PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2012**

College of Sciences

Section 1 **Quiz 10** **06 December 2012**

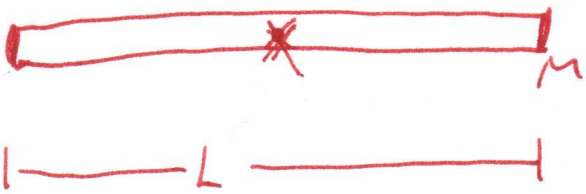
Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

Name: **Student ID:** → L **Signature:** → m

A rod of mass M = 1 kg and length 1 m connects 2 small 1 kg masses. Find the moment of inertia of the composite system about an axis through the center, perpendicular to the rod.

- For an uniform rod free to rotate by an axis passing through center of mass:

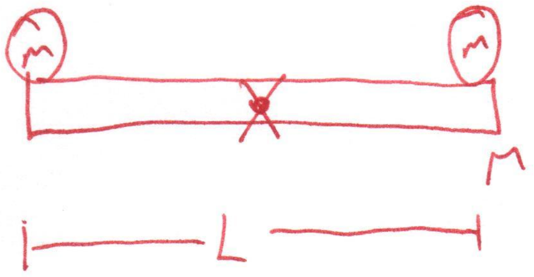


$$I_{rod,\,CM} = \frac{1}{12} M L^2 = \frac{M}{L}\int_{-L/2}^{+L/2} x^2\,dx$$

- Two equidistant small masses, rotating through same center:

$$I_{masses} = m\left(\frac{L}{2}\right)^2 + m\left(\frac{L}{2}\right)^2 = \frac{2mL^2}{4} = \frac{mL^2}{2}$$

- Combine/superpose these:



$$I_{sys} = \frac{ML^2}{12} + \frac{mL^2}{2} = (M+6m)\frac{L^2}{12}$$

$$I_{sys} = \frac{(1\,kg + 6\times 1\,kg)}{12}(1\,meter)^2 = \frac{7}{12}\,[kg\cdot m^2]$$

PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2012**

College of Sciences

Section 2 **Quiz 10** **06 December 2012**

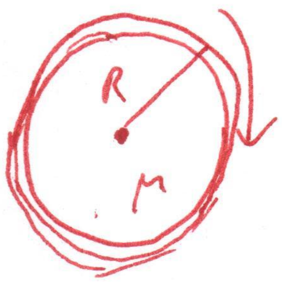
Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

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

How much energy is dissipated when a M = 2 kg wheel of radius R = 2 m is brought to rest from an initial velocity of 30 revolutions per minute (rpm).

(Moment of inertia of the disk is $I = MR^2/2$. Take $\pi = 3$).



$E_{initial} = K_{initial}$

$K_{initial} = \frac{1}{2} I w_{in}^2$

$E_{final} = 0$

$E_{dissipated} = E_{initial} - E_{final}$: Since mech. energy is not conserved

$= \frac{1}{2} I w_{in}^2$

$= \frac{1}{2} (4\ kg \cdot m^2)(3\ rad/s)^2$

$E_{dis} = 18\ kg\ m^2/s^2 \equiv 18$ Joule

$W_{initial} = 30\ rev/min$

$1\ rev \equiv 2\pi\ rad$

$1\ min \equiv 60s$

$W_{initial} = 30 \frac{2\pi\ rad}{60s}$

$= \frac{60\pi\ rad}{60s} \simeq 3\ rad/s$

$I = \frac{(2\ kg)}{2}(2\ meter)^2$

$= 4\ [kg \cdot m^2]$

PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2012**

College of Sciences

Section 3 **Quiz 10** **06 December 2012**

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

$1\,rev \equiv 2\pi\,rad$

$1\,min \equiv 60\,s$

Name: $R = 0.1\,m$ **Student ID:** **Signature:**

A disk of radius 10 cm starts to rotate, about a fixed perpendicular axis through its center, from rest and accelerates for 2 s (no acceleration after 2 s) with constant angular acceleration to an angular speed of 30 revolutions per minute (rpm). (i) Find the (radial and tangential) components of the linear acceleration of a point on the edge 1 s after the rotation is turned on, and (ii) 3 s after the rotation is turned on. (Take π = 3).

