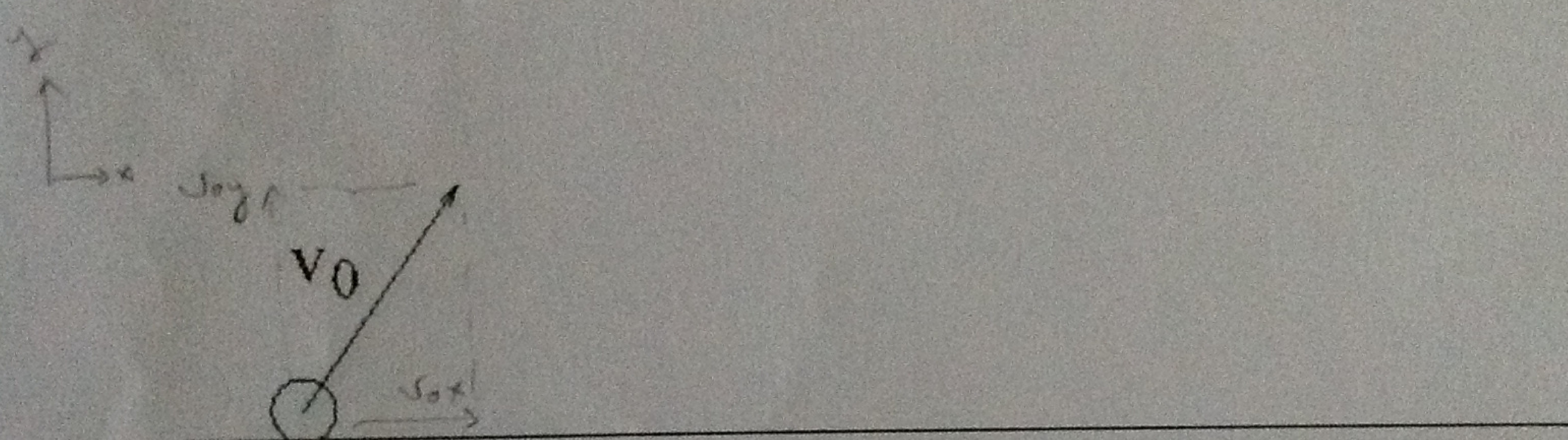
PHYS 101: General Physics | **KOÇ UNIVERSITY** | **Fall Semester 2014**

College of Sciences

Section | **Quiz 3** | **09 October 2014**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

Consider the motion shown in the figure, where a ball starts moving at time $t = 0$ with speed v_0 and making an angle of $\pi/4$ radians with the horizontal axis. If the horizontal and vertical accelerations of the ball are given by $a_x = -2A$ and $a_y = -B$, respectively, find its vertical and horizontal displacements with respect to the initial position as a function of time. Here A and B are positive constants. You may ignore the effects of gravity.



