PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2013**

College of Sciences

Section 1 **Quiz 10** **05 December 2013**

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

Quiz duration: 10 minutes

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

A turntable rotates with a constant 2.25 rad/s^2 angular accelearation. After 4 s it has rotated through an angle of 60 rad. Find the angular velocities of the wheel (i) at the beginning and (ii) at the end of the 4 s interval.

$\alpha = 2.25 \text{ rad}/s^2 = \text{constant.}$

$\omega = \int \alpha dt = \alpha t + \omega_0$

$\theta = \int \omega dt = \int (\alpha t + \omega_0) dt = \frac{\alpha t^2}{2} + \omega_0 t + \theta_0$

Take $\theta_0 = 0 \rightarrow \theta = \frac{\alpha t^2}{2} + \omega_0 t.$

$t=4 \rightarrow \theta = 60 = \frac{\alpha}{2}(4)^2 + \omega_0 4.$

$\omega_0 = \frac{60 - 8 \cdot (2{,}25)}{4} = 10 \text{ rad}/s$

$\omega(t=4) = 2.25(4) + 10 = 19 \text{ rad}/s$

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Section 2 **Quiz 10** **05 December 2013**

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Quiz duration: 10 minutes

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

A flywheel of radius R starts from rest and accelerates with a constant angular acceleration α. Give expressions for the tangential acceleration, the radial acceleration and the resultant acceleration of a point on its rim (i) at the start and (ii) after it has turned through Δθ.

$\alpha = \alpha_0 = \text{constant}$

$w = \int \alpha_0 dt = \alpha_0 t + w_0 \quad w_0 = 0 \longrightarrow w = \alpha_0 t$

$a_{tan.} = r\alpha_0$

$a_{rad.} = w^2 r$. at $t = 0$,

$a_{tan} = r\alpha_0 \quad a_{rad} = w^2 r = 0 \longrightarrow a = r\alpha_0 = \sqrt{a_{tan}^2 + a_{rad}^2}$

$\theta = \int w\, dt = \frac{\alpha_0 t^2}{2} + \theta_0$

$\theta - \theta_0 = \Delta\theta = \frac{\alpha_0 t^2}{2}$

$t = \sqrt{\frac{2\Delta\theta}{\alpha_0}}$

$w\left(t = \frac{2\Delta\theta}{\alpha_0}\right) = \alpha_0 \sqrt{\frac{2\Delta\theta}{\alpha_0}}$

$a_{tan} = r\alpha_0$

$a_{rad} = w^2 r = 2\Delta\theta\,\alpha_0 r$

$a = \sqrt{a_{rad}^2 + a_{tan}^2} = \sqrt{r^2\alpha_0^2 + 4\Delta\theta^2\alpha_0^2 r^2}$

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Section 3 | Quiz 10 | 05 December 2013

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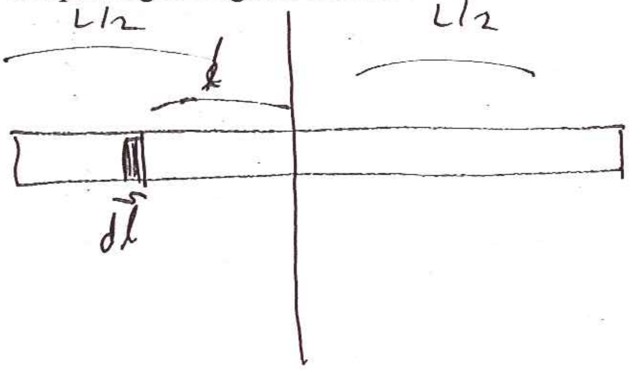
Quiz duration: 10 minutes

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

Calculate the moment of inertia of a thin uniform rod of length L, about an axis perpendicular to it and passing through its center.



$M/L = \lambda$

$dI = dm\, l^2 = \lambda\, dl \cdot l^2$

$$I = 2\int_0^{L/2} \lambda l^2\, dl = 2\lambda \frac{l^3}{3}\Big|_0^{L/2} = 2\lambda\frac{L^3}{24} = \frac{2M}{L}\frac{L^3}{24} = \frac{ML^2}{12}$$

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Section 4 | Quiz 10 | 05 December 2013

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Quiz duration: 10 minutes

Name: Student ID: Signature:

State and prove the parallel-axis theorem.

The relationship between the moment of inertia I_{cm} of a body of mass M about an axis through its center of mass and the moment of inertia I_p about any other axis parallel to the original one but displaced by a distance d is

$$I_p = I_{cm} + Md^2$$

Take $x_{cm} = y_{cm} = z_{cm} = 0$

$$I_{cm} = \sum m_i (x_i^2 + y_i^2)$$ (about center of mass)

about any other point (a, b)

$$I_p = \sum m_i [(x_i - a)^2 + (y_i - b)^2]$$

$$= \underbrace{\sum m_i (x_i^2 + y_i^2)}_{I_{cm}} - 2a \underbrace{\cancel{\sum m_i x_i}}_{0} - 2b \underbrace{\cancel{\sum m_i y_i}}_{0} + \underbrace{(a^2 + b^2)}_{d}\sum m_i$$

since $x_{cm} = y_{cm} = 0$

$$= I_{cm} + Md^2$$

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Section 5 | Quiz 10 | 05 December 2013

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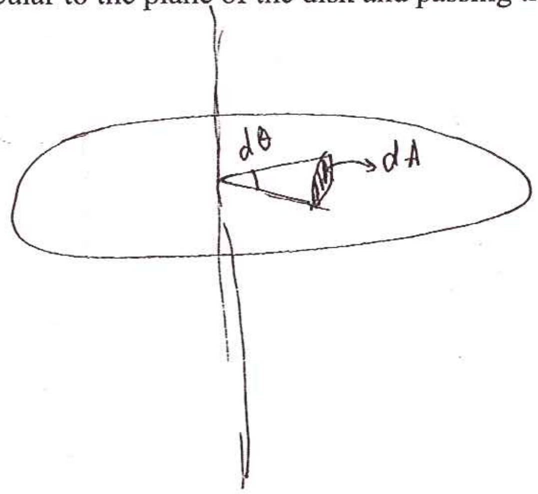
Quiz duration: 10 minutes

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

Calculate the moment of inertia of a uniform, solid disk with mass M and radius R for an axis perpendicular to the plane of the disk and passing through its center.



$$\lambda = \frac{M}{\pi R^2}$$

Area element in polar coordinates

$$dA = r\,dr\,d\theta$$

$$dI = dm\,r^2 = \lambda r^2 dA = \lambda r^3 dr\,d\theta$$

$$I = \int_0^{2\pi}\int_0^R \lambda r^3 dr\,d\theta = \frac{\lambda R^4}{4} \cdot 2\pi = \frac{MR^2}{2}$$