PHYS 1311 chapter 9 EOC

Problems P13, P19, P27, P33, & P35 4-20-2016

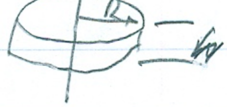
Problems P13 $I = 19\ kgm^2,\ \omega = 70\ rad/s$

$$K_{rot} = \frac{1}{2} I \omega^2 = \frac{1}{2}(19\ kgm^2)\left(70\ \frac{rad}{s}\right)^2 = \boxed{46{,}550\ J}$$

$$= 4.7 \times 10^4\ J$$

Problem P19 Uniform density disk, $I = \frac{1}{2} MR^2$

$M = 13\ kg,\ h = 0.5\ m,$
$R = 0.2\ m,\ T = 0.6\ s$



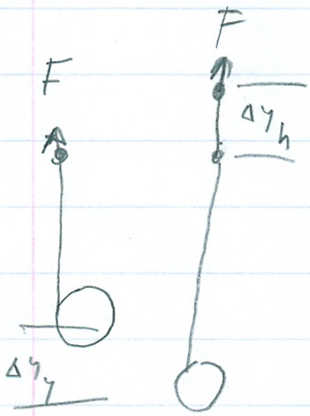
$$K_{rot} = \frac{1}{2} I \omega^2 \qquad \omega = \frac{2\pi}{T}$$

$$= \frac{1}{2}\left(\frac{1}{2} MR^2\right)\left(\frac{2\pi}{T}\right)^2 = M\left(\frac{R\pi}{T}\right)^2$$

$$= (13\ kg)\left(\frac{(0.2\ m)(\pi)}{0.6\ s}\right)^2 = \boxed{14.26\ J}$$

Problem P27

$F = 0.235\ N,\ \Delta y_h = 0.18\ m,\ \Delta y_1 = 0.70\ m$
$m = 0.025\ kg,\ v_i = \langle 0, -0.5, 0 \rangle\ m/s$
$\omega_i = 124\ rad/s$



a) Point-particle view

$$K_f + U_f = K_i + U_i + W_{surr}$$

$$\Delta K = W_{surr} - \Delta U = F\Delta y - mg\Delta y$$

$$= (F - mg)\Delta y = (0.235 - 0.025 \cdot 9.8)(-0.7)$$

~~= 0.0~~

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Problem 27 (cont'd)

$\Delta K = 0.007$ J

b) $\Delta K = K_f - K_i = \frac{1}{2}m(V_f^2 - V_i^2)$

or $V_f = \sqrt{\frac{2\Delta K}{m} + V_i^2} = \sqrt{\frac{2(0.007)}{0.025} + 0.5^2}$

$= 0.90$ m/s

c) Treat like rigid-body

$E_f = E_i + W_{surr}$

$K_f + K_f^{rot} + U_{gf} = K_i + K_i^{rot} + U_i + W_{surr}$

$\Delta K_{rot} = W_{surr} - \Delta U - \Delta K$

$= F\Delta y_h - mg\Delta y_y - F\Delta y_y + mg\Delta y_y$

$= F(\Delta y_h - \Delta y_y) = 0.235(0.18 + 0.7)$

$= 0.2068$ J

d) $\Delta K_{rot} = \frac{1}{2}I(\omega_f^2 - \omega_i^2)$

$\omega_f = \sqrt{\frac{2\Delta K_{rot}}{I} + \omega_i^2}$

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Prob 27 (cont'd)

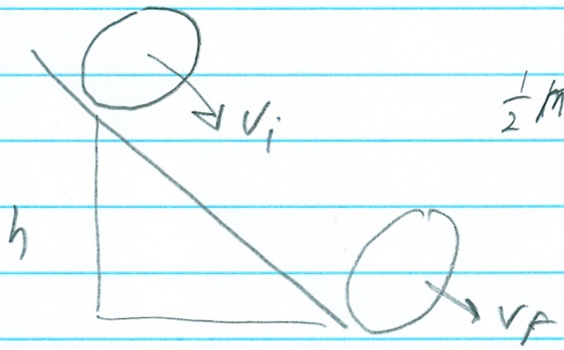
$$\omega_f = \sqrt{\frac{2\Delta K_{rot}}{\frac{1}{2}MR^2} + \omega_1^2} = \sqrt{\frac{2(0.2068)}{\frac{1}{2}(0.025)(.02)^2} + 124^2}$$

