Physics 113 - Fall 2006 – Problems for workshop 8

1. An astronaut floats in a long spaceship with a uniform linear mass density (say what?). If the back end of the spaceship is sitting at x=0, the front end is measured to reach x=25 meters. The spaceship has a mass of 2000 kg (built with very light materials!). If the astronaut, whose mass is 70 kg, is floating at x=4 meters, where is the center-of-mass of the astronaut-spaceship system?
2. An astronaut stands at the back end of a rocket ship travelling with a velocity V in the x direction. The astronaut quickly moves toward the front of the spaceship and suddenly stops, then moves forward again quickly, stopping at the front. Qualitatively describe what happens to the center-of-mass of the rocket ship/astronaut system during throughout this event. How does the astronaut's motion affect that of the rocket ship? It might be useful to start out considering the situation where V=0.
3. Consider a right cylindrical can with mass M, height H, and uniform density that is initially filled with soda pop of mass m. Small holes are punched in the bottom and top of the can and the liquid slowly drains out. What is the height h of the center of mass of the can and pop system initially? What is the center of mass of the system after all the liquid has drained out (ignore the soda on the floor). If x is the height of the remaining soda pop at any given instant, find x (in terms of M, H, and m) when the center of mass reaches its lowest point.
4. In rewind mode, many cassette and video recorders have one spool that turns at constant angular velocity pulling the tape from the other spool. What happens to the angular velocity of the other spool as the tape moves from one spool to the other (changing the outer radii of the spools). Why?
5. A wheel (call it wheel A) of radius 10 cm is coupled by a rubber fan belt to a different wheel (call it B) of radius 25 cm. Wheel A increases its angular speed from rest at a uniform rate of 1.2 rad/s^2. Find the time for wheel B to reach a rotational speed of 100 rev/min, assuming the belt does not slip.
6. An early method of measuring the speed of light makes use of a rotating slotted wheel. A beam of light passes through a slot on the outside edge of the wheel, travels to a distant mirror, and returns to the wheel just in time to pass through the next slot in the wheel. One such slotted wheel has a radius of 5.0 cm and 500 slots at its edge. Measurements taken when the mirror was 500 m from the wheel indicated a speed of light of 3.0×10^8 m/s. a) What was the (constant) angular speed of the wheel? b) What was the linear speed of a point of the edge of the wheel?