PHYSICS 191
Test # 3: MOMENTUM & ROTATION
December 5, 1995

1. A 15 kg dog runs along a dock, then leaps at 5 m/s into a 40 kg canoe at rest. A 7 kg cat is sitting in the front of the canoe.

   (a) What will be the speed of the canoe relative to the shore after the dog lands in it? Assume that the dog, an experienced canoeist, sits immediately.

   (b) If the cat now leaps out the front end at 6 m/s relative to the canoe, what will be the canoe's speed relative to the shore?

2. A wheel of 3 cm radius starts rotating from rest at $t = 0$s with constant angular acceleration, and reaches a speed of 5 rev/s when it has gone through 40 rev.

   (a) At what time will it reach a speed of 20 rev/s?

   (b) What is the tangential acceleration of a point on the rim of the wheel at $t = 2$s?

3. A moving 3 kg particle is located at $x = 2 + 4t$, where x is in meters and t is in seconds. A 5 kg particle is at $y = 6 - 5t$.

   (a) Where is the center of mass of this system at $t = 3$s?

   (b) What is the speed of the center of mass?

4. (a) What impulse is required to bat a 0.15 kg baseball moving at 35 m/s straight back to the pitcher at 40 m/s?

   (b) What is the average force required if the collision of the bat and ball lasts for 0.12s?

5. A 7 kg bowling ball of radius 11 cm is hanging on a 2 m long wire of negligible mass, as shown. The ball swings back and forth as a pendulum.

   (a) What is the rotational inertia of the pendulum?

   (b) If the wire is initially at a 20° angle from vertical, what will be the linear speed of the center of the ball at the bottom of its swing?

6. Romeo, mass 80 kg, is running North at 6 m/s. He collides with Juliet, mass 50 kg, who is running South at 8 m/s.

   (a) If the collision is elastic, what will be Juliet's velocity afterwards?

   (b) If the collision is completely inelastic, what percentage of the kinetic energy is lost?