$$x - x_0 = v_{0x} t + \frac{1}{2} a_x t^2$$

$$\cos\frac{\pi}{4} = \sin\frac{\pi}{4} = \frac{\sqrt{2}}{2}$$

$$x - x_0 = \frac{\sqrt{2}}{2} v_0 t + \frac{1}{2}(-2A)t^2$$

$$\boxed{x - x_0 = \frac{\sqrt{2}}{2} v_0 t - At^2}$$

$$y - y_0 = v_{0y} t + \frac{1}{2} a_y t^2$$

$$\boxed{y - y_0 = \frac{\sqrt{2}}{2} v_0 t - \frac{B}{2} t^2}$$

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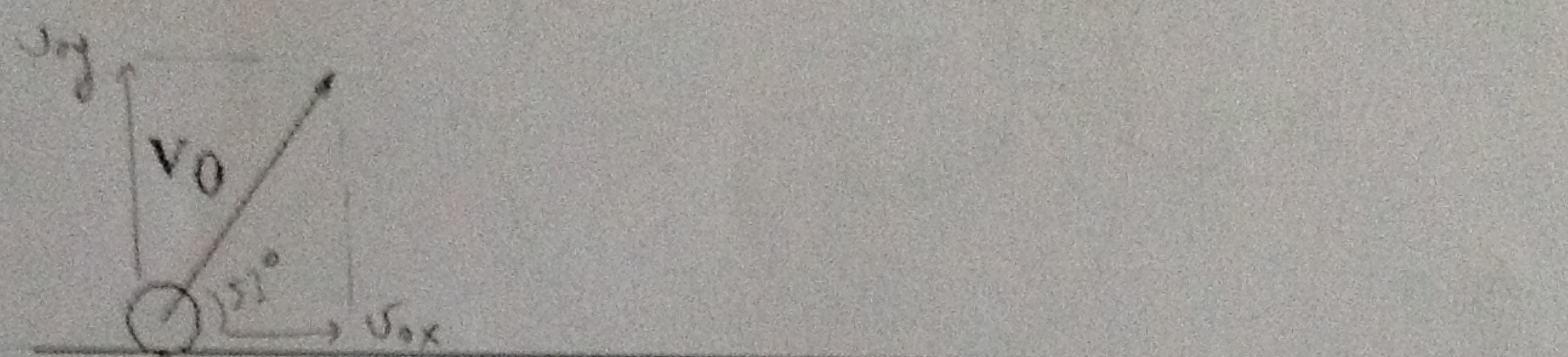
First Name: **Last name:** **Student ID:** **Signature:**

Consider the motion shown in the figure, where a ball starts moving at time $t = 0$ with speed v_0 and making an angle of 53° with the horizontal axis. If the horizontal and vertical accelerations of the ball are given by $a_x = -A$ and $a_y = -2B$, respectively, find the condition for the projectile to come back to its initial (starting) position. Here A and B are positive constants. You may ignore the effects of gravity.



$$x - x_0 = v_{0x} t + \frac{1}{2} a_x t^2$$

$$y - y_0 = v_{0y} t + \frac{1}{2} a_y t^2$$

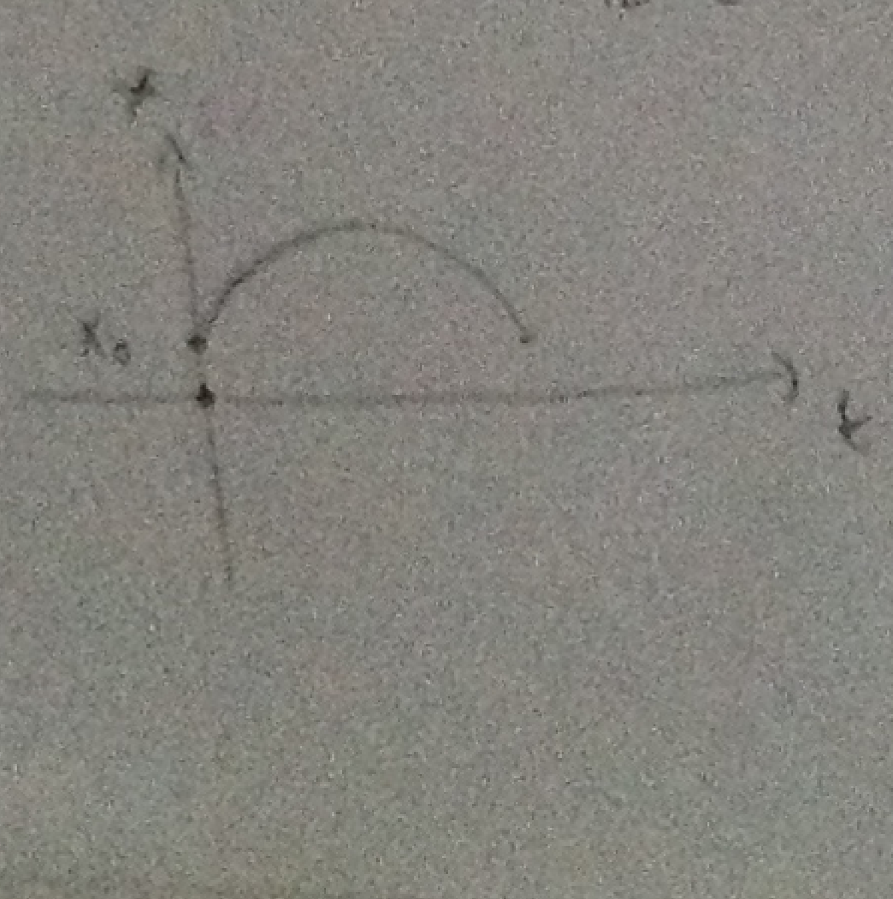
$$x = x_0 \rightarrow v_{0x} t + \frac{1}{2} a_x t^2 = 0 \qquad (v_0 \cos 53^\circ) t - \frac{A}{2} t^2 = 0$$

