PHYS 101: General Physics 1 | KOÇ UNIVERSITY | Fall Semester 2014

College of Sciences

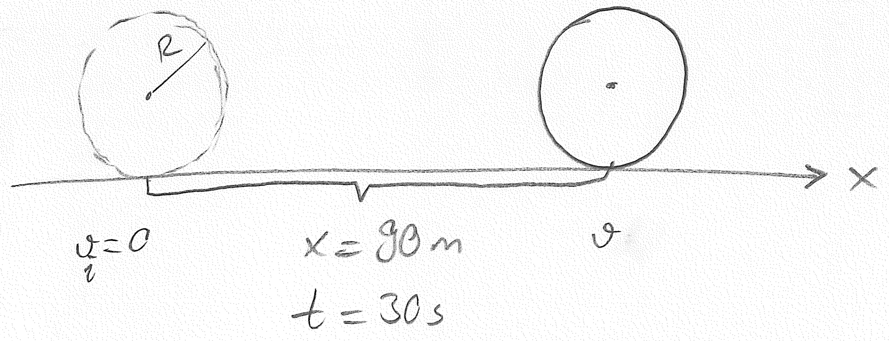
Section 1 | Quiz 10 | 11 December 2014

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

Quiz duration: 10 minutes

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

A wheel of radius 2 m starts from rest and rolls 90 m without slipping in 30 s. (i) Calculate its average angular velocity. (ii) Assuming that the angular acceleration of the wheel is constant, calculate its angular acceleration. (iii) What is the final angular velocity of the wheel? Determine the (iv) tangential velocity and (v) tangential acceleration of a point on the rim of the wheel after one complete revolution.



i) $v_{ave} = \frac{x}{t} = \frac{90}{30} = 3\,m/s$ no slipping $\Rightarrow$ $\omega_{ave} = \frac{v_{ave}}{R} = 1.5\,rad/s$

ii) $\alpha = const \Rightarrow a = \alpha R = const.$ since $v_i = 0 \Rightarrow x = \frac{1}{2}at^2$

$a = \frac{2x}{t^2} = 0.2\,m/s^2$ $\alpha = \frac{a}{R} = 0.1\,rad/s^2$

iii) $v_i = 0$, $a = const.$ $\Rightarrow$ $v(t) = at$ similarly $\omega(t) = \alpha t$ $\omega(30) = 3\,rad/s$

iv) After 1 revolution $x = 2\pi R = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{4\pi R}{a}}$

$v(t) = a \cdot t = \sqrt{4\pi R a} = 2.24\,m/s$

v) $a_{tan} = \alpha R = 0.2\,m/s^2$

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Section 2 **Quiz 10** **11 December 2014**

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Quiz duration: 10 minutes

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

A flywheel with a radius of 50 cm starts from rest and accelerates with a constant angular acceleration of 2 rad/s^2. (i) What is the radial acceleration of a point at the start? What is the (ii) radial and (iii) tangential acceleration of a point on its rim after it has turned 60 degrees?

i) $a_{rad} = \omega^2 R \qquad \omega_i = 0 \Rightarrow \underline{\underline{a_{rad} = 0}}$

ii) $\theta = 60^\circ = \pi/3 \text{ rad} = \frac{1}{2}\alpha t^2 \Rightarrow t = \sqrt{\frac{2\pi}{3\alpha}}$

$a_{rad} = \omega^2 R \qquad \omega = \alpha t = \sqrt{\frac{2\pi\alpha}{3}} \Rightarrow a_{rad} = \frac{2\pi\alpha R}{3} = \underline{\underline{2.09 \text{ m/s}^2}}$

iii) $a_{tan} = \alpha R = \underline{\underline{1 \text{ m/s}^2}}$

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Section 3 **Quiz 10** **11 December 2014**

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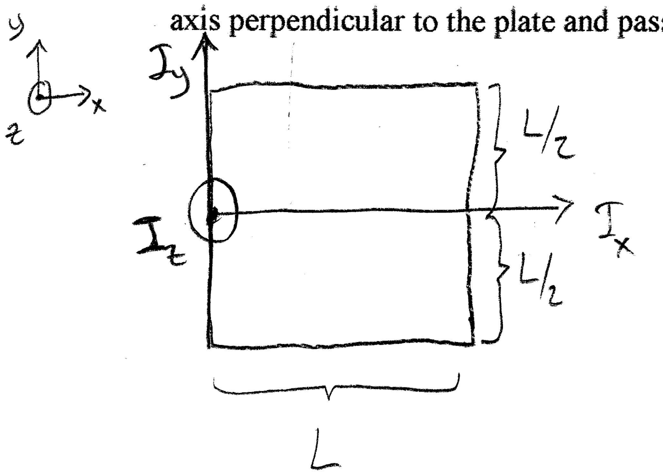
Quiz duration: 10 minutes

