PHY 2048C Exam III, Fall 2016.

Name____VID____

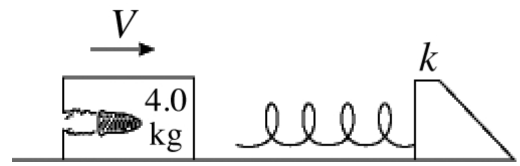
Make sure to show all of your work in a neat and organized way, and to circle or underline your final answers. You must also include units on your answers for full credit. Good luck!

1) As a tile falls from the roof of a building to the ground is its momentum is conserved? Explain.

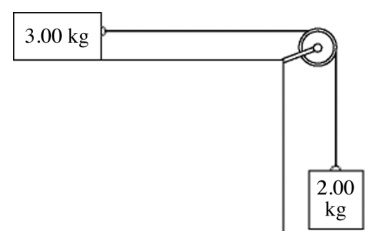
2) Two ice skaters push off against one another starting from a stationary position. The 45.0-kg skater acquires a speed of 0.375 m/s. Assume that any other unbalanced forces during the collision are negligible.
   (a) What speed does the 60.0-kg skater acquire?
   (b) What is the velocity of the center of mass of the two skaters?

3) A car heading north collides at an intersection with a truck of the same mass as the car heading east. If they lock together and travel at 28 m/s at 46° north of east just after the collision, how fast was the car initially traveling? Assume that any other unbalanced forces including friction with the road are negligible.

4) An 8.0-g bullet is shot into a 4.0-kg block, at rest on a frictionless horizontal surface (see the figure). The bullet remains lodged in the block. The block moves into an ideal massless spring and compresses it by 8.7 cm. The spring constant of the spring is 2400 N/m.
What is the initial velocity of the bullet before it imbeds itself in the wooden block?



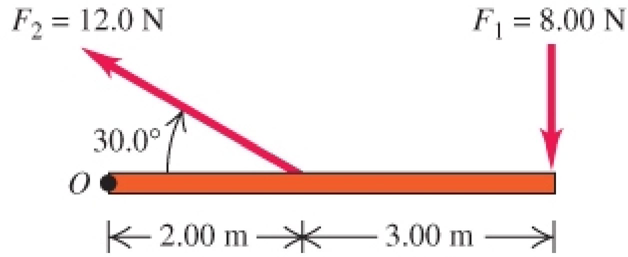
5) In the figure, two blocks, of masses 2.00 kg and 3.00 kg, are connected by a light string that passes over a frictionless pulley of moment of inertia 0.00400 kg $\cdot$ m^2 and radius 5.00 cm. The coefficient of friction for the tabletop is 0.300.
(a) The blocks are released from rest. Find the speed of the upper block just as it has moved 0.600 m.
(b) Find the angular acceleration of the pulley.



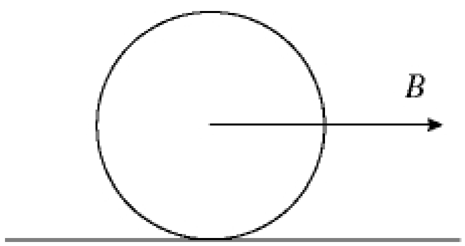
6) A piece of thin uniform wire of total mass m and length $3b$ is bent into an equilateral triangle. Find the moment of inertia of the wire triangle about an axis perpendicular to the plane of the triangle and passing through one of its vertices. (Even though this is multiple choice, you still have to show your work or at least justify your answer in words!)

A) $\frac{2}{3}mb^2$ B) $\frac{7}{12}mb^2$ C) $\frac{1}{3}mb^2$ D) $\frac{7}{4}mb^2$ E) $\frac{1}{2}mb^2$

7) The rod shown in the figure below has a mass of 1.30kg.
   (a) Determine the magnitude of the net torque on the rod.
   (b) Breifly describe the direction of the net torque on the rod.
   (c) What is the angular acceleration of the rod?
   (d) How many revolutions will the rod make in 30s?



8) A construction roller in the form of a uniform solid cylinder is being pulled horizontally by a horizontal force B applied to an axle through the center of the roller, as shown in the figure. The roller has radius 0.65 meters and mass 5100 kg and rolls without slipping. What magnitude of the force B is required to give the center of mass of the roller an acceleration of 2.8 m/s^2?



9) A 5.0-m radius playground merry-go-round with a moment of inertia of 2000 kg•m^2 is rotating freely with an angular speed of 1.0 rad/s. Two people, each having a mass of 60 kg, are standing right outside the edge of the merry-go-round and step on it with negligible speed. What is the angular speed of the merry-go-round right after the two people have stepped on?