$$y = y_0 \rightarrow v_{0y} t + \frac{1}{2} a_y t^2 = 0 \qquad (v_0 \sin 53^\circ) t - B t^2 = 0$$

$$\Rightarrow \quad A t^2 = 2 (v_0 \cos 53^\circ) t$$

$$B t^2 = (v_0 \sin 53^\circ) t$$

$$\boxed{B/A = \frac{1}{2} \tan 53^\circ}$$



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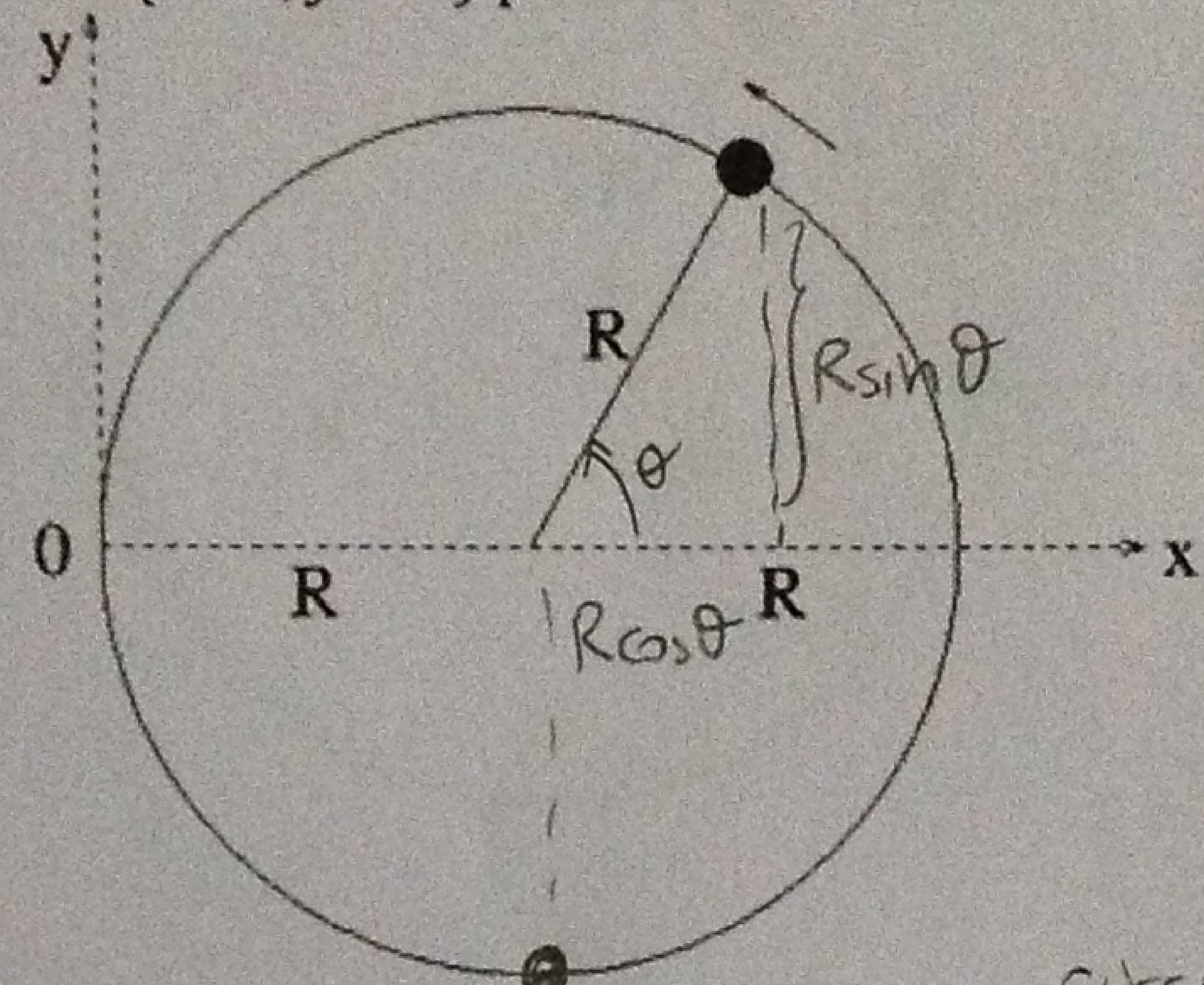
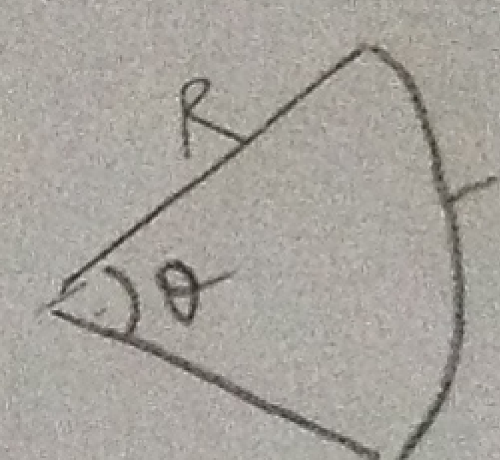
Consider the *uniform circular motion* shown in the figure, where an object is rotating along the circular track with a constant tangential speed of period *T*. Using the *x-y* coordinate system indicated in the figure, find the position of the object as a function of time *t*, assuming the object passes $(x = R, y = -R)$ point at time $t = 0s$.