α

• for $\alpha(t) = \alpha \rightarrow w(t) = w_0 + \alpha t \rightarrow \theta(t) = \theta_0 + w_0 t + \frac{1}{2}\alpha t^2$

and we can choose our referencing angle to be zero, $\theta_0 = 0$

• Initially; $w_0 = 0$ (at rest) $\rightarrow w(t = \underset{t'}{2s}) = \alpha t' = w_{t'=2s} = 30\,rpm$

$w_{t'=2s} = 30\,rev/min = 30\,\frac{2\pi\,rad}{60\,s} \cong 3\,rad/s = \alpha \cdot (2\,s)$

$\rightarrow \alpha = \frac{3}{2}\,rad/s^2$: amount of constant angular acceleration : $a = \frac{3}{2} \times 10^{-1}\,m/s^2$ ($a \equiv \alpha R$)

(i) $w(t=1s) = \left(\frac{3}{2}\,rad/s^2\right) \cdot (1\,s) = \frac{3}{2}\,rad/s$

$\alpha_{rad}(t=1s) = \frac{a_{rad}(t=1s)}{R} = \frac{v^2(t=1s)}{R^2}$

$= w^2(t=1s)$

$a_{rad}(t=1s) = \left(\frac{3}{2}\,rad/s\right)^2 \cdot (0.1\,m)$

$= \frac{9}{4} \times 10^{-1}\,m/s^2$

$a_{tan}(t=1s) =$ ~~[crossed out]~~

$= a \cong \frac{3}{2} \times 10^{-1}\,m/s^2$

(ii) $w(t=3s) = \left(\frac{3}{2}\,rad/s^2\right) \cdot (2\,s) = 3\,rad/s$

$a_{rad}(t=3s) = w^2(t=3s) \cdot R$

$= (3\,rad/s)^2 \cdot (0.1\,m) =$ ~~$\frac{81}{4} \times 10^{-1}\,m/s^2$~~

$= 9 \times 10^{-1}\,m/s^2$

$a_{tan}(t=3s) = 0\,m/s^2$

→ Because, no acceleration after $t = 2s$

$<$

PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2012**

College of Sciences

Section 4 **Quiz 10** **06 December 2012**

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

$1\,rev \equiv 2\pi\,rad$

$1\,min \equiv 60\,s$

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

A disk starts to rotate, about a fixed perpendicular axis through its center, from rest and accelerates with constant angular acceleration to an angular speed of 30 revolutions per minute (rpm) in 2 s. (i) Find the angular acceleration in rad/s^2. (ii) Find the angle turned through in degrees. (Take $\pi = 3$).

$\bullet\ W(t=2s) = 30\,rev/min = 30\,\frac{2\pi\,rad}{60\,s} \simeq 3\,rad/s$; $W_0 = 0$ rest

for $\alpha(t) = \alpha \rightarrow w(t) = W_0 + \alpha t \rightarrow \theta(t) = \theta_0 + w_0 t + \frac{1}{2}\alpha t^2$

where referencing angle can chosen to be zero, $\theta_0 = 0$.

$\bullet\ w(t=2s) = 3\,rad/s = \alpha \cdot (2s)$; $\alpha = 3/2\,rad/s^2$ (i)

(ii) $\theta(t=2s) \equiv \frac{1}{2}\alpha\,(t_{=2s})^2 = \frac{1}{2}\left(\frac{3}{2}\,rad/s^2\right)(2s)^2$

$\rightarrow \theta(t=2s) = 3\,rad \simeq \pi\,rad = 180°$, turned

PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2012**

College of Sciences

Section 5 **Quiz 10** **06 December 2012**

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

1rev = 2π rad

Name: **Student ID:** **Signature:** 1 min = 60 s

A disk of radius 10 cm rotates, about a fixed perpendicular axis through its center, at an angular speed of 30 revolutions per minute (rpm). It decelerates uniformly to a stop in 2 complete revolutions. (i) Find the angular acceleration in rad/s^2. (ii) Find the time it takes to come to a stop. (Take $\pi = 3$).

• for $\alpha(t) = \alpha \rightarrow w(t) = w_0 + \alpha t \rightarrow \theta(t) = \theta_0 + w_0 t + \frac{1}{2}\alpha t^2$

where referencing angle θ_0 can be chosen to be zero $\boxed{\theta_0 = 0}$

• With initial speed $w_0 = 30 \, rev/min = 30 \frac{2\pi \, rad}{60 s} \simeq 3 \, rad/s$ & $\boxed{\alpha(t) = -\alpha}$ constant deceleration

we have:

$w(t) = (w_0 - \alpha t)$; $\theta(t) = w_0 t - \frac{1}{2}\alpha t^2$

(i) $w(t = t_{stop}) = w_0 - \alpha t_{stop} \equiv 0 \rightarrow \boxed{\alpha = w_0 / t_{stop}}$

$\theta(t = t_{stop}) = w_0 t_{stop} - \frac{1}{2}\alpha t_{stop}^2 = 2rev = 4\pi \, rad \simeq 12 \, rad$

↑ given $w_0 t_{stop}/2 = 12$ rad

$\rightarrow w_0 t_{stop} - \frac{1}{2}(w_0/t_{stop}) t_{stop}^2 = 12 \, rad \rightarrow$

(ii) $\boxed{t_{stop} = \frac{2 \times 12 \, rad}{(3 \, rad/s)} = 8 s}$

(i) $\alpha = \frac{[3 \, rad/s]}{[8 s]}$ ←

$\rightarrow \boxed{\alpha = 3/8 \, rad/s^2}$