Name:	Signature:
Surname:	Number:

KOÇ UNIVERSITY

College of Sciences

PHYS 101 General Physics 1

Fall Semester 2015

Midterm1 Exam

October 26, 2015 Monday, 19:00-21:00

Please read.

- Count to make sure that there are 5 pages in this question booklet
- Check your **name, number, on front page, and student ID on each page.**.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- You are not allowed to use calculators during this exam.
- Turn off your mobile phones, and put away.
- You are not allowed to leave the class during the first 15 minutes, and last 15 minutes.
- Write your final answers into the boxes. No points will be given to unjustified answers. Incomplete calculations will not be graded.

P101_Index:

1	2	3	4	Total

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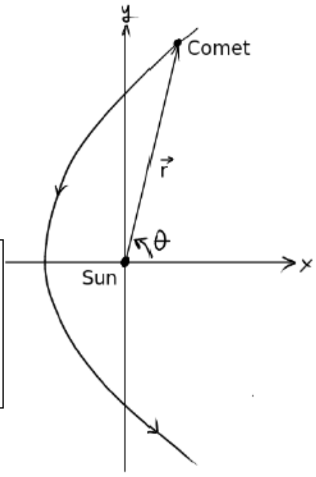
1 (25 pts) A comet is orbiting the sun as shown in the figure. The distance *r* of the comet from the sun is given in terms of its angular coordinate θ as

$$r = \frac{a}{1-\cos\theta}$$

where *a* is constant.



a) (2 pts) What is the minimum distance $r_{\min}$ between the comet and the sun? At which angle $\theta_{\min}$ is it realized?

$r_{\min} =$

$\theta_{\min} =$

b) (3 pts) Write down <u>the vector</u> $\vec{r}$ when $\theta = \pi/3$ for the coordinate system given in the figure. ($\pi/3 = 60^0$)

$\vec{r} =$

c) (5pts) Find a tangent vector $\vec{t}$ to the orbit at $\theta = \pi/3$.

$\vec{t} =$

Our next goal is to calculate the velocity vector $\vec{v} = (v_x\hat{i} + v_y\hat{j})$ at $\theta = \pi/3$.

d) (5 pts) Find an algebraic equation relating v_x and v_y at $\theta = \pi/3$, using the fact that $\vec{v}$ is tangent to the orbit.

e) (5 pts) For orbital motion, $\vec{r} \times \vec{v} = \vec{l}$, where $\vec{l}$ is a constant vector. Evaluate the cross product to get a second algebraic relation between v_x and v_y at $\theta = \pi/3$.

f) (5 pts) Find the speed of the comet at $\theta = \pi/3$.

$\sin(\pi/3) = \sqrt{3}/2$, $\cos(\pi/3) = 1/2$

$v =$

Solution continues on the back side of the page **Yes** □ **No** □

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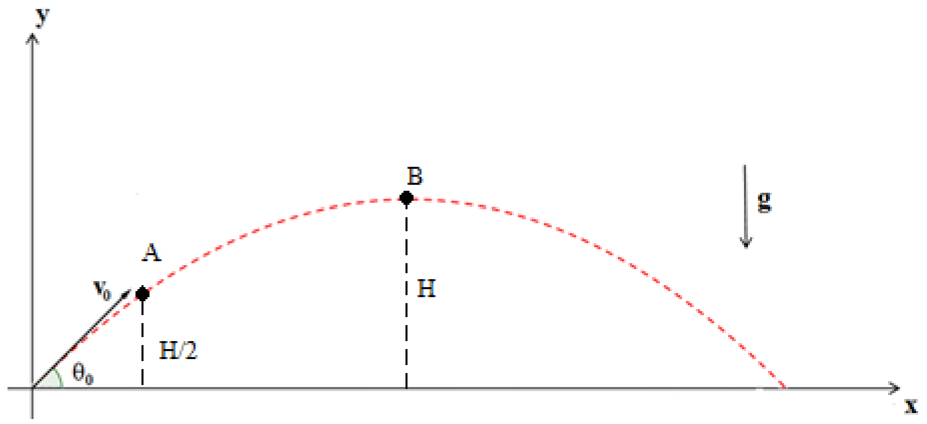
2 (25 pts) A ball is thrown from the ground with a speed v_0 at an angle of θ_0 from the horizontal. The speed of the ball at its maximum height is $\sqrt{6/7}$ of its speed when it is at half of its maximum height. Calculate angle θ_0.



