7. If v is less than $R\omega$, the object is $\boxed{\text{slipping}}$. $\boxed{\text{Yes}}$, it is possible for v to be greater than $R\omega$ when the object is $\boxed{\text{sliding}}$.

8. According to $v_t = r\omega$. the reading of the speedometer is $\boxed{v/2}$. The point on the top of the tire has twice the radius as the center of the tire (the point at which the tire makes contact with the ground is the axis of rotation), and the speedometer reads the speed of the center of the tire (v_{CM}).

11. $s = r\theta$, ☞ $r = \dfrac{s}{\theta} = \dfrac{3.2\text{ m}}{5.0(2\pi\text{ rad})} = \boxed{0.10\text{ m}}$.

12. $\omega = \dfrac{\Delta\theta}{\Delta t} = \dfrac{7.5(2\pi\text{ rad})}{2.0\text{ s}}\ \boxed{\approx 24\text{ rad/s}}$ (2 significant figures).

So $r\,\omega = (0.150\text{ m})(24\text{ rad/s}) = 3.6\text{ m/s} = 3.60\text{ m/s} = v_{CM}$. The answer is $\boxed{\text{no slipping}}$.

13. $v_{CM} = r\omega$, ☞ $\omega = \dfrac{v_{CM}}{r} = \dfrac{0.25\text{ m/s}}{0.15\text{ m}} = \boxed{1.7\text{ rad/s}}$.

15. (a) $\theta = \dfrac{s}{r} = \dfrac{2.50\text{ m}}{0.0300\text{ m}} = 83.33\text{ rad}$.

$\omega^2 = \omega_o^2 + 2\alpha\theta$, ☞ $\alpha = \dfrac{\omega^2 - \omega_o^2}{2\theta} = \dfrac{0 - (2.35\text{ rad/s})^2}{2(83.33\text{ rad})} = -\boxed{0.0331\text{ rad/s}^2}$.

(b) The top part of the ball has the maximum tangential acceleration. It is 0.0600 m above the contact point, so i

$a_t = r\,\alpha = (0.0600\text{ m})(-0.0331\text{ rad/s}^2) = -\boxed{1.99 \times 10^{-3}\text{ m/s}^2}$.

16. $\alpha = \dfrac{a_t}{r} = \dfrac{0.018\text{ m/s}^2}{0.10\text{ m}} = 0.18\text{ rad/s}^2$. $\omega^2 = \omega_o^2 + 2\alpha\theta$,

so $\theta = \dfrac{\omega^2 - \omega_o^2}{2\alpha} = \dfrac{(1.25\text{ rad/s})^2 - (0.50\text{ rad/s})^2}{2(0.18\text{ rad/s}^2)} = 36.5\text{ rad} = \boxed{0.58\text{ rotations}}$.

$\boxed{20}$. When you use the back, the back has to rotate, and the lever arm is greater so the $\boxed{\text{back muscles have to exert greater torque}}$. If the legs are used, then the back can keep in a straight position and exert no torque.

21. This is $\boxed{\text{to lower the center of gravity}}$, so the weight will have a shorter lever arm therefore smaller torque.

22. In all three cases, $\boxed{\text{the centers of gravity must be directly below the base of support}}$. The torque is zero because the force of the CG is through the axis of rotation.

23. Frictional torque causes the motorcycle to rotate upward until balanced by the torque of weight.

24. An example is $\boxed{\text{a cylinder or a sphere on a level surface}}$.

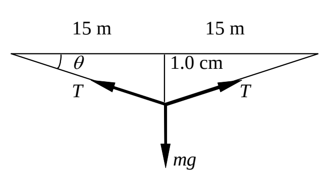
25. Use the numbers from Example 8.1.

$\tau = Fr_\perp$, ☞ $F = \dfrac{\tau}{r_\perp} = \dfrac{18\text{ m·N}}{(0.040\text{ m})\cos 37°} = \boxed{5.6 \times 10^2\text{ N}}$.

$\boxed{32}$. (a) $\boxed{\text{No}}$, it is not possible to have the lines perfectly horizontal, because the weight has to be supported by an upward component of the tensions in the lines. If the lines were horizontal, then they cannot support the weight.

(b) $\theta = \tan^{-1}\left(\dfrac{0.010}{15}\right) = 0.0382°$. $\Sigma F_y = 2T\sin\theta - mg = 0$.

So $T = \dfrac{mg}{2\sin\theta} = \dfrac{(0.25\text{ kg})(9.80\text{ m/s}^2)}{2\sin 0.0382°} = \boxed{1.8 \times 10^3\text{ N} > 400\text{ lb}}$.



35. (a) If the ball skids to your right, the frictional forced is to your left. Its torque is $\boxed{\text{clockwise}}$.

(b) $f_k = \mu_k N = \mu_k mg = (0.400)(7.00 \text{ kg})(9.80 \text{ m/s}^2) = 27.44 \text{ N}$.

