P11.3 (a) $\vec{\mathbf{A}}\times\vec{\mathbf{B}}=\begin{vmatrix}\hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}}\\ -3 & 4 & 0\\ 2 & 3 & 0\end{vmatrix}=\boxed{-17.0\hat{\mathbf{k}}}$

(b) $\left|\vec{\mathbf{A}}\times\vec{\mathbf{B}}\right|=\left|\vec{\mathbf{A}}\right|\left|\vec{\mathbf{B}}\right|\sin\theta$

$$17=5\sqrt{13}\sin\theta$$

$$\theta=\sin^{-1}\left(\frac{17}{5\sqrt{13}}\right)=\boxed{70.6^\circ}$$

Section 11.2 **Angular Momentum**

P11.11 $L=\sum m_i v_i r_i$

$$=(4.00\text{ kg})(5.00\text{ m/s})(0.500\text{ m})+(3.00\text{ kg})(5.00\text{ m/s})(0.500\text{ m})$$

$L=17.5\text{ kg}\cdot\text{m}^2/\text{s}$, and

$$\boxed{\vec{\mathbf{L}}=\left(17.5\text{ kg}\cdot\text{m}^2/\text{s}\right)\hat{\mathbf{k}}}$$

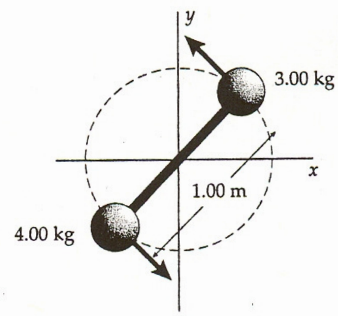

FIG. P11.11

P11.33 $I_i\omega_i=I_f\omega_f$: $\left(250\text{ kg}\cdot\text{m}^2\right)(10.0\text{ rev/min})=\left[250\text{ kg}\cdot\text{m}^2+25.0\text{ kg}(2.00\text{ m})^2\right]\omega_2$

$$\omega_2=\boxed{7.14\text{ rev/min}}$$

P11.37 (a) $L_i=mv\ell \qquad \sum\tau_{\text{ext}}=0,$

so

$$L_f=L_i=\boxed{mv\ell}$$

$$L_f=(m+M)v_f\ell$$

$$v_f=\left(\frac{m}{m+M}\right)v$$

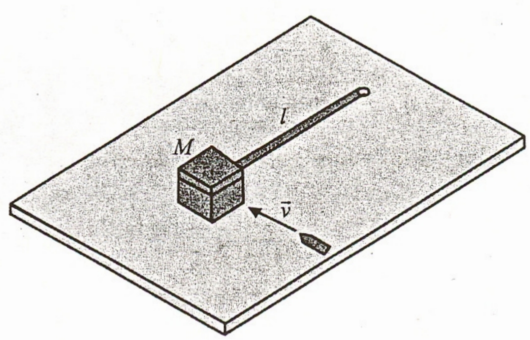

FIG. P11.37

(b) $K_i=\frac{1}{2}mv^2$

$$K_f=\frac{1}{2}(M+m)v_f^2$$

$v_f=\left(\dfrac{m}{M+m}\right)v\Rightarrow$ velocity of the bullet and block

Fraction of K lost $=\dfrac{\frac{1}{2}mv^2-\frac{1}{2}m^2v^2/(M+m)}{\frac{1}{2}mv^2}=\boxed{\dfrac{M}{M+m}}$

P11.42 Angular momentum of the system of the spacecraft and the gyroscope is conserved. The gyroscope and spacecraft turn in opposite directions.

$$0 = I_1\omega_1 + I_2\omega_2: \qquad -I_1\omega_1 = I_2\frac{\theta}{t}$$

$$-20 \text{ kg}\cdot\text{m}^2(-100 \text{ rad/s}) = 5\times10^5 \text{ kg}\cdot\text{m}^2\left(\frac{30°}{t}\right)\left(\frac{\pi \text{ rad}}{180°}\right)$$

$$t = \frac{2.62\times10^5 \text{ s}}{2\,000} = \boxed{131 \text{ s}}$$

P11.50 (a) Angular momentum is conserved:

$$\frac{mv_i d}{2} = \left(\frac{1}{12}Md^2 + m\left(\frac{d}{2}\right)^2\right)\omega$$

$$\omega = \boxed{\frac{6mv_i}{Md+3md}}$$

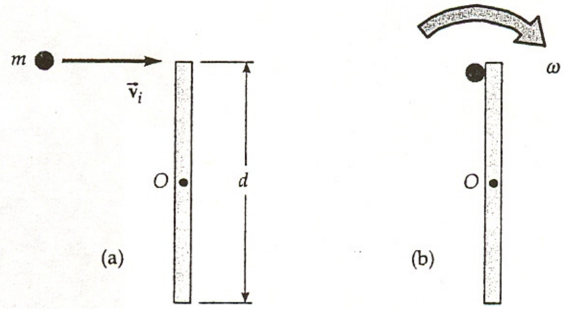

FIG. P11.50

(b) The original energy is $\frac{1}{2}mv_i^2$.

The final energy is

$$\frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{1}{12}Md^2 + \frac{md^2}{4}\right)\frac{36m^2v_i^2}{(Md+3md)^2} = \frac{3m^2v_i^2d}{2(Md+3md)}$$

The loss of energy is

$$\frac{1}{2}mv_i^2 - \frac{3m^2v_i^2d}{2(Md+3md)} = \frac{mMv_i^2d}{2(Md+3md)}$$

and the fractional loss of energy is

$$\frac{mMv_i^2d2}{2(Md+3md)mv_i^2} = \boxed{\frac{M}{M+3m}}$$