PHYS 101:General Physics1 **KOÇ UNIVERSITY** **Fall Semester 2016**

College of Sciences

Section 1 **Quiz 11** **December 16, 2016**

Closed book. Duration: 10 minutes

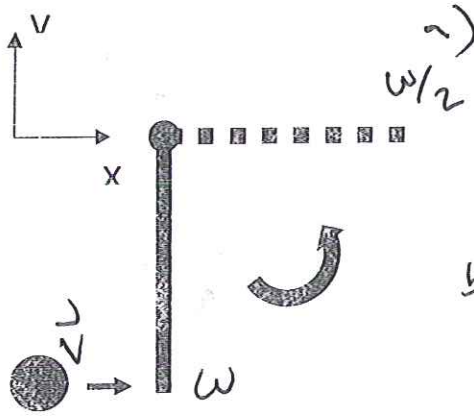
Name: A **Student ID:** **Signature:**

A rod of length l and mass m is initially vertical as in the figure and can freely rotate around a pivot on one end. A ball of mass m moving in the +x direction hits the rod on the other end, and comes to a stop immediately after the collision.

a) Find the moment of inertia of the rod with respect to the pivot. Moment of inertia of the rod for an axis through its center is $\frac{1}{12}ml^2$

b) If the angular velocity of the rod when it becomes horizontal is half its initial angular velocity right after the ball hits it, what is the initial velocity of the ball?

c) What are the x and y components of the force the pivot exerts on the rod when the rod is horizontal.



a) $I = I_{cm} + md^2$

$= \frac{1}{12}mL^2 + m\left(\frac{L}{2}\right)^2 = \frac{1}{3}mL^2$

b) After collision $E_i = E_f$

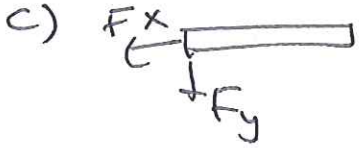
$\frac{1}{2}I\omega^2 - mg\frac{L}{2} = \frac{1}{2}I\left(\frac{\omega}{2}\right)^2$

$\omega^2 = \frac{4mgL}{3I} \Rightarrow \omega^2 = 4g/L$

During collision

$L_i = L_f$

$mV\frac{L}{2} = I\omega \Rightarrow V = \frac{I\omega}{m \cdot L/2} \Rightarrow V = \frac{2}{3}\sqrt{8gL}$

c) 

$F_x = ma_r = -m\omega^2 \cdot \frac{L}{2}\hat{x} = -2mg\hat{x}$

$F_y = ma_y = m\alpha \cdot \frac{L}{2}$

$\tau = I\alpha$

$-mg\frac{L}{2} = \frac{1}{3}mL^2 \cdot \alpha$

$\alpha = -\frac{3}{2}\frac{g}{L}$

insert $F_y = -\frac{3}{4}mg\hat{y}$

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Section 3 **Quiz** 11 **December 16, 2016**

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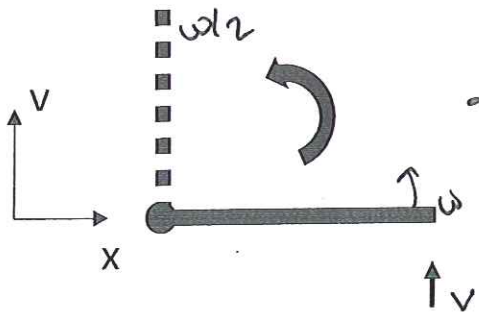
Name: **Student ID:** **Signature:**

A rod of length l and mass m is initially horizontal as in the figure, and can freely rotate around a pivot on one end. A ball of mass m moving in the +y direction hits the rod on the other end, and comes to a stop immediately after the collision.

a) Find the moment of inertia of the rod with respect to the pivot. Moment of inertia of the rod for an axis through its center is $\frac{1}{12}ml^2$

b) If the angular velocity of the rod when it becomes vertical is half its initial angular velocity right after the ball hits it, what is the initial velocity of the ball?

c) What are the x and y components of the force the pivot exerts on the rod right after the ball hits it and it starts rotating?



a) $I = I_{cm} + md^2$

$= \frac{1}{12}mL^2 + m(L/2)^2 = \frac{1}{3}mL^2$ //

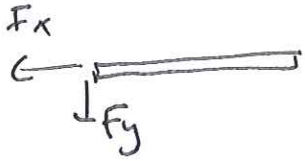
b) After collisn $E_i = E_f \Rightarrow \frac{1}{2}I\omega^2 = \frac{1}{2}I\left(\frac{\omega}{2}\right)^2 + mg\,L/2$

$\omega^2 = \frac{4mgL}{3I} \Rightarrow \omega^2 = 4g/L$

collisin $L_i = L_f$

$mvL = I.\omega \quad v = \frac{\frac{1}{3}mL^2}{mL} 2\sqrt{g/L} = \frac{2}{3}\sqrt{gL}$ //

c)



$F_x = ma_r = -m\omega^2 \frac{L}{2}\hat{x} = -2mg\,\hat{x}$

$F_y = ma_y = ma\,L/2$

$\tau = I\kappa$

$-mgL/2 = \frac{1}{3}mL^2\alpha$

$\alpha = -\frac{3}{2}g/L$

insert $f_y = -\frac{3}{4}mg\,\hat{y}$

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Section 2 **Quiz** 11 **December 16, 2016**

