PHYSICS 1030
Homework #5

(Due Nov. 18, 2024, 6:00 pm)

1. (Serway 9-45) Four objects are situated along the y axis as follows: a 2.00-kg object is at $+3.00$ m, a 3.00-kg object is at $+2.50$ m, a 2.50-kg object is at the origin, and a 4.00-kg object is at 0.500 m. Where is the center of mass of these objects?

2. A ball is dropped from rest onto a fixed horizontal surface and rebounds to a height which is 64% of its original height. (a) What is the coefficient of restitution? (b) With what vertical velocity must the ball strike the surface to rebound to a height of 25 ft?

3. A bullet of mass 20 g is fired into a ballistic pendulum of mass 5 kg. The center of gravity of the pendulum rises 10 cm after being struck. Find the initial velocity of the bullet.

4. (Serway 10-15) A racing car travels on a circular track of radius 250 m. Assuming the car moves with a constant speed of 45.0 m/s, find (a) its angular speed and (b) the magnitude and direction of its acceleration.

5. (Serway 10-37) A potter's wheel—a thick stone disk of radius 0.500 m and mass 100 kg—is freely rotating at 50.0 rev/min. The potter can stop the wheel in 6.00 s by pressing a wet rag against the rim and exerting a radially inward force of 70.0 N. Find the effective coefficient of kinetic friction between wheel and rag.

6. (Serway 10-39) A uniform, thin, solid door has height 2.20 m, width 0.870 m, and mass 23.0 kg. (a) Find its moment of inertia for rotation on its hinges. (b) Is any piece of data unnecessary?

7. (Serway 10-40) Two balls with masses M and m are connected by a rigid rod of length L and negligible mass. For an axis perpendicular to the rod, (a) show that the system has the minimum moment of inertia when the axis passes through the center of mass. (b) Show that this moment of inertia is $I = \mu L^2$, where $\mu = mM/(m + M)$.

8. (Serway 10-60) A solid sphere is released from height h from the top of an incline making an angle θ with the horizontal. Calculate the speed of the sphere when in reaches the bottom of the incline (a) in the case that it rolls without slipping, and (b) in the case that it slides frictionlessly without rolling. (c) Compare the time intervals required to reach the bottom in cases (a) and (b).

9. A block slides down a frictionless inclined plane, staring from rest. A solid cylinder rolls the same distance down a plane of similar geometry without slipping. (a) Find the ratio of the velocity of the block to the velocity of the center of mass of the cylinder when each body has reached the bottom of the plane. (b) What is the ratio of the final kinetic energies of the two bodies?

10. A solid cylinder rolls without slipping down a plane inclined 37° to the horizontal. (a) What is the minimum coefficient of friction between the cylinder and the surface which will allow the cylinder to roll without slipping? (b) If the cylinder starts from rest, how far must it roll down the plane to acquire a velocity of 280 cm/sec?