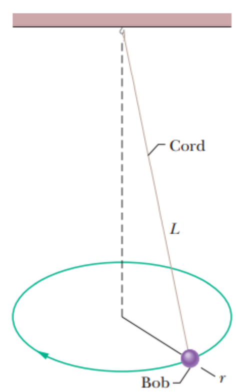
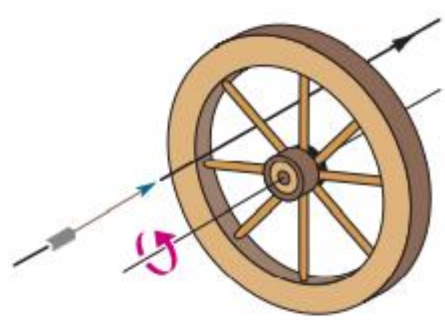
PHY-102 Applied Physics
DE-42 (CE-A & B)
Assignment #2, Mechanics (CH-10 Physics Serway 9th Ed)
Due Date: 9th January 2020

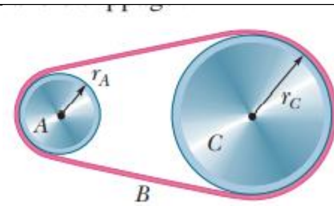
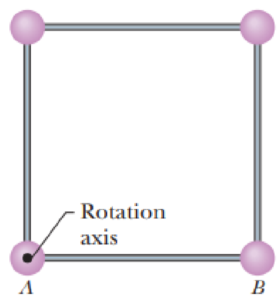
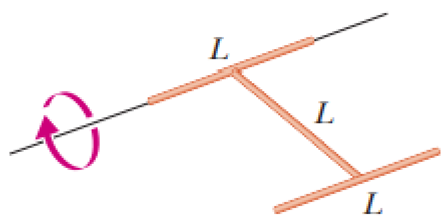
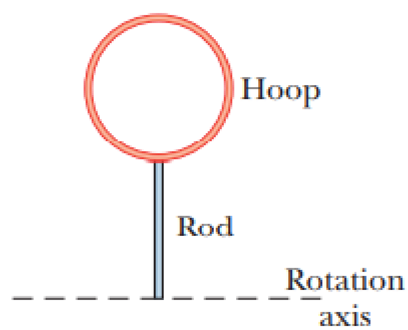
- Solve each problem according to the strategy discussed in class
- Copied assignments will get zero marks.

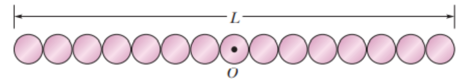
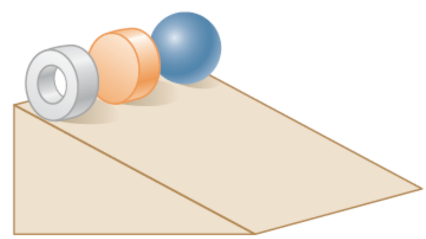
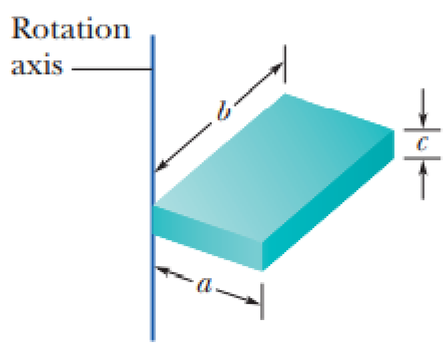
Grading Policy

- thoroughness
- Timely Submission
- Neatness

(CLO-1 - PLO-1)

Q1		
a)	Figure 6-53 shows a conical pendulum, in which the bob (the small object at the lower end of the cord) moves in a horizontal circle at constant speed. (The cord sweeps out a cone as the bob rotates.) The bob has a mass of 0.040 kg, the string has length L 0.90 m and negligible mass, and the bob follows a circular path of circumference 0.94 m. What are (a) the tension in the string and (b) the period of the motion?	 **Figure 6-53** Problem 70.
b)	A circular curve of highway is designed for traffic moving at 60 km/h. Assume the traffic consists of cars without negative lift. (a) If the radius of the curve is 150 m, what is the correct angle of banking of the road? (b) What would be the minimum coefficient of friction between tires and road that would keep traffic from skidding out of the turn when traveling at 70 km/h?	
c)	The wheel in Fig. 10-30 has eight equally spaced spokes and a radius of 30 cm. It is mounted on a fixed axle and is spinning at 2.5 rev/s. You want to shoot a 20-cm-long arrow parallel to this axle and through the wheel without hitting any of the spokes. Assume that the arrow and the spokes are very thin. (a) What minimum speed must the arrow have? (b) Does it matter where between the axle and rim of the wheel you aim? If so, what is the best location?	 **Figure 10-30** Problem 7.