at $t=0$
$x=R$
$y=-R$



length of arc $= \theta R$

$\theta R = vt \rightarrow \theta = \frac{vt}{R}$

circumference $= 2\pi R$
time required for 1 full lap $= T$

$2\pi R = vT$

$\frac{v}{R} = \frac{2\pi}{T}$

$x = R - R\cos(\theta_0 + \frac{vt}{R})$ θ_0: initial position

$y = R\sin(\theta_0 + \frac{vt}{R})$

at $t=0$ s. $\rightarrow$ $x = R - R\cos\theta_0 = R$, $-R\cos\theta_0 = 0 \rightarrow \theta_0 = \frac{3\pi}{2}$

$\rightarrow$ $y = R\sin\theta_0 = -R$, $\sin\theta_0 = -1 \rightarrow \theta_0 = \frac{3\pi}{2}$

$\Rightarrow$ $x = R - R\cos(\frac{3\pi}{2} + \frac{vt}{R})$

$y = R\sin(\frac{3\pi}{2} + \frac{vt}{R})$

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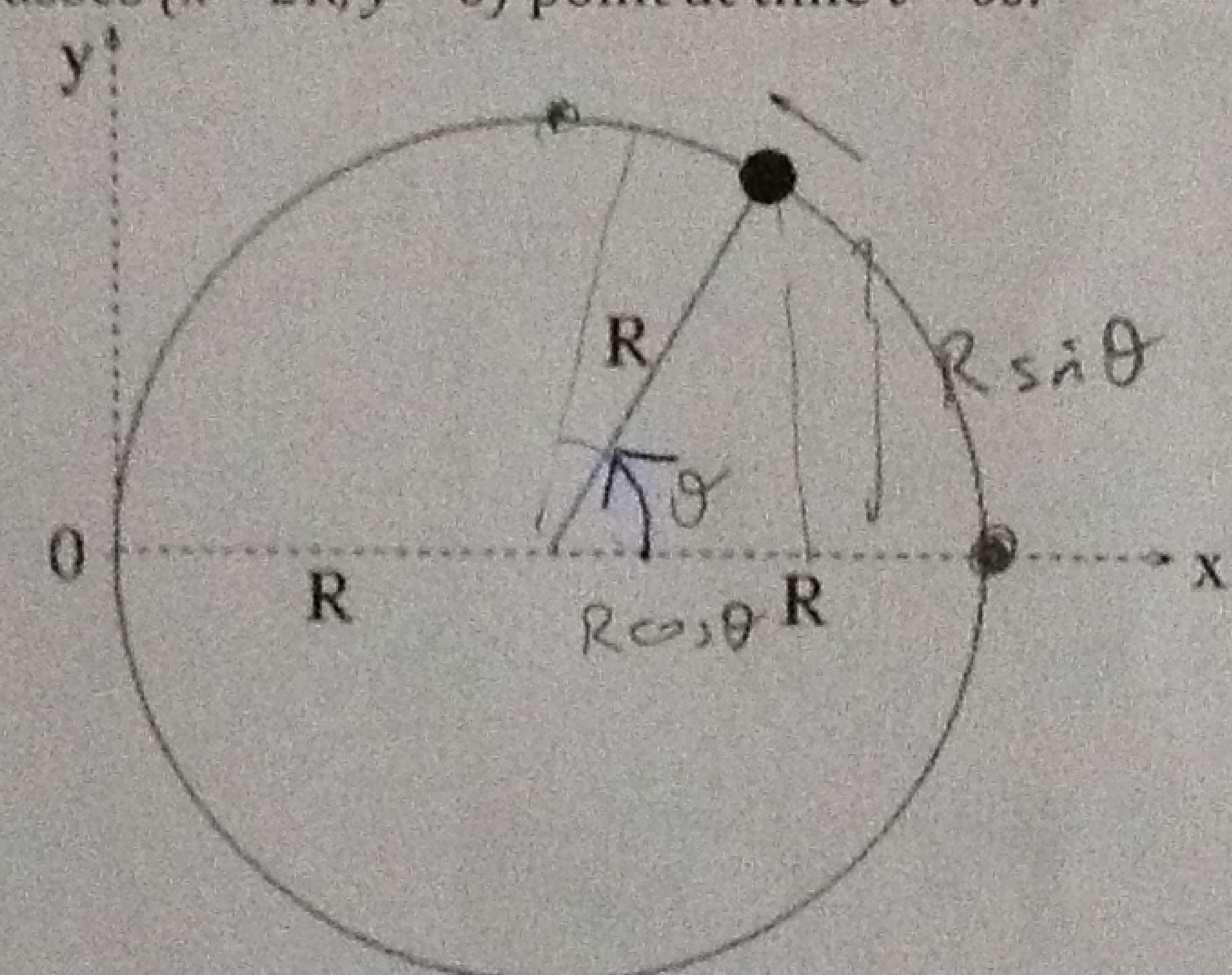
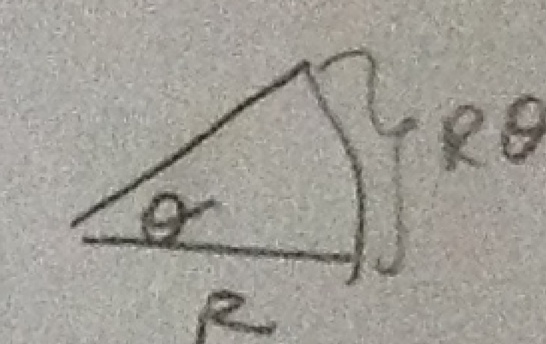
Consider the *uniform circular motion* shown in the figure, where an object is rotating along the circular track with a constant tangential speed of period *T*. Using the *x-y* coordinate system indicated in the figure, find the velocity of the object as a function of time *t*, assuming the object passes *(x = 2R, y = 0)* point at time *t = 0s*.





