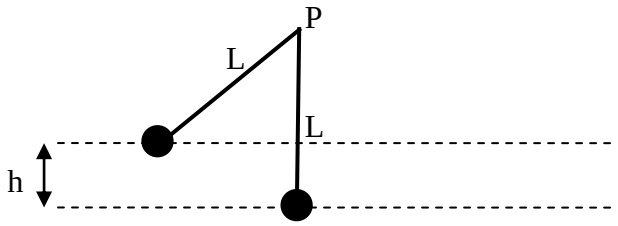
PHYS 101: General Physics **KOÇ UNIVERSITY** **Fall Semester 2012**
College of Sciences
Section 1 **Quiz 12** **20 December 2012**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 15 minutes
First Name: **Last name:** **Student ID:** **Signature:**



Consider two identical point particles with mass *m* that are attached to the end points of massless rigid rods with length *L*. The rods are free to rotate about the pivot point *P*. The particles are initially stationary, their locations are given in the figure above. After the particle that is located at height *h* is released, it collides with the other particle. Following the totally inelastic collisionin two particles start swinging together. Find the maximum height that will be reached by two particles after the collision using the conservation of angular momentum principle. (No credit wil be give if you solve this question using the conservation of momentum principle)

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Section 2 **Quiz 12** **20 December 2012**

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Quiz duration: 15 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A person stands at the center of a frictionless turntable. The arms of the person are stretched and the person holds 5 kg dumbbells in each hand, 1 m away from the axis of rotation. He is initially rotating making one revolution in 2 s. Find the work that needs to be done by the person in order to bring each dumbbell to a distance 0.2 m away from the axis of rotation. (Assume that the moment of inertia of the person remains constant during the process.)

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Section 3 Quiz 12 20 December 2012

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Quiz duration: 15 minutes
First Name: Last name: Student ID: Signature:

Consider two identical disks with moments of inertia I, rotating with constant angular speeds ω_A and ω_B, respectively. The disks are pushed together with forces acting along the axis, so as no torque is applied on either disk. The disks rub against each other and eventually reach a common angular speed ω. Find an expression for the energy lost by the disks during this process as a function of I, ω_A and ω_B.

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Section 4 Quiz 12 20 December 2012

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Quiz duration: 15 minutes
First Name: Last name: Student ID: Signature:

A door 1 m wide, of mass 1.5 kg, can rotate freely about a vertical axis through its hinges. A bullet with a mass of 10 g and a speed of 400 m/s strikes the center of the door, in a direction perpendicular to the plane of the door, and embeds itself there. Find the door's angular speed after the collision. (Take the moment of inertia of the door as $I_{door}=Md^2/3$, where M=1.5 kg and d=1 m.)

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Section 5 **Quiz 12** **20 December 2012**

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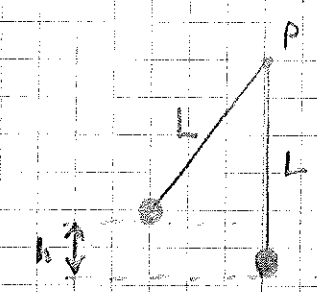
Quiz duration: 15 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A uniform rod rotates, about one end at angular speed ω, on the xy plane. The rod has a mass m and length L. A point particle with mass m is attached to the rotating end of the rod. Find an expression for the magnitude of the total angular momentum of the rod and ponit mass system. (You may choose to write the moment inertia for the rod directly, or you may derive it using integration.)



Conservation of Energy (Before the Coll.)

$$mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh}$$

Then the angular vel of the ball just before the collision is,

$$\omega = Lv = L\sqrt{2gh}$$

Conservation of Angular Momentum;

Before the Coll. — After the Coll

$$L_i = L_f$$

$$I_i \omega_i = I_p \omega_f$$

$$(mL^2)(L\sqrt{2gh}) = (2mL^2)\omega_f$$

$$\omega_f = L\sqrt{\frac{gh}{2}} \left(= \frac{\omega_i}{2}\right)$$

$$\Rightarrow v_f = \frac{\omega_f}{L} = \sqrt{\frac{gh}{2}}$$

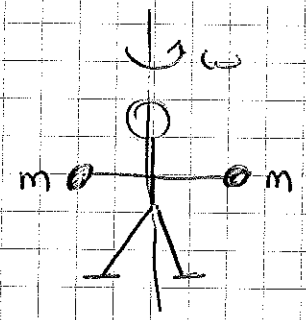
Conservation of Energy.

$$\frac{1}{2}(2m)v_f^2 = 2mgh_f$$

$$\frac{gh}{4} = gh_f \Rightarrow \boxed{h_f = h/4}$$

Quiz XII

Section 2



$f_i = \frac{1}{2}\ s^{-1}$

$\omega_i = 2\pi f = \pi\ rad/s$

Conservation of ang. mom.

