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

College of Sciences

Section 2 **Quiz 3** **10 October 2013**

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 $a_x = A$ and $a_y = -B$, respectively, find the maximum displacements in the vertical and horizontal directions. Here A and B are positive constants. You may ignore the effects of gravity.

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Section 4 **Quiz 3** **10 October 2013**

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 37^o with the horizontal axis. If the horizontal and vertical accelerations of the ball are given by $a_x = A$ and $a_y = -B\,t$, respectively, find the maximum height reached by the object during its motion. Here A and B are positive constants. You may ignore the effects of gravity. Warning: acceleration is time-dependent.

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Section 5 **Quiz 3** **10 October 2013**

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 53^o with the horizontal axis. If the horizontal and vertical accelerations of the ball are given by $a_x = A\,t$ and $a_y = -B$, respectively, find the range of the motion in the horizontal direction. Here A and B are positive constants. You may ignore the effects of gravity. Warning: acceleration is time-dependent.

PHYS 101: General Physics	**KOÇ UNIVERSITY** **College of Sciences**	**Fall Semester 2013**
Section 1	**Quiz 3**	**10 October 2013**

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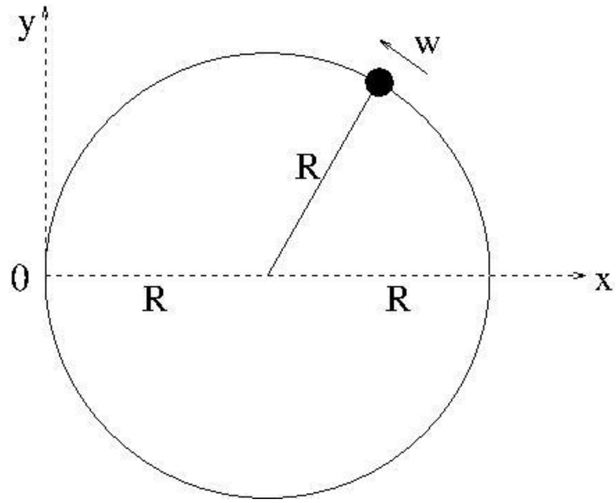
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

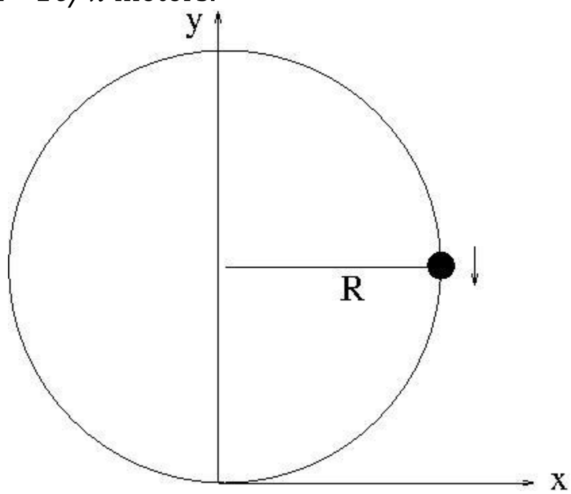
Consider the uniform circular motion shown in the figure, where an object is rotating along the circular track with a constant angular frequency $w = 2\pi/T$. Here T is the period of the motion. Using the *x-y* coordinate system indicated in the figure, find the position and acceleration of the object as a function of time t, assuming the object passes $(x = 0, y = 0)$ point at time $t = 0s$.



PHYS 101: General Physics	**KOÇ UNIVERSITY** **College of Sciences**	**Fall Semester 2013**
Section 3	**Quiz 3**	**10 October 2013**

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

Consider the nonuniform circular motion shown in the figure, where an object is rotating along the circular track with a time-dependent tangential acceleration given by $a_{\text{tang}} = A\ t$, 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 $A = 3m/s^3$ and $R = 16/\pi$ meters.



