Name ________________________

PHY2048C, Homework 3

A- Upload a picture or scan of the solutions (a clearly readable .pdf) to Canvas.

Problem 0

Show that Newtonian Gravity ($\mathbf{F}=\mathbf{r}GmM/r^3$) is conservative (remember that $r=x\mathbf{i}+y\mathbf{j}$)

Problem 1

A good baseball pitcher can throw a baseball toward home plate at 90 miles/h with a spin of 1800 rev/min. How many revolutions does the baseball make on its way to home plate? For simplicity, assume that the 60 ft between the pitcher mound and the home pate is a straight line path.

Problem 2 (Knight)

Figure1 shows masses that are connected by massless, rigid rods. (a) Find the coordinates of the center of mass. (b) Find the moment of inertia about an axis that passes through mass A and is perpendicular to the page.

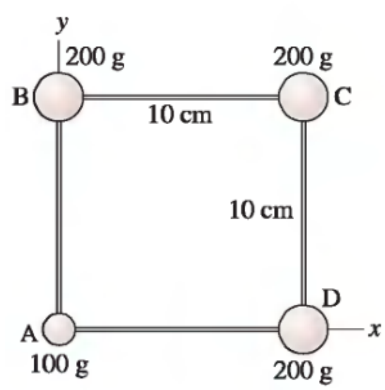

Figure 1

Problem 3

Can an object's translational and rotational motions be changed by a single force? Explain.

Problem 4

The rotational kinetic energy of a rolling automobile wheel is 40% of its translational kinetic energy. The wheel is then redesigned to have 10% lower rotational inertia and 20% less mass, while keeping its radius the same. By what percentage does its total kinetic energy at a given speed decrease?

Problem 5 (Sears and Zemansky)

A string is wrapped several times around the rim of a small hoop with radius 8.00 cm and mass 0.180 kg. The free end of the string is held in place and the hoop is released from rest (Figure 2). After the hoop has descended 75.0 cm, calculate (a) the angular speed of the rotating hoop and (b) the speed of its center of mass.

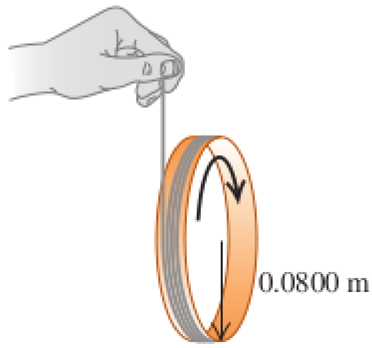

Figure 2

Problem 6

When an object rolls without slipping, the rolling friction force (which is static friction) is significantly lower than the friction force when the object is sliding. For instance, a Martinelli coin will roll on its edge for much longer than it will slide on its flat side before it stops. When an object is rolling without slipping on a perfectly horizontal surface, we can take the friction force to be zero, so that a_x and a_y are zero and α_z and a_x are constant. Rolling without slipping means $v_x = r\omega_z$ and $a_z = r\alpha_z$. If an object is set in motion on a surface without enough static firction, sliding (kinetic) friction will act on the object as it slips until rolling without slipping sets in. A solid cylinder with mass M and radius R, rotating with angular speed v_0 about an axis through its center, is set on a horizontal surface for which the kinetic friction coefficient is μ_k. (a) Draw a free-body diagram for the situation. What is the direction of the kinetic friction force on the cylinder? Calculate the accelerations a_x of the center of mass and α_z of rotation about the center of mass. (b) The cylinder is initially slipping completely, so initially $\alpha_z = \alpha_0$ but $v_x = 0$. Rolling without slipping sets in when $v_x = r\omega_z$. Calculate the distance the cylinder rolls before slipping stops. (c) Calculate the work done by the friction force on the cylinder during this sliding motion.

Problem 7

A 4.00 kg ball is dropped from a height of 11.0 m above one end of a uniform bar that pivots at its center. The bar weighs 9.00 kg and is 3.00 meters in length. At the other end of the bar sits another 4.00 kg ball, unattached to the bar. The dropped ball sticks to the bar after the collision. How high will the other ball go after the collision?