d)	In Fig. 10-31, wheel A of radius r_A=10 cm is coupled by belt B to wheel C of radius r_C =25 cm. The angular speed of wheel A is increased from rest at a constant rate of 1.6 rad/s^2 . Find the time needed for wheel C to reach an angular speed of 100 rev/min, assuming the belt does not slip. (Hint: If the belt does not slip, the linear speeds at the two rims must be equal.)	 **Figure 10-31** Problem 28.
e)	Four particles, each of mass, 0.20 kg, are placed at the vertices of a square with sides of length 0.50 m. The particles are connected by rods of negligible mass. This rigid body can rotate in a vertical plane about a horizontal axis A that passes through one of the particles. The body is released from rest with rod AB horizontal (Fig. 10-64). (a) What is the rotational inertia of the body about axis A? (b) What is the angular speed of the body about axis A when rod AB swings through the vertical position? © Find rotational kinetic energy of the rigid object.	 **Figure 10-64** Problem 104.
f)	A rigid body is made of three identical thin rods, each with length L 0.600 m, fastened together in the form of a letter H (Fig. 10-52). The body is free to rotate about a horizontal axis that runs along the length of one of the legs of the H. The body is allowed to fall from rest from a position in which the plane of the H is horizontal. What is the angular speed of the body when the plane of the H is vertical?	 **Figure 10-52** Problem 78.
g)	Figure 10-48 shows a rigid assembly of a thin hoop (of mass m and radius R 0.150 m) and a thin radial rod (of mass m and length L 2.00R). The assembly is upright, but if we give it a slight nudge, it will rotate around a horizontal axis in the plane of the rod and hoop, through the lower end of the rod. Assuming that the energy given to the assembly in such a nudge is negligible, what would be the assembly's angular speed about the rotation axis when it passes through the upside-down (inverted) orientation?	 **Figure 10-48** Problem 67.

h)	Figure 10-36 shows an arrangement of 15 identical disks that have been glued together in a rod-like shape of length L=1.0 m and (total) mass M=100mg. The disks are uniform, and the disk arrangement can rotate about a perpendicular axis through its central disk at point O. (a) What is the rotational inertia of the arrangement about that axis? (b) If we approximated the arrangement as being a uniform rod of mass M and length L, what percentage error would we make in using the formula in Table 10-2e(CH-10: Serway book) to calculate the rotational inertia?	 Figure 10-36 Problem 40.
	(a) Determine the acceleration of the center of mass of a uniform solid disk rolling down an incline making angle theta with the horizontal. (b) Compare the acceleration found in part (a) with that of a uniform hoop. (c) What is the minimum coefficient of friction required to maintain pure rolling motion for the disk and hoop?	
Q2	(a) Derive an expression to calculate rotational inertia of uniform rigid rod of mass M and length L. (b) Derive an expression to calculate rotational inertia of uniform rigid rectangular plate of length b and width a about an axis passes through its center and perpendicular to plate (using rotational inertia of rigid rod and parallel axis theorem) (c) Derive an expression for rotational inertia of rigid rod.The uniform solid block in Fig. 10-38 has mass 0.172 kg and edge lengths a 3.5 cm, b 8.4 cm, and c 1.4 cm. Calculate its rotational inertia about an axis through one corner and perpendicular to the large faces	 Figure 10-38 Problem 43.

<table>
<tr>
<td>Q3</td>
<td>Consider two objects with $m1 > m2$ connected by a light string that passes over a pulley having a moment of inertia of I about its axis of rotation as shown in Figure P10.50. The string does not slip on the pulley or stretch. The pulley turns without friction. The two objects are released from rest separated by a vertical distance 2h.

(a) find the translational speeds of the objects as they pass each other.

(b) Find the angular speed of the pulley at this time.

