle 60,0,0\rangle)$

$= \boxed{\langle 29.4,0,0\rangle\ kg\,m/s}$

b) $\vec{V}_{cm} = \frac{m_1\vec{V}_1 + m_2\vec{V}_2}{2m} = \frac{V_1+V_2}{2} = \langle 49,0,0\rangle\ m/s$

c) $\vec{L}_{tot,A} = (\vec{r}\times\vec{p})_A$ $\vec{r}_1 = \langle -w, h+d, 0\rangle$ $\vec{r}_2 = \langle -w, h, 0\rangle$

d) $\vec{L}_{rot} = (\vec{r}\times\vec{p})_{cm}$

$\vec{L}_{tot,A} = \vec{r}_1\times\vec{P}_1 + \vec{r}_2\times\vec{P}_2$

4-28-2018

P27 (Cont'd)

$$\vec{L}_{tot,A} = \langle -w, h+d, 0\rangle \times \langle mV_1, 0, 0\rangle + \langle -w, h, 0\rangle \times \langle mV_2, 0, 0\rangle$$

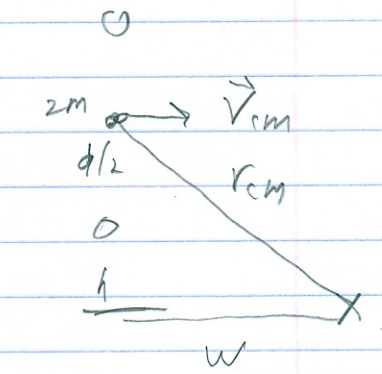
$$= \langle 0, 0, -(h+d)mV_1\rangle + \langle 0, 0, -hmV_2\rangle$$

$$= \langle 0, 0, -m[(h+d)V_1 + hV_2]\rangle$$

$$= \langle 0, 0, -0.3[(0.3+1.5)38 + (0.3)(60)]\rangle$$

$$= \langle 0, 0, -25.9\rangle \ \frac{kg\,m^2}{s}$$

b) $\vec{L}_{trans,A} = \vec{r}_{cm} \times \vec{p}_{cm}$



$$= \langle -w, \tfrac{d}{2}+h, 0\rangle \times \langle 2mV_{cm}, 0, 0\rangle$$

$$= \langle 0, 0, -(\tfrac{d}{2}+h)2mV_{cm}\rangle$$

$$= \langle 0, 0, -(\tfrac{1.5}{2}+0.3)2(0.3)(49)\rangle = \boxed{\langle 0, 0, -30.9\rangle \ \frac{kg\,m^2}{s}}$$

c) $\vec{L}_{rot} = \vec{L}_{tot,A} - \vec{L}_{trans,A}$

$$= \langle 0, 0, +4.95\rangle \ \frac{kg\,m^2}{s}$$

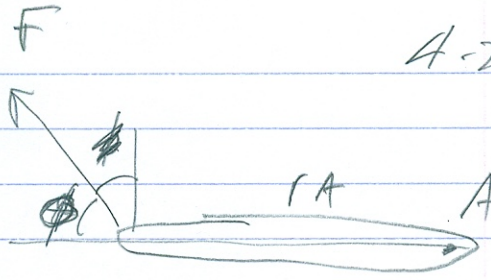
f) $\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

$$= \langle 29.4, 0, 0\rangle + \langle 41-26, 0, 0\rangle 0.235$$

$$= \langle 32.85, 0, 0\rangle \ \frac{kg\,m}{s}$$

4-28-2014

P32



a) $r_A = 3m, \quad F = 8N$

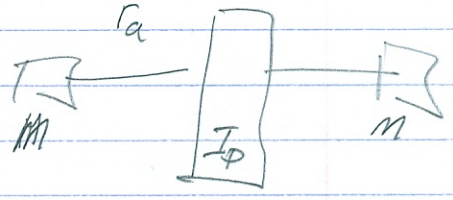
$\phi = 51^\circ$, ~~$\phi = 51^\circ$~~

$$|\vec{\tau}| = |\vec{r}_A||\vec{F}|\sin\phi = (3m)(8N)\sin 51^\circ = \boxed{18.65\ Nm}$$

b) $|\vec{\tau}_\perp| = |\vec{r}_A||\vec{F}_\perp|\sin 90^\circ \Rightarrow \tau_\perp = r_A F_\perp$

$$F_\perp = \frac{\tau_\perp}{r_A} = \frac{18.65}{3} = \boxed{6.22N}$$

P63



$T = 2s$

$L_i = L_f$ | $I_i = I_p + 2mr_a^2$

$I_f = I_p, \quad r_{af} \sim 0$

assume $r_a \sim \frac{1}{2}m$, $m = 10kg$ $\quad I_p \sim 200$, $I_b \sim$ ~~5~~