$\tau = Fr = (27.44 \text{ N})(0.170 \text{ m}) = \boxed{4.66 \text{ m·N}}$.

46. Choose the left end as the axis. $\Sigma\tau = 0$,

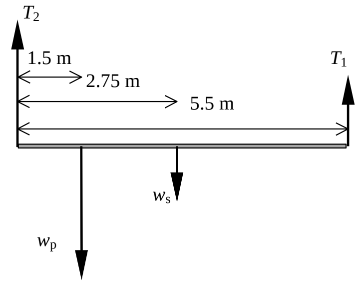
$T_2(0) - (70 \text{ kg})(9.80 \text{ m/s}^2)(1.5 \text{ m}) - (15 \text{ kg})(9.80 \text{ m/s}^2)(2.75 \text{ m}) + T_1(5.5 \text{ m}) = 0$,

so $T_1 = \boxed{2.6 \times 10^2 \text{ N}}$.

$\Sigma F_y = 0$, ☞ $T_1 + T_2 = (70 \text{ kg} + 15 \text{ kg})(9.80 \text{ m/s}^2)$,

so $T_2 = 833 \text{ N} - 261 \text{ N} = \boxed{5.7 \times 10^2 \text{ N}}$.

T_2 can also be found by choosing the right end as the axis.



54. The moment of inertia $\boxed{\text{depends on how mass is distributed about an axis}}$.

Physically, this means that, under a constant torque, the angular acceleration depends on the location of the axis of rotation.

55. The $\boxed{\text{hard-boiled egg is a rigid body}}$, while the raw egg is not.

61. (a) $I = \Sigma(mr^2) = (2.0 \text{ kg})(0.30 \text{ m})^2 + (4.0 \text{ kg})(0.75 \text{ m})^2 = \boxed{2.4 \text{ kg·m}^2}$.

(b) $X_{CM} = \dfrac{\Sigma_i(m_i x_i)}{M} = \dfrac{(2.0 \text{ kg})(0.30 \text{ m}) + (4.0 \text{ kg})(0.75 \text{ m})}{2.0 \text{ kg} + 4.0 \text{ kg}} = 0.60 \text{ m}$.

So $I = (2.0 \text{ kg})(0.60 \text{ m} - 0.30 \text{ m})^2 + (4.0 \text{ kg})(0.75 \text{ m} - 0.60 \text{ m})^2 = \boxed{0.27 \text{ kg·m}^2}$.

(c) $I = I_{CM} + Md^2 = 0.27 \text{ kg·m}^2 + (6.0 \text{ kg})(0.60 \text{ m})^2 = \boxed{2.4 \text{ kg·m}^2 \text{ (same)}}$.

66. Let L be the length of the shaft. The moment of inertia of each shaft is

$I_{shaft} = \frac{1}{3}mL^2 = \frac{1}{3}(50.0 \text{ kg})(0.250 \text{ m})^2 = 1.042 \text{ kg·m}^2$.

The moment of inertia of the door is calculated using the parallel-axis theorem (w is the width of the door).

$I_{door} = \frac{1}{12}Mw^2 + M(L + w/2)^2$

$= \frac{1}{12}(200 \text{ kg})(0.500 \text{ m})^2 + (200 \text{ kg})[0.250 \text{ m} + (0.500 \text{ m})/2]^2 = 54.17 \text{ kg·m}^2$.

So the total moment of inertia is $I = 2I_{shaft} + I_{door} = 2(1.042 \text{ kg·m}^2) + 54.17 \text{ kg·m}^2 = \boxed{56.3 \text{ kg·m}^2}$

$\boxed{68}$. (a) Apply Newton's second law and note $a = r\alpha$.

m_2: $T_2 - m_2 g = m_2 a$, (1)

pulley: $T_1 R - T_2 R = I\alpha = \frac{1}{2}MR^2\alpha = \frac{1}{2}MRa$,

or $T_1 - T_2 = 0.5Ma$, (2)

m_1: $m_1 g \sin\theta - T_1 = m_1 a$, (3)

Equation (1) + Equation (2) + Equation (3) gives

$m_1 g \sin\theta - m_2 g = (m_1 + m_2 + 0.5M)a$,

so $a = \dfrac{(m_1 \sin\theta - m_2)g}{m_1 + m_2 + 0.5M} = \dfrac{[(8.0 \text{ kg}) \sin 30° - (3.0 \text{ kg})](9.80 \text{ m/s}^2)}{8.0 \text{ kg} + 3.0 \text{ kg} + 0.5(0.10 \text{ kg})} = \boxed{0.89 \text{ m/s}^2}$.