Closed book. Duration: 10 minutes

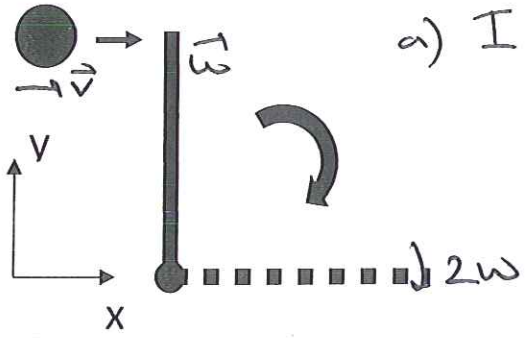
Name: **Student ID:** **Signature:**

A rod of length l and mass m is initially vertical as in the figure, and can freely rotate around a pivot on one end. A ball of mass m moving in the +x direction hits the rod on the other end, and comes to a stop immediately after the collision.

a) Find the moment of inertia of the rod with respect to the pivot. Moment of inertia of the rod for an axis through its center is $\frac{1}{12}ml^2$

b) If the angular velocity of the rod when it becomes horizontal is twice its initial angular velocity right after the ball hits it, what is the initial velocity of the ball?

c) What are the x and y components of the force the pivot exerts on the rod when the rod is horizontal.



a) $I = I_{cm} + md^2$

$= \frac{1}{12}ml^2 + m\left(\frac{L}{2}\right)^2 = \frac{1}{3}mL^2$

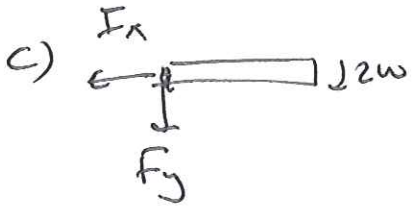
b) After collision $E_i = E_f$; $\frac{1}{2}I\omega^2 + mg\frac{L}{2} = \frac{1}{2}I(2\omega)^2$

$\omega^2 = \frac{mgL}{3I} = 3/L$

collision $L_i = L_f$

$mvL = I\omega \Rightarrow v = \frac{\frac{1}{3}mL^2\sqrt{3/L}}{mL} = \frac{1}{3}\sqrt{3L}$

c)



$F_x = ma_c = -m(2\omega)^2 \cdot L/2$

$= -4m\omega^2 \cdot L/2 = -2mg\hat{x}$

$F_y = ma_y = m\alpha \cdot L/2$

$\tau = I\alpha$

$-mg \cdot L/2 = \frac{1}{3}mL^2 \cdot \alpha$

$\alpha = -\frac{3mg}{2L}$

inset

$f_y = -\frac{3mg}{4}\hat{y}$

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Section 4 **Quiz** 11 **December 16, 2016**

Closed book. Duration: 10 minutes

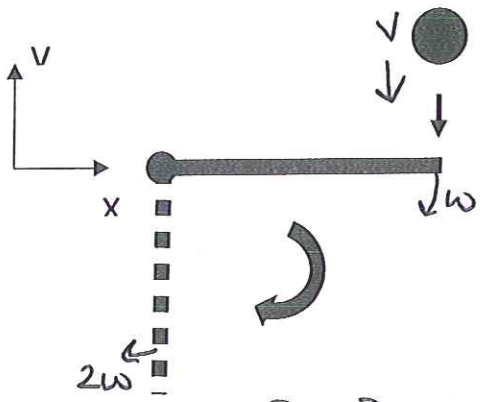
Name: **Student ID:** **Signature:**

A rod of length l and mass m is initially horizontal as in the figure, and can freely rotate around a pivot on one end. A ball of mass m moving in the -y direction hits the rod on the other end, and comes to a stop immediately after the collision.

a) Find the moment of inertia of the rod with respect to the pivot. Moment of inertia of the rod for an axis through its center is $\frac{1}{12}ml^2$

b) If the angular velocity of the rod when it becomes vertical is twice its initial angular velocity right after the ball hits it, what is the initial velocity of the ball?

c) What are the x and y components of the force the pivot exerts on the rod right after the ball hits it and it starts rotating?



a) $I = I_{cm} + md^2$

$= \frac{1}{12}mL^2 + m\left(\frac{L}{2}\right)^2 = \frac{1}{3}mL^2$

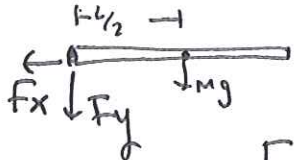
b) After collision $E_i = E_f \Rightarrow \frac{1}{2}I\omega^2 = \frac{1}{2}I(2\omega)^2 - mgL/2$

$\omega^2 = \frac{mgL}{3I} = 3g/L$

collision $L_i = L_f$

$mV.L = I\omega \Rightarrow V = \frac{1}{3}\frac{mL^2}{mL}\sqrt{3g/L} = \frac{1}{3}\sqrt{gL}$

c)



$F_x = ma_r = -m\omega^2 . L/2\,\hat{x} = -mg/2\,\hat{x}$

$f_y = m.a_y = m.\alpha.L/2$

$\tau = I\alpha$

$-mg.L/2 = \frac{1}{3}mL^2.\alpha$

$\alpha = -\frac{3}{2}g/L$

insert $\Rightarrow F_y = -m.\frac{3}{2}\frac{g}{L}.\frac{L}{2} = -\frac{3mg}{4}\hat{y}$