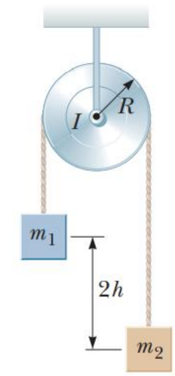
(c) Find Tensions in the string</td>
<td>

Figure P10.50</td>
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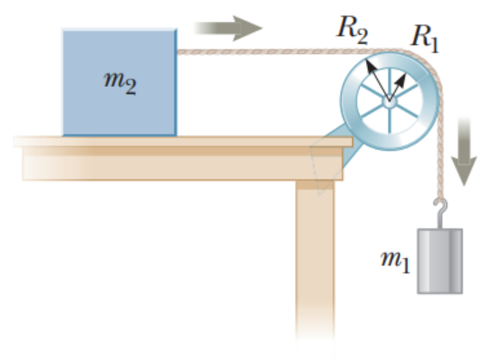
<tr>
<td>Q4</td>
<td>In Figure P10.53, the hanging object has a mass of m1=0.420 kg; the sliding block has a mass of m2= 0.850 kg and the pulley is a hollow cylinder with a mass of M=0.350 kg, an inner radius of R_1=0.020m, and an outer radius of R_2=0.030m. Assume the mass of the spokes is negligible. The coefficient of kinetic friction between the block and the horizontal surface is $\mu_k = 0.25$. The pulley turns without friction on its axle. The light cord does not stretch and does not slip on the pulley. The block has a velocity of $v_i = 0.820\ m/s$ toward the pulley when it passes a reference point on the table.
(a) its speed after it has moved to a second point, 0.700 m away.
(b) Find the angular speed of the pulley at the same moment.
(c) Find net torque acting on pulley.
Solve using both dynamical (Newton’s second law of rotation and translation) and energy method.</td>
<td>

Figure P10.53</td>
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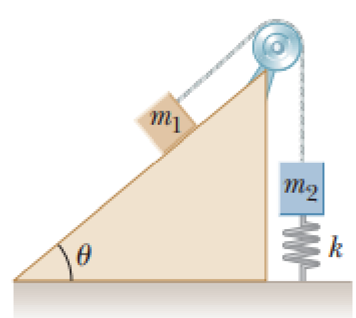
<tr>
<td>Q5</td>
<td>A block of mass m_1 = 20.0 kg is connected to a block of mass m_2 = 30.0 kg by a massless string that passes over a light, frictionless pulley. The 30.0-kg block is connected to a spring that has negligible mass and a force constant of k = 250 N/m as shown in Figure P8.64. The spring is unstretched when the system is as shown in the figure, and the incline is frictionless. The 20.0-kg block is pulled a distance h = 20.0 cm down the incline of angle $\theta = 40^o$ and released from rest. Find the speed of each block when the spring is again unstretched.</td>
<td>

Figure P8.64</td>
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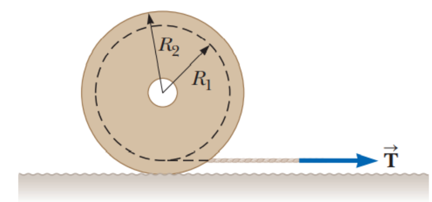
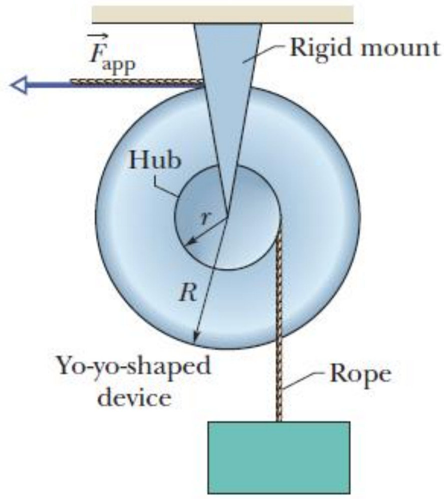
Q6	A spool of thread consists of a cylinder of radius R_1 with end caps of radius R_2 as depicted in the end view shown in Figure P10.91. The mass of the spool, including the thread, is m, and its moment of inertia about an axis through its center is I. The spool is placed on a rough, horizontal surface so that it rolls without slipping when a force T acting to the right is applied to the free end of the thread. (a) Show that the magnitude of the friction force exerted by the surface on the spool is given by $$f = \left(\frac{1 + mR_1R_2}{1 + mR_2^2}\right)T$$ (b) Determine the direction of the force of friction.	 Figure P10.91
Q-7	A yo-yo-shaped device mounted on a horizontal frictionless axis is used to lift a 30 kg box as shown in Fig. The outer radius *R* of the device is 0.50 m, and the radius *r* of the hub is 0.20 m. When a constant horizontal force of magnitude 140 N is applied to a rope wrapped around the outside of the device, the box, which is suspended from a rope wrapped around the hub, has an upward acceleration of magnitude 0.80 m/s2. a. What is the rotational inertia of the device about its axis of rotation? b. If Friction about axis of rotation is also present and the acceleration is 0.70 m/s2, determine the torque due to force of friction. Draw Figure to illustrate. c. For the frictionless case, using energy method determine the velocity of the box as it is lifted upward a distance h=5m starting from rest.	

********************* Good Luck************************