$R\theta = vt$

$\theta = \frac{vt}{R}$

$2\pi R = vT$

$x = R - R\cos(\theta_0 + \frac{vt}{R})$

at $t=0$

$x = 2R = R - R\cos\theta_0$

$\to \cos\theta_0 = -1$

$\theta_0 = \pi$

$x = R - R\cos(\pi + \frac{vt}{R})$

$y = R\sin(\theta_0 + \frac{vt}{R})$

at $t=0$ $y = 0 = R\sin\theta_0$

$\theta_0 = \pi$

$y = R\sin(\pi + \frac{vt}{R})$

$v_x = \frac{dx}{dt} = \frac{vR}{R}\sin(\pi + \frac{vt}{R})$

$v_y = \frac{dy}{dt} = \frac{vR}{R}\cos(\pi + \frac{vt}{R})$

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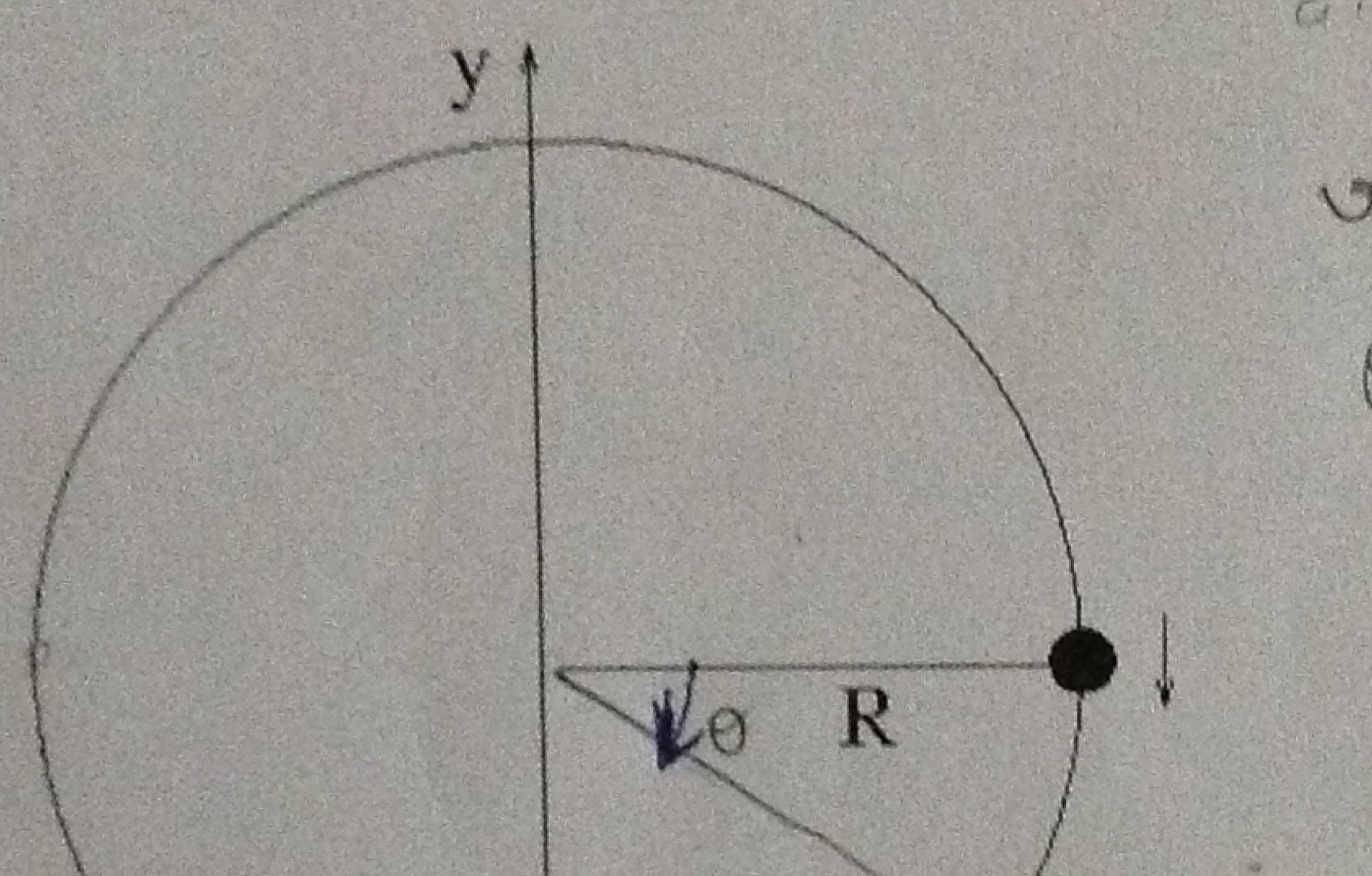
First Name: **Last name:** **Student ID:** **Signature:**

Consider the circular motion shown in the figure, where an object is rotating along the circular track with speed $v = A\,t$, where A is a positive constant and t is time. If the object starts at rest from the position shown in the figure, find its position in the x-y coordinate system at time t = 2s. Here, you may set $A = 8m/s^2$ and $R = 16/\pi$ meters.

at $t=0$ $v=0$



$v = At$

$\theta R = vt$

$\theta = \frac{vt}{R}$

angle θ taken in time t by an object with velocity v along a circle with radius R.

$x = R\cos\left(\theta_0 + \frac{vt}{R}\right)$

$y = R - R\sin\left(\theta_0 + \frac{vt}{R}\right)$

at $t=0$ $x = R = R\cos\theta_0$ $\cos\theta_0 = 1$ $\theta_0 = 0^\circ$

$x = R\cos\left(\frac{vt}{R}\right)$

at $t=0$ $y = R = R + R\sin\left(\frac{vt}{R}\right)$ $\sin\theta_0 = 0$ $\theta_0 = 0^\circ$

$y = R - R\sin\left(\frac{vt}{R}\right)$

at $t = 2s$. $v = At$

$v = 8m/s^2 \cdot 2s = 16m/s$

$\rightarrow \frac{vt}{R} = \frac{(16m/s)(2s)}{16/\pi\ m} = 2\pi$

$x = R\cos(2\pi) = R$

$y = R + R\sin(2\pi) = R$