

Physics 10310 — General Physics I

Hour Exam 3 – Fall 2009

**There are 5 problems. Please do all problems.
Please show all work.**

1. A small bag of sand is suspended by a thread of length $L = 1.2$ m. A bullet of mass $m = 8.0$ g moving with a speed $v_0 = 600$ m/s in the horizontal direction hits the bag and leaves with a speed $v = 250$ m/s. The bag swings to a maximum angle of $\theta = 40^\circ$. What is the mass of the sandbag?
2. Two students sit on opposite ends of a 4 m long sled that is initially at rest on frictionless ice. Each student has a mass of 65 kg. The sled's mass is 30 kg. The student at the left end slides a 3.0 kg object on the sled across to the other student at a uniform speed of 6.0 m/s relative to the sled. The object moves friction free on the sled.
 - a) What is the sled's speed relative to the ice while the 3.0 kg object is moving before the second student catches it?
 - b) What is the sled's speed after the second student catches the object?

- c) Over what distance does the sled move while the object slides across?
 - d) Over what distance does the center of mass move while the object slides across?
3. A motorcycle has a mass of 500 kg. The wheels have a diameter of 60 cm. The center of the wheels are separated by 1.5 m. Assuming that the weight is distributed evenly over the wheels, that the wheels roll without sliding and the coefficient of static friction between the wheels and the road is $\mu_s = 0.5$ calculate the torque about the center of the front wheel exerted by the forces between the road and the wheels when there is maximum braking.
4. When a bicycle rider accelerates, he must accelerate his own and his bicycle's linear motion as well as the angular motion of the wheels. Suppose the cyclist has a mass of 55 kg; the bicycle, not counting the wheels 8 kg and both wheels together 1.8 kg. Assume that the wheels, each of radius 30 cm, have all their mass concentrated in the thin rim.
- a) At 25 km/h what fraction of the kinetic energy of the rider plus his bicycle is in linear motion and what fraction is in rotational motion?

- b) Suppose the cyclist loses 3.0 kg on a diet. What percentage of the original force is required to accelerate the system uniformly from 0 to 25 km/h in 10 s?
- c) Instead of a diet the cyclist replaces his wheels with new ones with a total mass of 1.2 kg. Now what is the percentage of the original force required to accelerate the system uniformly from 0 to 25 km/h in 10 s?
5. A skater twirls at 0.7 rev/s with her arms extended and holds a 3 kg mass in each hand. Each mass is 0.8 m from the axis of rotation. She pulls the masses in along the radial direction until they are 0.4 m from the axis of rotation. Assuming that the rotational inertia of the arms is negligible and that the rotational inertia of the skater without the masses is 2.3 kg m^2 .
- a) What is the speed of rotation after the masses have been pulled in? b) What is the difference between the final and the initial kinetic energy? c) Where did this energy come from?