Trigonometry

(1) $\cos(\theta) = \frac{adj}{hyp}, \sin(\theta) = \frac{opp}{hyp}, \tan(\theta) = \frac{opp}{adj}$

(2) $hyp^2 = adj^2 + opp^2$

Quadratic Formula:

$$Ax^2 + Bx + C = 0 \Rightarrow x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

Displacement, Velocity, Acceleration:

(1) $\Delta\vec{r} = \vec{r}_f - \vec{r}_0$

(2) $\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t}$

(3) $\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t}$

Kinematic Equations for constant acceleration:

(1) $x_f = x_0 + v_0 t + \frac{1}{2}at^2$

(2) $v_f = v_0 + at$

(3) $v_f^2 = v_0^2 + 2a(x_f - x_0)$

(4) $x_f - x_0 = \frac{1}{2}(v_f + v_0)t$

Work & Energy:

(1) $W_{net} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2 = \Delta K.E.$

(2) $W = \vec{F} \cdot \vec{s}$ $(Const.\ Force)$

(3) $W = \int_a^b \vec{F} \cdot d\vec{s}$ $(Varying\ Force)$

(4) $\Delta K.E. + \Delta U - W_{nc} = 0$ $(No\ Ext.\ Forces)$

(5) $U_{Grav} = mgy$ $U_{Spring} = \frac{1}{2}kx^2$

(6) $\Delta U_{ab} = -W_{ab} = -\int_a^b \vec{F} \cdot d\vec{s}$

(7) $\vec{F} = -\nabla U = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$

Vector Products

(1) $\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}|\cos\phi_{AB} = A_x B_x + A_y B_y + A_z B_z$

(2) $|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}|\sin\phi_{AB}$

(3) $\vec{A} \times \vec{B} = \det\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$

(4) $\vec{v}_{inst} = \frac{d\vec{r}}{dt}, \vec{\omega}_{inst} = \frac{d\theta}{dt}$

(5) $\vec{a}_{inst} = \frac{d\vec{v}}{dt}, \alpha_{inst} = \frac{d\omega}{dt}$

(6) $|\vec{a}_{circular}| = \frac{v^2}{r}$

Newton's Laws:

(1) $\vec{F}_{net} = 0 \Rightarrow \vec{a} = 0$

(2) $\vec{F}_{net} = m\vec{a}$

$\vec{F}_{AB} = -\vec{F}_{BA}$

Force Laws:

(1) $\vec{F}_{fricetion} : \begin{matrix} = \mu_k N \\ \le \mu_s N \end{matrix}$

(2) $\vec{F}_{Spring} = -k\vec{x}$

(3) $\vec{F}_{Grav} = \begin{matrix} mg\ \ (Earth's\ Surface) \\ \frac{Gm_1 m_2}{r^2}\ \ (Otherwise) \end{matrix}$

Impulse & Momentum:

(1) $\vec{F}_{net} = \dfrac{d\vec{p}}{dt}$

(2) $\vec{J}_{net} = F_{AVG}\Delta t = \int_0^t \vec{F}_{net}\,dt = m\vec{v}_f - m\vec{v}_i = \Delta\vec{p}$

(3) $\dfrac{d\vec{p}_{Total}}{dt} = 0 \ \ (No\ \ Ext.\ \ Forces)$

Center of Mass:

(1) $\vec{F}_{net\,EXT} = M_{Total}\vec{a}_{CM}$

(2) $\vec{r}_{CM} = \dfrac{m_1\vec{r}_1 + m_2\vec{r}_2 + \ldots}{m_1 + m_2 + \ldots} = \dfrac{1}{M_{Total}}\int \vec{r}\,dm$

(3) $\rho = \dfrac{M}{V} = \dfrac{dm}{dV}$

Moment of Inertia:

(1) $I_z = \int r^2\,dm$

(2) $I_{Parallel} = I_{CM} + Md^2$

Kinematic Equations for constant acceleration:

(1) $\theta_f = \theta_0 + \omega_0 t + \dfrac{1}{2}\alpha t^2$

(2) $\omega_f = \omega_0 + \alpha t$

(3) $\omega_f^2 = \omega_0^2 + 2\alpha(\theta_f - \theta_0)$

(4) $\theta_f - \theta_0 = \dfrac{1}{2}(\omega_f + \omega_0)t$

(5) $s = r\theta, (\theta\ in\ radians)$

(6) $\vec{v}_T = \vec{\omega} \times \vec{r}$

(7) $\vec{a}_T = \vec{\alpha} \times \vec{r}$

(8) $a_R = \dfrac{v^2}{r}$

Rotational Work & Energy:

(1) $W_{net} = \int \tau_{net}\,d\theta = \dfrac{1}{2}I\omega_f^2 - \dfrac{1}{2}I\omega_0^2 = \Delta K.E._{Rotational}$

Rotational Dynamics:

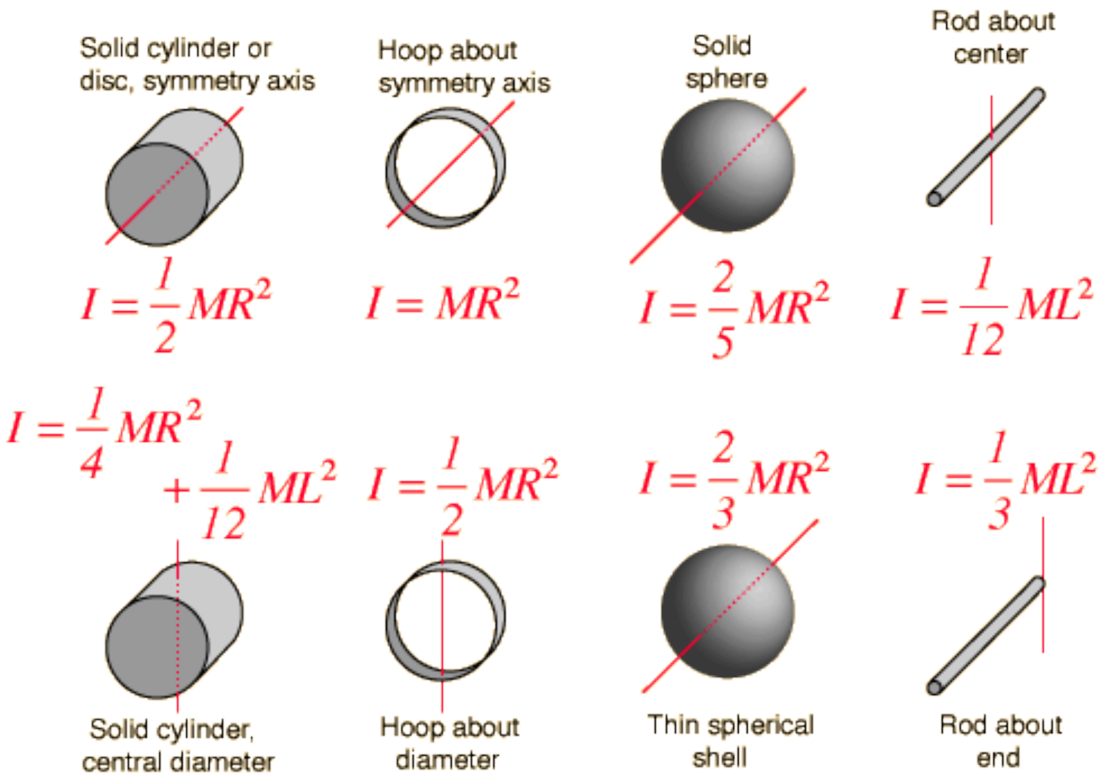
(1) $\vec{\tau} = \vec{r} \times \vec{F}, \ \ |\vec{\tau}| = |\vec{r}||\vec{F}|\sin\theta_{rF}$

(2) $\vec{\tau}_{net} = 0 \Rightarrow \vec{\alpha} = 0$

(3) $\vec{\tau}_{net} = I\vec{\alpha}$

(4) $\vec{\tau}_{AB} = -\vec{\tau}_{BA}$

(5) $\vec{L}_{Totf} = \sum I_f\vec{\omega}_f = \vec{L}_{Tot0} = \sum I_0\vec{\omega}_0 \quad (No\ \ Ext.\ \ Torques)$


Solid cylinder or disc, symmetry axis
$I = \frac{1}{2} MR^2$
Hoop about symmetry axis
$I = MR^2$
Solid sphere
$I = \frac{2}{5} MR^2$
Rod about center
$I = \frac{1}{12} ML^2$
$I = \frac{1}{4} MR^2 + \frac{1}{12} ML^2$
Solid cylinder, central diameter
$I = \frac{1}{2} MR^2$
Hoop about diameter
$I = \frac{2}{3} MR^2$
Thin spherical shell
$I = \frac{1}{3} ML^2$
Rod about end