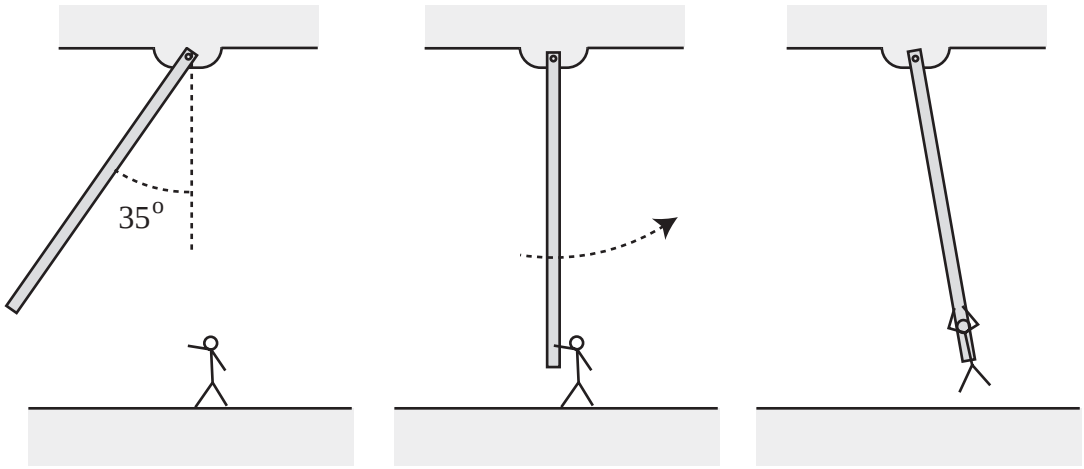
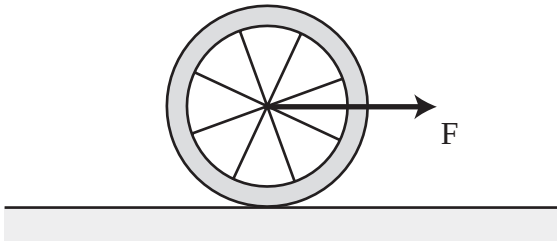
Midterm 3

1. A pole of length 4.5 m and mass 16 kg is attached to a pivot on the ceiling. It is released from rest at an initial angle of 35°, as shown at left. When the pole reaches the bottom of its swing, a circus performer of mass 36 kg grabs onto the end of the pole. **What is the maximum angle of the upward swing of the pole with the circus performer on the end of the pole?** The moment of inertia of the pole is $\frac{1}{3}M\ell^2$, where M is the mass of the pole and ℓ is its length. Treat the circus performer as a point mass and neglect friction between the circus performer and the floor.



2. A bicycle wheel of mass M and radius R is initially at rest on a horizontal surface. It is accelerated by a constant horizontal force F acting on the axle as shown. The moment of inertia of the wheel is MR^2. Assume the wheel rolls without slipping.



(a) (18 points) Use the work-energy theorem to **find the horizontal velocity v as a function of the distance d travelled by the wheel.**

(b) (15 points) Using your result for part (a), **find the horizontal acceleration a of the wheel.** Hint: the answer is *not* $a = F/M$!

3. A balance scale consists of a rod of mass 0.15 kg and length 45 cm that can rotate freely about a pivot at the center. A weight with mass 55 g is placed on one end of the rod. The system is released at rest with the rod horizontal, as shown at left. **Find the angular velocity of the rod about the center when the rod makes an angle of 15° with the horizontal.** Treat the weight as a point mass and assume that it does not slide on the scale. The moment of inertia of a rod of mass M and length ℓ for rotation about its center is $\frac{1}{12}M\ell^2$.