$$L_i = L_f$$

$$I_i\omega_i = I_f\omega_f$$

$$(2md_i^2)\omega_i = (2md_f^2)\omega_f$$

$$\omega_f = \left(\frac{d_i}{d_f}\right)^2 \omega_i$$

Total work done,

$$W_{tot} = \frac{1}{2} I_f \omega_f^2 - \frac{1}{2} I_i \omega_i^2$$

$$= \frac{1}{2}(2md_f^2)\omega_f^2 - \frac{1}{2}(2md_i^2)\omega_i^2$$

$$= m d_f^2 \left(\frac{d_i}{d_f}\right)^4 \omega_i^2 - m d_i^2 \omega_i^2$$

$$= m\left(\frac{d_i^2}{d_f^2} - 1\right) d_i^2 \omega_i^2$$

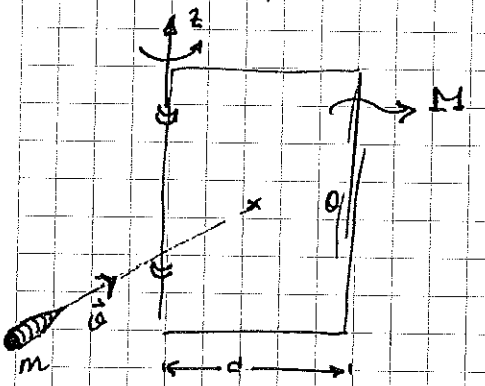
$$= 5kg\left(\left(\frac{1m}{0.2m}\right)^2 - 1\right)(1m)^2 (\pi\ rad/s)^2$$

$$= 5 * 25 \times \pi\ kg\ m^2 rad^2/s^2$$

$$W_{tot} \simeq 392.64\ J$$

Quiz #12

Section 4



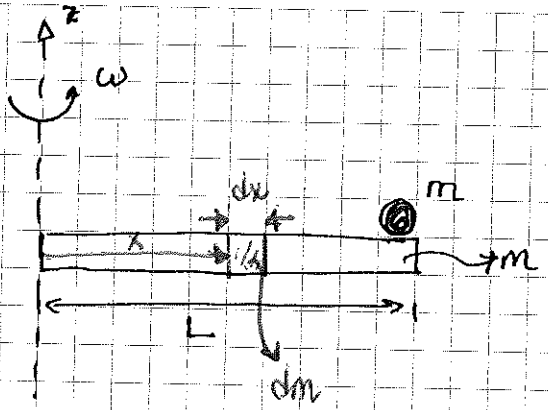
Conservation of momentum

$$m\vec{v} = (M+m)\vec{v}'$$

$$\vec{v}' = \frac{m}{M+m}\vec{v}$$, velocity of the composite sys. just after the collision

Quiz #12

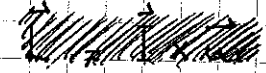
Section 5



$$I_{rod} = \int_0^L dm\, x^2 \quad , \quad dm = \frac{m}{L}\, dx$$

$$= \frac{m}{L} \int_0^L x^2\, dx = \frac{1}{3} m L^2$$

$$I_{particle} = m L^2$$



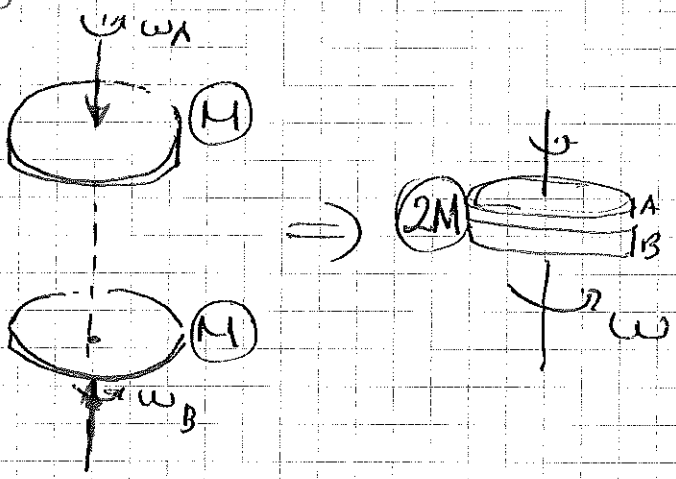
$$\vec{L} = I \vec{\omega}$$

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

$$\boxed{\vec{L} = \frac{4}{3} m L^2 \omega \hat{z}}$$

Quiz #12

Section 3



Conservation of angular momentum,

$$L_i = L_f$$

$$I(\omega_A + \omega_B) = 2I \cdot \omega$$

$$\Rightarrow \omega = \frac{\omega_A + \omega_B}{2}$$

$$E_i = \frac{1}{2} I (\omega_A^2 + \omega_B^2)$$

$$E_f = \frac{1}{2} 2I \omega^2 = \frac{1}{2} I \left(\frac{\omega_A^2 + 2\omega_A\omega_B}{2} \right.$$

Energy lost,

$$E_i - E_f = \frac{1}{2} I \left(\frac{\omega_A^2 - 2\omega_A\omega_B + \omega_B^2}{2} \right.$$

$$\Delta E_{loss} = \frac{1}{4} I (\omega_A - \omega_B)^2$$