## Physics 171

May 1, 2000
Exam \# 3
Do the attached problems on the paper provided. Extra paper is available at the front of the room if you need more. Be sure to write your name and the problem number on any extra sheets you use!!
You may use your own pens, pencils, erasers, calculator and one $8 \frac{1}{2}$ " $\times 11$ " sheet of paper pre-prepared with any information you think you might need.
The exam will be graded on the basis of CLARITY of PRESENTATION of your reasoning, as well as correctness of the final answer. You must also show the units on numerical answers to obtain full credit.

Name

1. Two masses, m 1 and m 2 are suspended from a cable that passes over a pulley. The pulley has mass M and radius R , and it is a homogeneous flat disk. Mass m 2 is greater than mass ml and the two masses are released from rest. The cable does not slip on the surface of the pulley.
a) Explain why or why not each of the following quantities is conserved: momentum, kinetic energy, total energy, angular momentum.
b) What is the moment of inertia of the pulley?
c) What is the speed of mass m 2 after it has descended a distance h ?
d) Is the torque on the pulley negative, zero or positive?

2. Two nuclei approach each other head on. The first has mass $\mathrm{m} 1=20.00 \mathrm{mp}$, where mp is the mass of a proton. It is traveling at speed 0.89 c . The second has mass $\mathrm{m} 2=$ 63.14 mp . The two masses collide inelastically, creating a new particle that is stationary (final velocity $=0$ ).
a) What quantities are conserved in this process?
b) What was the initial speed of the nucleus of mass m2?
c) What is the mass of the new particle created in the collision?

m1

m2
3. A narrow rod has a mass of 4.42 kg and a length of 1.23 m . It is at rest on a frictionless surface. A point mass, $\mathrm{m}=2.40 \mathrm{~kg}$ traveling perpendicular to the stick with speed $v=0.334 \mathrm{~m} / \mathrm{s}$ hits it 0.350 m off center.
a) What is the position of the center of mass when the point mass hits the rod? (treat the rod as having no width)
b) What is the angular momentum of the point mass with respect to the center of mass just as it hits the rod? (treat the rod as having no width)
b) If the point mass sticks to the rod in the collision, what is the velocity of the center of mass of the rod plus mass after the collision?
c) If the point mass sticks to the rod in the collision, what is the moment of inertia of the rod plus point mass with respect to an axis through the center of mass?
d) What is the angular velocity of the rod plus mass (as it rotates about the center of mass) after the collision

4. A satellite of mass 2500 kg orbits the earth in an elliptical orbit where its closest point is a distance $r_{c}=15,000 \mathrm{~km}$ from the earth's center, and its farthest distance is $r_{f}=60,000$ km from the earth's center.
a) What is the total energy of the orbiting satellite?
b) What is speed of the satellite at its distance of closest approach?
c) What is the angular momentum of the satellite?
