Assignment IX, PHYS 111 (General Physics I)
Fall 2016
Due 11/11/16 at start of class

As always, please put your clearly written answers on separate paper.

1. A 16-lb bowling ball is thrown down a lane. Assume that the ball is a uniform sphere of with diameter 21.5 cm. Initially, the ball is thrown with a velocity of 21 mph and slides down the lane without any rotation. Due to the torque of the frictional force on the ball, the ball accelerates with uniform α until it begins to roll without slipping. At this point, the center of mass of the bowling ball is moving at 16 mph.

   a) What is the angular velocity ω when the ball starts to roll without slipping?

   b) How much total kinetic energy was lost to friction between when the ball was released and it began to roll without slipping?

   c) If the ball started rolling without slipping 3/4 of the way down the 18.30 meter lane, what was μ_k?

2. A standard, hinged door can be treated as a 2-dimensional plate with dimensions h and w (for height and width, respectively). The moment of inertia of a flat rectangular plate around an axis going through its center, parallel to the long direction, and in the plane of the plate is $I = \frac{1}{12}mw^2$.

   a) What is the moment of inertia of this plate with respect to its long edge? (i.e with respect to a door's normal axis of rotation).

   b) Let's say that a real door has a numerical moment of inertia about its hinges equal to 25 kg m^2, with a width of 1.3 meters. Neglecting friction, what steady force – applied at its outer edge and perpendicular to the door – can move the door from rest through an angle of $\pi/2$ radians in 1.8 seconds?

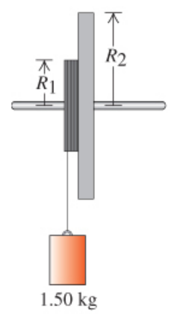
   c) What force would have to be applied if the force was applied at the door's center (instead of its outer edge) and perpendicular to the door to close the door in 1.8 seconds?

3. Two uniform metal disks with masses m_1 and m_2 and radii R_1 and R_2 are welded together and mounted on a frictionless axis through their common center as shown below.

   a) What is the total moment of inertia of the two disks with respect to the axis?

   b) Let $R_1 = 7.00$ cm and $R_2 = 11.0$ cm. Let $m_1 = 1.35$ kg and $m_2 = 4.23$ kg. A massless, inextensible string is wrapped around the edge of the smaller disk and a 1.50 kg block is suspended from the free end of the string. If the block is released from rest a distance 10.00 m above the floor, what is the block's speed just before it strikes the floor?

   c) Repeat your calculation completed in part (b) above if the string is wrapped around the edge of the larger disk instead.



4. Under certain circumstances, a star can collapse into an extremely dense object called a neutron star. (1 tablespoon full of a neutron star has approximately the same mass as the whole Earth). Let's talk about a star that has an initial radius of 9×10^8 meters and collapses down into a neutron star that has a radius of about 2×10^4 meters. You may assume that the mass of each star is uniformly distributed throughout its volume.

   a) If no mass is lost in this process, what is the rotational period of the neutron star if the original star had a rotational period of 2 weeks?

   b) Find the ratio $\frac{[v_{\text{rim}}]_{\text{neutron star}}}{[v_{\text{rim}}]_{\text{original star}}}$. Where v_{rim} corresponds to the velocity of a piece of the star at the surface and on the equator of the rotating star.