(b) Pulley: $T_1 R - T_2 R - \tau_f = I\alpha = \frac{1}{2}MR^2\alpha = \frac{1}{2}MRa$,

or $T_1 - T_2 - \dfrac{\tau_f}{R} = 0.5Ma$. (4)

Equation (4) replacing Equation (2) gives $a = \dfrac{(m_1 \sin\theta - m_2)g - \dfrac{\tau_f}{R}}{m_1 + m_2 + 0.5M}$ (extra factor due to $\dfrac{\tau_f}{R}$)

So $a = \dfrac{[(8.0 \text{ kg}) \sin 30° - (3.0 \text{ kg})](9.80 \text{ m/s}^2) - \dfrac{0.050 \text{ m·N}}{0.10 \text{ m}}}{8.0 \text{ kg} + 3.0 \text{ kg} + 0.5(0.10 \text{ kg})} = \boxed{0.84 \text{ m/s}^2}$.

The tensions are different because of the frictional torque.

78. The wheels would have **small total mass with more mass near the center**. This decreases the moment of inertia, which in turn decreases the rotational kinetic energy for a given angular speed.

79. According to the work-energy theorem, **rotational work** is required to produce a change in rotational kinetic energy. Rotational work (W) is done by a torque (τ) acting through an angular displacement (θ).

85. Apply energy conservation and note $v = r\omega$. $\frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + Mg(0) = \frac{1}{2}M(0)^2 + \frac{1}{2}I(0)^2 + Mgh$,

or $\frac{1}{2}MR^2\omega^2 + \frac{1}{2}(\frac{2}{5}MR^2)\omega^2 = Mgh$,

so $h = \dfrac{7}{10g}r^2\omega^2 = \dfrac{7}{10(9.80\text{ m/s}^2)}(0.15\text{ m})^2(10\text{ rad/s})^2 = \boxed{0.16\text{ m}}$.

90. Apply energy conservation and note $v = r\omega$. $\frac{1}{2}M(0)^2 + \frac{1}{2}I(0)^2 + Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + Mg(0)$.

or $\frac{1}{2}Mv^2 + \frac{1}{2}Mv^2 = Mv^2 = Mgh$, ☞ $v = \sqrt{gh} = \sqrt{(9.80\text{ m/s}^2)(1.2\text{ m})} = \boxed{3.4\text{ m/s}}$.

94. (a) $\omega = 2\pi$ rad/s = 6.28 rad/s. The moment of inertia of a hoop is $I = MR^2$.

$K = \frac{1}{2}I\omega^2 = \frac{1}{2}(MR^2)\omega^2 = \frac{1}{2}(35.0\text{ kg})(0.500\text{ m})^2(6.28\text{ rad/s})^2 = 172.5\text{ J} = \boxed{173\text{ J}}$.

(b) $\theta = \bar{\omega}t = \dfrac{\omega_o + \omega}{2}\times t = \dfrac{0 + 6.28\text{ rad/s}}{2}\times(2.50\text{ s}) = 7.85\text{ rad}$.

From the work-energy theorem: $W = \tau\theta = K - K_o = K - 0 = K$. So $\tau = \dfrac{K}{\theta} = \dfrac{172.5\text{ J}}{7.85\text{ rad}} = \boxed{22.0\text{ m·N}}$.

97. (d). The Earth is the closest to the Sun on Dec. 21 among the choices.

105. $L = I\omega$, ☞ $\omega = \dfrac{L}{I} = \dfrac{L}{\frac{1}{2}MR^2} = \dfrac{0.45\text{ kg·m}^2\text{/s}}{\frac{1}{2}(10\text{ kg})(0.25\text{ m})^2} = \boxed{1.4\text{ rad/s}}$.

109. $\omega_{1o} = \dfrac{2\pi\text{ rad}}{5.00\text{ s}} = 1.256\text{ rad/s}$.

The moment of inertia of the merry-go-round and the boy are $I_1 = \frac{1}{2}MR^2$ and $I_2 = mR^2$, respectively.

$I_1\omega_{1o} + I_2\omega_{2o} = I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\,\omega$,

$\omega = \dfrac{I_1\omega_{1o} + I_2\omega_{2o}}{I_1 + I_2} = \dfrac{I_1\omega_{1o} + 0}{I_1 + I_2} = \dfrac{\frac{1}{2}MR^2\,\omega_{1o}}{\frac{1}{2}MR^2 + mR^2} = \dfrac{M\,\omega_{1o}}{M + 2m} = \dfrac{(250\text{ kg})(1.256\text{ rad/s})}{250\text{ kg} + 15.0\text{ kg}} = \boxed{1.18\text{ rad/s}}$.

114. $I = MR^2 = (3.25\text{ kg})(0.410\text{ m})^2 = 0.5463\text{ kg·m}^2$. $\omega_o = 2.00(2\pi)\text{ rad/s} = 12.56\text{ rad/s}$.

$\tau\Delta t = FR\Delta t = L - L_o = 0 - L_o = -L_o = -I\,\omega_o$, So $F = \dfrac{-I\,\omega_o}{R\Delta t} = -\dfrac{(0.5463\text{ kg·m}^2)(12.56\text{ rad/s})}{(0.410\text{ m})(3.50\text{ s})} = \boxed{4.78\text{ N}}$.