$\theta_0 =$

Solution continues on the back side of the page **Yes** □ **No** □

Exam Room:	**P101_Index:**
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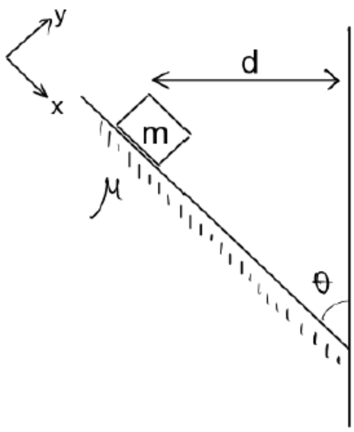
Q3 (25 pts) An object with mass *m* slides down a flat surface under the influence of gravity. The surface meets a vertical wall at an angle θ and the object is initially at rest at a distance d from the wall, as shown in the figure. The coefficient of friction for the contact between the object and the surface is $\mu (= \mu_s = \mu_k)$.



a) (3 pts) Draw the free diagram for the object.

Express your answers to the questions below in terms of m, θ, d, μ gravitational acceleration *g* (you may not need all of them) and necessary unknowns.

b) (3 pts) Write down Newton's Second Law for the forces parallel to the surface (along *x*).

c) (3 pts) Write down Newton's Second Law for the forces perpendicular to the surface (along *y*).

d) (5pts) Find $\theta_{\max}$, maximum value of θ for which the object can slide down.

$\theta_{\max} =$

e) (5 pts) For $\theta \leq \theta_{\max}$, find the time it takes for the object to reach the vertical wall.

$t =$

f) (6 pts) Imagine θ is adjustable while d is fixed. Calculate the angle θ_c at which the object reaches the wall in shortest time.

You may want to use following identities:

$\sin(2\theta) = 2\sin\theta\cos\theta$

$\cos(2\theta) = \cos^2\theta - \sin^2\theta$

$\theta_c =$

Solution continues on the back side of the page **Yes** □ **No** □

Exam Room:	**P101_Index:**
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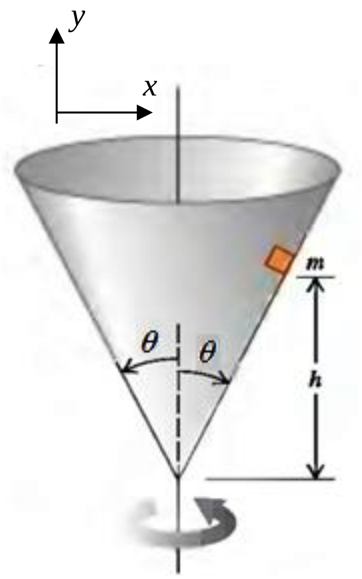
Q4 (25 pts) A small block with mass m is placed inside an inverted cone that is rotating about a vertical axis with period *T*. The walls of the cone make an angle q with the vertical axis. The coefficient of static friction between the block and cone surface is μ_s. The block is initially at a height *h* above the apex of the cone. Calculate the maximum value of *T* such that the block remains always at constant height *h* (i.e. does not slide down). *Use the coordinate system drawn on the figure.*



a.) Draw the free body force diagram for the block.

b.) Write the equations of Newton's 2nd law of motion in *x* and *y* directions.

c.) Using the equations in part (b), calculate the maximum value of *T* in terms of h, g , μ_s , and θ.

$T_{\max} =$

d.) Using the properties of uniform circular motion, calculate the radial acceleration of the block in terms of g , m_s, and q.

$a_r =$

Solution continues on the back side of the page **Yes** □ **No** □