103. (a) From angular momentum conservation: \[ I \omega = I_0 \omega_0. \]
so \[ \omega = \frac{1}{I} I_0 \omega_0 = \frac{L}{I_0} = \frac{1}{1 - 0.075} (4.0 \text{ rad/s}) = 4.3 \text{ rad/s}. \]

(b) \[ \frac{K}{K_0} = \frac{\frac{1}{2}I_0 \omega_0^2}{\frac{1}{2}I \omega^2} = \frac{(0.925)(4.32 \text{ rad/s})^2}{(1)(4.0 \text{ rad/s})^2} = 1.1. \] so \[ K = 1.1K_0. \]

(c) The extra kinetic energy comes from the work done by the skater in tucking her arms.

104. From angular momentum conservation: \[ I \omega = I_0 \omega_0, \]
or \[ Mb^2 \frac{v_f}{b} = Md^2 \frac{v}{d}. \] So \[ d = \frac{b(v_f, v_0)}{v}. \]

105. (a) From angular momentum conservation, the lazy Susan will rotate in the opposite direction.

(b) The initial total angular momentum (before the kitten walks) is zero.

\[ L = L_0, \quad mR^2 \omega_0 + \frac{1}{2} M_1 R^2 \omega_1 = m_2 R^2 \frac{v_0}{R} + \frac{1}{2} M_2 R^2 \omega_1 = 0 + 0, \]
so \[ \omega_1 = \frac{2m_2 v_0}{M_2 R} = \frac{2(0.50 \text{ kg})(0.25 \text{ m/s})}{(1.5 \text{ kg})(0.30 \text{ m})} = -0.56 \text{ rad/s}. \]
Therefore the lazy Susan rotates at \[ 0.56 \text{ rad/s}. \]

(c) No, the kitten will not be above the same point due to the rotation of the lazy Susan.

The relative angular velocity of the kitten relative to the ground is \[ \frac{0.25 \text{ m/s}}{0.30 \text{ m}} + (-0.556 \text{ rad/s}) = 0.277 \text{ rad/s}. \] It takes \[ \frac{2\pi \text{ rad}}{(0.25 \text{ m/s})(0.30 \text{ m})} = 7.54 \text{ s} \] for the kitten to go around.

During that time the angular distance from where the kitten was to where the kitten is (relative to the ground) is \[ \theta = \frac{0.277 \text{ rad/s})(7.54 \text{ s})}{2.1 \text{ rad}, \] (If we all run eastward the Earth would have to rotate slower in the eastward direction due to angular momentum conservation. This results in a longer day.)

106. Chose the right support as axis of rotation.

\[ \Delta \tau = Mg(5.0 \text{ m}) + mg(7.0 \text{ m}) - F_L(10 \text{ m}) = 0, \] so
\[ (10000 \text{ kg})(9.80 \text{ m/s}^2)(5.0 \text{ m}) + (2000 \text{ kg})(9.80 \text{ m/s}^2)(7.0 \text{ m}) = F_L(10 \text{ m}) \]

\[ F_L = 6.27 \times 10^3 \text{ N} = 6.3 \times 10^3 \text{ N}. \]

\[ \Sigma F_y = F_L - mg - Mg = 0, \quad \Rightarrow \quad F_R = (m + M)g - F_L \]
\[ = (10000 \text{ kg} + 2000 \text{ kg})(9.80 \text{ m/s}^2) - 6.27 \times 10^3 \text{ N} = 5.5 \times 10^4 \text{ N}. \]