37. **THINK** We want to calculate the rotational inertia of a meter stick about an axis perpendicular to the stick but not through its center.

**EXPRESS** We use the parallel-axis theorem: $I = I_{com} + Mh^2$, where $I_{com}$ is the rotational inertia about the center of mass (see Table 10-2(d)), $M$ is the mass, and $h$ is the distance between the center of mass and the chosen rotation axis. The center of mass is at the center of the meter stick, which implies $h$ = 0.50 m – 0.20 m = 0.30 m.

**ANALYZE** With $M = 0.56\,\text{kg}$ and $L = 1.0\ \text{m}$, we have

$$I_{com} = \frac{1}{12}ML^2 = \frac{1}{12}(0.56\ \text{kg})(1.0\ \text{m})^2 = 4.67\times10^{-2}\ \text{kg}\cdot\text{m}^2.$$

Consequently, the parallel-axis theorem yields

$$I = 4.67\times10^{-2}\ \text{kg}\cdot\text{m}^2 + (0.56\ \text{kg})(0.30\ \text{m})^2 = 9.7\times10^{-2}\ \text{kg}\cdot\text{m}^2.$$

**LEARN** A greater moment of inertia $I > I_{com}$ means that it is more difficult to rotate the meter stick about this axis than the case where the axis passes through the center.

41. The particles are treated "point-like" in the sense that Eq. 10-33 yields their rotational inertia, and the rotational inertia for the rods is figured using Table 10-2(e) and the parallel-axis theorem (Eq. 10-36).

(a) With subscript 1 standing for the rod nearest the axis and 4 for the particle farthest from it, we have

$$I = I_1 + I_2 + I_3 + I_4 = \left(\frac{1}{12}Md^2 + M\left(\frac{1}{2}d\right)^2\right) + md^2 + \left(\frac{1}{12}Md^2 + M\left(\frac{3}{2}d\right)^2\right) + m(2d)^2$$

$$= \frac{8}{3}Md^2 + 5md^2 = \frac{8}{3}(1.2\ \text{kg})(0.056\ \text{m})^2 + 5(0.85\ \text{kg})(0.056\ \text{m})^2$$

$$= 0.023\ \text{kg}\cdot\text{m}^2.$$

(b) Using Eq. 10-34, we have

$$K = \frac{1}{2}I\omega^2 = \left(\frac{4}{3}M + \frac{5}{2}m\right)d^2\omega^2 = \left[\frac{4}{3}(1.2\ \text{kg}) + \frac{5}{2}(0.85\ \text{kg})\right](0.056\ \text{m})^2(0.30\ \text{rad/s})^2$$

$$= 1.1\times10^{-3}\ \text{J}.$$

43. **THINK** Since the rotation axis does not pass through the center of the block, we use the parallel-axis theorem to calculate the rotational inertia.

**EXPRESS** According to Table 10-2(i), the rotational inertia of a uniform slab about an axis through the center and perpendicular to the large faces is given by $I_{\text{com}} = \frac{M}{12}\left(a^2+b^2\right)$. A parallel axis through the corner is a distance $h=\sqrt{(a/2)^2+(b/2)^2}$ from the center. Therefore,

$$I = I_{\text{com}} + Mh^2 = \frac{M}{12}\left(a^2+b^2\right) + \frac{M}{4}\left(a^2+b^2\right) = \frac{M}{3}\left(a^2+b^2\right).$$

**ANALYZE** With $M = 0.172\ \text{kg}$, $a = 3.5\ \text{cm}$ and $b = 8.4\ \text{cm}$, we have

$$I = \frac{M}{3}\left(a^2+b^2\right) = \frac{0.172\ \text{kg}}{3}[(0.035\ \text{m})^2 + (0.084\ \text{m})^2] = 4.7\times10^{-4}\ \text{kg}\cdot\text{m}^2.$$

**LEARN** A greater moment of inertia $I > I_{\text{com}}$ means that it is more difficult to rotate the block about the axis through the corner than the case where the axis passes through the center.

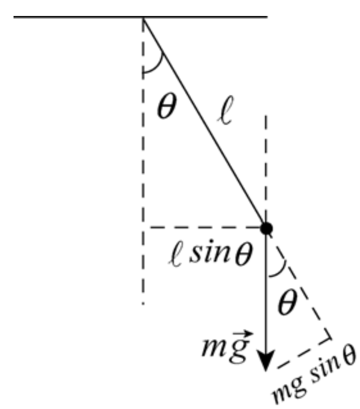
46. The net torque is

$$\begin{aligned}\tau &= \tau_A + \tau_B + \tau_C = F_A r_A \sin\phi_A - F_B r_B \sin\phi_B + F_C r_C \sin\phi_C \\ &= (10)(8.0)\sin135° - (16)(4.0)\sin 90° + (19)(3.0)\sin160° \\ &= 12\ \text{N}\cdot\text{m}.\end{aligned}$$

47. **THINK** In this problem we have a pendulum made up of a ball attached to a massless rod. There are two forces acting on the ball, the force of the rod and the force of gravity.

**EXPRESS** No torque about the pivot point is associated with the force of the rod since that force is along the line from the pivot point to the ball. As can be seen from the diagram, the component of the force of gravity that is perpendicular to the rod is $mg \sin\theta$. If $\ell$ is the length of the rod, then the torque associated with this force has magnitude

$$\tau = mg\ell\sin\theta.$$




**ANALYZE** With $m = 0.75\ \text{kg}$, $\ell = 1.25\ \text{m}$ and $\theta = 30°$, we find the torque to be

$$\tau = mg\ell\sin\theta = (0.75)(9.8)(1.25)\sin 30° = 4.6\ \text{N}\cdot\text{m}.$$

**LEARN** The moment arm of the gravitational force $mg$ is $\ell \sin\theta$. Alternatively, we may say that $\ell$ is the moment arm of $mg\sin\theta$, the tangential component of the gravitational force. Both interpretations lead to the same result: $\tau = (mg)(\ell \sin\theta) = (mg\sin\theta)(\ell)$.