$$= \boxed{313 \text{ rad/s}}$$

Prob P33

$M, R, \omega = V_{cm}/R \rightarrow 0$

$E_f = E_i + W_{surr}$, $I = MR^2$



$$\frac{1}{2}MV_f^2 + \frac{1}{2}I\omega_f^2 + 0 = \frac{1}{2}mV_1^2 + \frac{1}{2}I\omega_1^2 + mgh + 0$$

$$mV_f^2 + \frac{1}{2}MR^2\frac{V_f^2}{R^2} = \frac{1}{2}MR^2\frac{V_1^2}{R^2} + mV_1^2 + 2mgh$$

or $2V_f^2 = 2V_1^2 + 2gh$

$$\boxed{V_f = \sqrt{V_1^2 + gh}}$$

b) $I_{bike} = MR^2$, add $M \rightarrow M+m$ (except for rotation)

$$\frac{1}{2}(M+m)V_f^2 + \frac{1}{2}MV_f^2 = \frac{1}{2}(M+m)V_1^2 + \frac{1}{2}MV_1^2 + 2(M+m)gh$$

$$(2M+m)V_f^2 = (2M+m)V_1^2 + 2(M+m)gh$$

$$V_f = \sqrt{V_1^2 + \frac{2(M+m)}{2M+m}gh}$$

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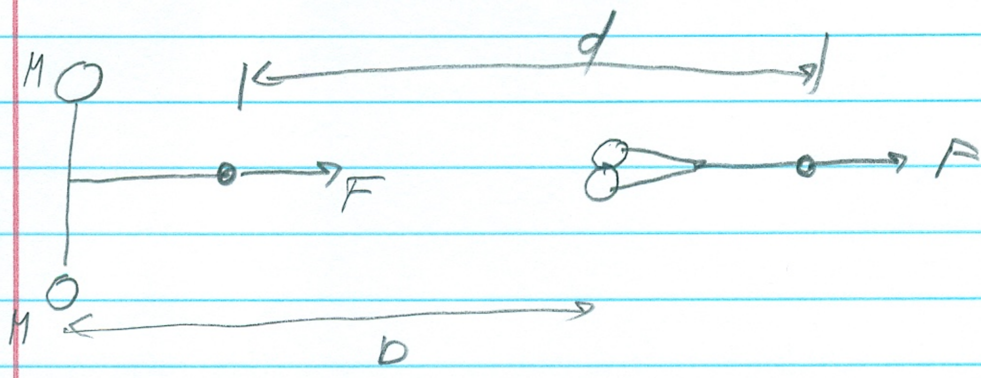
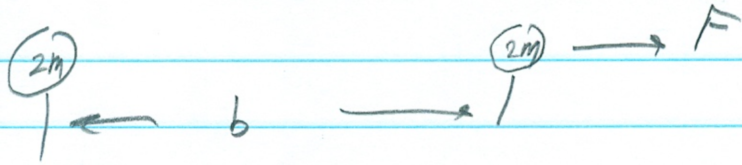
Prob. 35



a) consider motion of cm



$E_f = E_i + W_{surr}$ $\quad$ $U=0$, no friction

$\frac{1}{2}(2M)V_f^2 = \frac{1}{2}(2M)V_i^2 + Fb$

$V_f = \sqrt{V_i^2 + \frac{Fb}{M}}$ $\quad$ $V_i = 0$

$V_f = \sqrt{Fb/M}$

b) Motion of two disks

$K_f + E_{int,f} = K_i + E_{int,i} + W_{surr}$, $U=0$, $K_{rot}=0$

$E_{int} = E_{thermal}$

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$$K_f + E_{thermal,f} = K_i + E_{thermal,i} + Fd$$

$$\Delta E_{thermal} = Fd - \Delta K \qquad \text{pat a} \quad \Delta K = Fb$$

$$= Fd - Fb = \boxed{F(d-b)}$$