1 Section 1

From the figure, it is clear that

$$x = R + Rcos(\alpha)$$
$$y = Rsin(\alpha)$$

and the equation for the angle α at any time is equal to

$$\alpha = \omega t$$

so, equations of motion for x and y axes are

$$x = R + Rcos(\omega t)$$
$$\text{y=Rsin}(\omega t)$$

To find velocities, differentiate x and y coordinates with respect to time

$$\frac{dx}{dt} = v_x = -Rsin(\omega t)$$
$$\frac{dy}{dt} = v_y = Rcos(\omega t)$$
$$a_x = \frac{dv_x}{dt} = -R\omega^2 cos(\omega t)$$
$$a_y = \frac{dv_y}{dt} = -R\omega^2 sin(\omega t)$$

2 Section 2

Equations of motion for x and y axes are

$$y = -\frac{1}{2}Bt^2 + \frac{v_{0y}t}{\sqrt{2}}$$

(equation of motion with cons. acceleration; a=-B, v_0=v_0 sin(45), y_0=0)

$$x = \frac{1}{2}At^2 + \frac{v_0 t}{\sqrt{2}}$$

(same as y where a=A, v_0=$v_0$cos(45),x_0=0)

Then, in order to find maximum of y-function;

$$\frac{dy}{dt} = 0 = -Bt + \frac{v_0}{\sqrt{2}}$$
$$t = \frac{v_0}{B\sqrt{2}}$$

Plug $t = \frac{v_0}{B\sqrt{2}}$ into y equation of motion to find maximum of y.

$$y_{max} = \frac{v_0^2}{4B}$$

Same procedure for the range in x-direction with $t_{flight} = 2t$

$$x_{max} = v_0^2(\frac{A+1}{B})$$

3 Section 3

$$a_{tang} = At$$

Since the tangential acceleration is given, this motion does not have any difference from motion along a straight line.

$$v_{tang} = \int a_{tang}dt = \int Atdt = \frac{At^2}{2} \; x_{tang} = \int v_{tang}dt = \int At^2/2 = \frac{At^3}{6}$$

In two seconds, total distance covered is

$$x(t=2) = A(2)^3/6 = 4m.$$

The circumference of the circle is

$$2\pi R = 32m.$$

Total distance covered is equal to the 1/8 of circumference. Therefore, the total angle covered is

$$\alpha = \frac{2\pi}{8} = \pi/4$$

In this problem, x and y coordinates can be found via

$$x = Rcos(\alpha)$$
$$y = R - Rsin(\alpha)$$

where

$$R = \frac{16}{\pi}$$
$$\alpha = \pi/4$$

4 Section 4

Equations of motion;

$$x = \frac{At^2}{2} + v_0 cos(\alpha)$$

since it is motion with constant acceleration, and

$$v_y = \int -Btdt + v_0 sin(\alpha)$$
$$y = \int (-\frac{Bt^2}{2} + v_0 sin(\alpha))dt = \frac{Bt^3}{6} + v_0 sin(\alpha t)$$

To find maximum of y, take the derivative with respect to time and set equal to zero

$$\frac{dy}{dt} = 0 = -\frac{Bt^2}{2} + v_0 sin(\alpha)$$
$$t' = \sqrt{(}\frac{2v_0 \sin(\alpha)}{B})$$

Maximum height that the particle will achieve is

$$y(t = t') = -\frac{B}{6}(\frac{2v_0 \sin(\alpha)}{B})^{3/2} + v_0 sin(\alpha)\sqrt{(}\frac{2v_0 \sin(\alpha)}{B})$$

where $\alpha = 37$

5 Section 5

Equations of motion for x and y directions are

$$y = -\frac{Bt^2}{2} + v_0 sin(\alpha)t$$
$$v_x = \int Atdt + v_0 cos(\alpha) = \frac{At^2}{2} + v_0 cos(\alpha)$$
$$x = \int (\frac{At^2}{2} + v_0 cos(\alpha))dt = \frac{At^3}{6} + v_0 cos(\alpha)t$$

Time of flight t_{flight} can be calculated from the time required for the ball to reach its maximum height

$$\frac{dy}{dt} = 0 = -Bt + v_0 sin(\alpha)$$
$$t' = \frac{v_0 sin(\alpha)}{B}$$
$$t_{flight} = 2t'$$

and maximum displacement in x direction will be

$$x(t = t_{flight}) = \frac{A}{6}(\frac{8v_0^3 sin^3(\alpha)}{B^3}) + v_0 cos(\alpha)(\frac{2v_0 sin(\alpha)}{B})$$