## *Problem Set 9*

- Big Ben

Big Ben, the nickname for the clock in Elizabeth Tower (named after the Queen in 2012) in London, has an hour hand 2.70 m long with a mass of 60.0 kg and a minute hand 4.50 m long with a mass of 100 kg. You may model the hands as long, thin rods rotated about one end. Assume the hour and minute hands are rotating at a constant rate of one revolution per 12 hours and 60 minutes, respectively.

a) Calculate the total rotational kinetic energy of the two hands about the axis of rotation.
b) Calculate the total angular momentum of the two hands hands about the center point.

- American Flagpole

Patriotic Duffy just installed an American flagpole to his house. Duffy now sits in his front porch licking a bone and watching the flag flying in the breeze. Unfortunately, the ball with mass m fastened at the end of the flagpole becomes loose and starts to fall with acceleration $-g\hat{j}$ (probably because Duffy mounted the flagpole by himself to save $$$.) Assuming the length of the flagpole is $l$, and it makes an angle $\theta$ with the x axis.

a) Determine the angular momentum of the ball about the mounting bracket as a function of time.
b) For what physical reason does the angular momentum change?
c) What is the rate of change of the angular momentum of the ball about mounting bracket point?

*Figure 9.1*

*Figure 9.2*

- Curious George

*George loves bananas*

A light rope passes over a light, frictionless pulley. One end is fastened to a bunch of bananas of mass m, and Monkey George with the same mass m clings to the other end (Fig. 9.3). George climbs the rope in an attempt to reach the bananas.

a) Find the net torque on the system (George, bananas, rope and pulley) about the pulley axis.
b) What's the total angular momentum about the pulley axis and describe the motion of the system.
c) Will George reach the bananas?

*George climbs a log*

George (10.0 kg) climbs a uniform log with weight $1.20 \times 10^2\ N$ and length $L = 3.00\ m$ as shown in Fig 9.4. The log rests against a big rock and makes an angle of $\emptyset = 60.0°$ with the ground. The upper and lower ends of the log rest on frictionless rock surfaces. The lower end is connected to the wall by a horizontal rope that is frayed and can support a maximum tension of only 80.0 N.

a) Draw a force diagram for the log.
b) Find the normal force exerted on the bottom of the ladder.
c) Find the tension in the rope when George is two-thirds of the way up the ladder.
d) Find the maximum distance d that George can climb up the ladder before the rope breaks.
e) If the horizontal surface were rough and the rope were removed, how would you need to answer parts c) and d)?

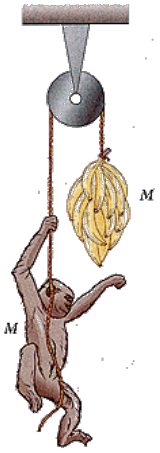


*Figure 9.3*

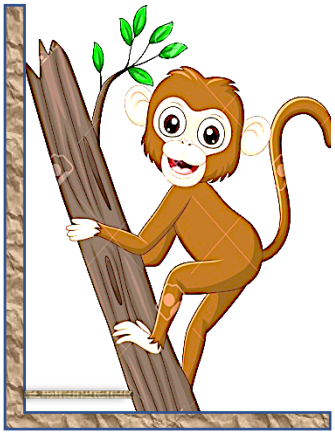

*Figure 9.4*