$I_i \omega_i = I_f \omega_f$ $\qquad \omega = \frac{2\pi}{T} = \frac{2\pi}{2} = \pi\ rad/s$

$(I_p + 2mr_a^2)\pi = I_p \omega_f$

~~$\omega_f = \frac{I_p}{I_p + 2mr_a^2}$~~

$$\omega_f = \left(\frac{I_p + 2mr_a^2}{I_p}\right)\pi \sim \left(\frac{205}{200}\right)\pi$$

$$= 1.025\pi\ rad/s \Rightarrow T = \frac{2\pi}{\omega} = \boxed{1.95\ s}$$

Chapter 11

PHYS 131

4-30-18

P46 $M = 43\ kg$, $R = 1.7\ m$
$m = 25\ kg$, $V = 2.3\ m/s$

$L_i = L_f$

$L_i = L_{im} + L_{ic}$ ← just before jump off

$= I_m \omega_{im} + mRV$

$= \frac{1}{2} MR^2 \omega_{im} + mRV$

$L_f = L_{fm} + L_{fc} = I_m \omega_{fm} + I_c \omega_{fc}$

$= \left(\frac{1}{2} MR^2 + mR^2\right) \omega_f$ $\qquad \omega_{fm} = \omega_{fc}$

$\frac{1}{2} MR^2 \omega_{im} + mRV = \left(\frac{1}{2} MR^2 + mR^2\right) \omega_f$

a) $\omega_{im} = 0 \Rightarrow \omega_f = \dfrac{mRV}{\left(\frac{1}{2} MR^2 + mR^2\right)}$

$\omega_f = \dfrac{(25)(1.7)(2.3)}{\left[\frac{1}{2}(43) + 25\right](1.7)^2} = \boxed{0.73\ rad/s}$

b) $K_i = \frac{1}{2} m v_i^2$

$K_f = \frac{1}{2} I \omega_f^2 = \frac{1}{2}\left(\frac{1}{2} MR^2 + mR^2\right) \omega_f^2$

$\Delta K = \frac{R^2}{2}\left(\frac{M}{2} + m\right) \omega_f^2 - \frac{1}{2} m v_i^2$

$= \frac{1.7^2}{2}\left(\frac{43}{2} + 25\right)(0.73)^2 - \frac{1}{2}(25)(2.3)^2 = \boxed{-30.32\ J}$

PHYS 131

4-30-17

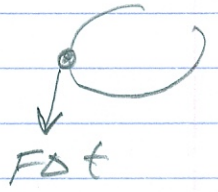
P46 (cont'd)

c) KE has some into heat, sound

d) $P_i = mV$, $P_f = 0$, disk does not translate

$P_i = (25)(2.3) = 57.5 \text{ kg}\frac{m}{s}$

e) Impulse results in $P_f = 0$



$\pm = P_f - P_i = -57.5 \text{ kg}\frac{m}{s}$

f) $L_i = L_f$

$L_{im} + L_{ic} = L_{fm} + L_{fc}$

$\left(\frac{1}{2}MR^2\right)\omega_i + mr_c^2\omega_i = \left(\frac{1}{2}MR^2 + mr_p^2\right)\omega_f \qquad v_c = R$

$\omega_f = \dfrac{\left(\frac{1}{2}M + m\right)R^2\omega_i}{\left(\frac{1}{2}MR^2 + mr_p^2\right)}$

$= \dfrac{\left[\frac{1}{2}(43) + 25\right](1.7)^2(0.73 \text{ rad/s})}{\left[\frac{1}{2}(43)(1.7)^2 + 25(0.85)^2\right]} = \dfrac{134.385}{80.2}(0.73)$

$= \boxed{1.223 \text{ rad/s}}$

Chap. 11, extra Problems

PHYS 1311 4-30-2018

P. 13 $\langle 5, 3, 0\rangle \times \langle -4, 2, 0\rangle$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 5 & 3 & 0 \\ -4 & 2 & 0 \end{vmatrix} = (0)\hat{i} + (0)\hat{j} + [5\cdot 2 - (-4)(3)]\hat{k}$$

$$= [10 + 12] = \boxed{22\hat{k}}$$

P15 $\vec{r}_A = \langle 6, 6, 0\rangle$ m $\quad \vec{p} = \langle -11, 13, 0\rangle$ kg $\frac{m}{s}$

$$\vec{L}_A = \vec{r}_A \times \vec{p} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 6 & 6 & 0 \\ -11 & 13 & 0 \end{vmatrix} = (0)\hat{i} + 0\hat{j} + (6)(13) - (-11)(6)\hat{k}$$

$$= [78 + 66]\hat{k} = \boxed{144\hat{k}\ \text{kg}\frac{m^2}{s}}$$