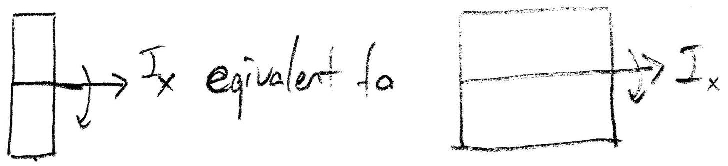
Name: **Student ID:** **Signature:**

Calculate the moment of inertia of a thin square plate of side length L and mass M, about an axis perpendicular to the plate and passing through the middle of one of its sides.



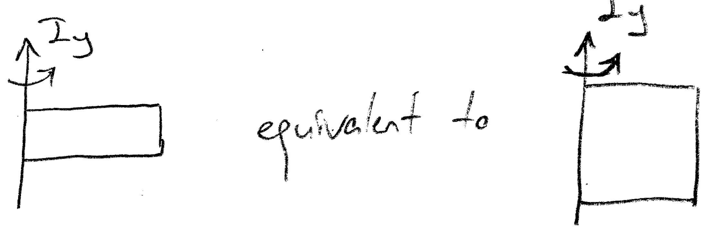
$$I_z = I_x + I_y$$

$\underline{I_x:}$



for a rod: $I_x = \frac{1}{12} ML^2$
axis through the center

$\underline{I_y:}$



for a rod: $I_y = \frac{1}{3} ML^2$
axis through one end

$$I_z = \frac{1}{12} ML^2 + \frac{1}{3} ML^2$$

$$I_z = \frac{5}{12} ML^2$$

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Section 4 **Quiz 10** **11 December 2014**

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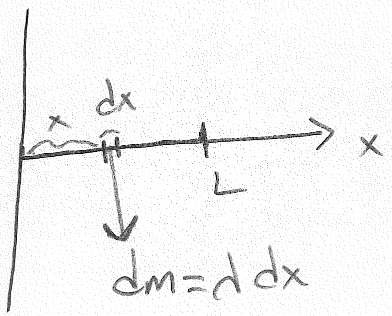
Quiz duration: 10 minutes

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

Calculate the moment of inertia of a thin rod of length L and mass M, about an axis at one end, perpendicular to the rod.



$dm = \lambda\, dx$

where $\lambda . L = M$

$$dI = dm . x^2 = \lambda x^2 dx$$

$$I = \int_0^L \lambda x^2 dx = \left(\frac{\lambda x^3}{3}\right|_0^L = \frac{\lambda L^3}{3}$$

$$\underline{\underline{I = \frac{1}{3} M L^2}} \quad \text{as } M = \lambda . L$$

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Section 5 **Quiz 10** **11 December 2014**

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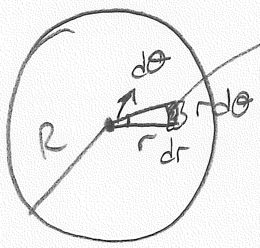
Quiz duration: 10 minutes

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 a point on its rim.



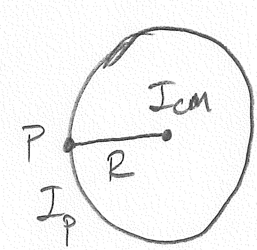
$dm = \sigma r\,dr\,d\theta$

$$dI = dm \cdot r^2 = \sigma r^3 dr\,d\theta$$

$$I = \int_0^{2\pi}\int_0^{R} \sigma r^3 dr\,d\theta = \int_0^{2\pi} \sigma \left(\frac{r^4}{4}\Big|_0^R\right) d\theta = \frac{\sigma R^4}{4} \cdot 2\pi$$

$$I = \frac{\sigma \pi R^4}{2} = \frac{1}{2} M R^2 \quad \text{as } \sigma \pi R^2 = M$$

for a point on the rim:



$$I_p = I_{cm} + Md^2 \quad \text{by parallel-axis theorem}$$

$$I_p = \frac{1}{2}MR^2 + MR^2 = \underline{\underline{\frac{3}{2}MR^2}}$$