

# Exam # 4 – Physics 151

November 25, 2008

Be sure to include pictures, coordinate systems, etc. where reasonable.

1. Much has been made of the analogy of rotations to translations. The three major modes of reasoning we have used to understand the behavior of an object are: Newton's laws, conservation of momentum, and conservation of energy. Write down the rotational version of these laws and carefully define any symbols you use.
2. A hoop like wheel of radius  $0.5m$  and mass  $1kg$  is initially spinning at a rate of 0.3 revolutions each second. It experiences a constant acceleration of  $3rad/s^2$  because of a motor attached to it.
  - (a) What is the angular displacement from  $t = 0$  (the moment the motor turns on) through  $t = 10s$ ?
  - (b) How big is the torque applied?
  - (c) What is the work done by the motor on the wheel during this time period?
3. Consider the following three objects shown in Fig. 1 that all have the same mass  $M$  and radius  $R$ . Rank the objects moment of inertia from **smallest to largest**. Defend your rankings through reasoning, not by appealing to Fig. 11-2.

4. Two identical tops spin with an angular velocity of  $35\pi rad/s$  up and  $25\pi rad/s$  down respectively about vertical axes on a table. The tops bump into one another and separate. After the collision, one of the tops has an angular velocity of  $30\pi rad/s$  in its original direction. What is the angular velocity of the other top?
  
5. The automatic flag raising system on a horizontal flagpole attached to the vertical outside wall of a tall building has become stuck. The management of the building wants to send a person crawling out along the flagpole to fix the problem. Because of your physics knowledge, you have been asked to consult with a group to decide whether or not this is possible. You are all too aware that no one could survive the 250 foot fall from the flagpole to the ground. The flagpole is a 120 lb steel I-beam which is very strong and rigid. One side of the flagpole is attached to the wall of the building by a hinge so that it can rotate vertically. Nine feet away, the other end of the flagpole is attached to a strong, lightweight cable. The cable goes up from the flagpole at an angle of  $30^\circ$  until it reaches the building where it is bolted to the wall. The mechanic who will climb out on the flagpole weighs 150 lbs including equipment. From the specifications of the building construction, both the bolt attaching the cable to the building and the hinge have been tested to hold a force of 500 lbs. Your boss has decided that the worse case is when the mechanic is at the far end of the flagpole, nine feet from the building.