PHY 140Y – FOUNDATIONS OF PHYSICS
1999-2000
Term Test #1, Version 2
Tuesday, November 2, 1999
6:30 PM - 8:30 PM

INSTRUCTIONS:

Please give your name, student number, and TA's name on <u>ALL</u> examination booklets used.
Answer <u>ALL</u> questions. Total marks = 100.
Marks, shown in brackets, will be given for workings and units as well as for final answers.
[Non-]programmable calculators may be used. No aid/crib sheets are allowed.

Constants:　　　　*g = 9.81 m/s²*

Calvin's approach is not recommended!
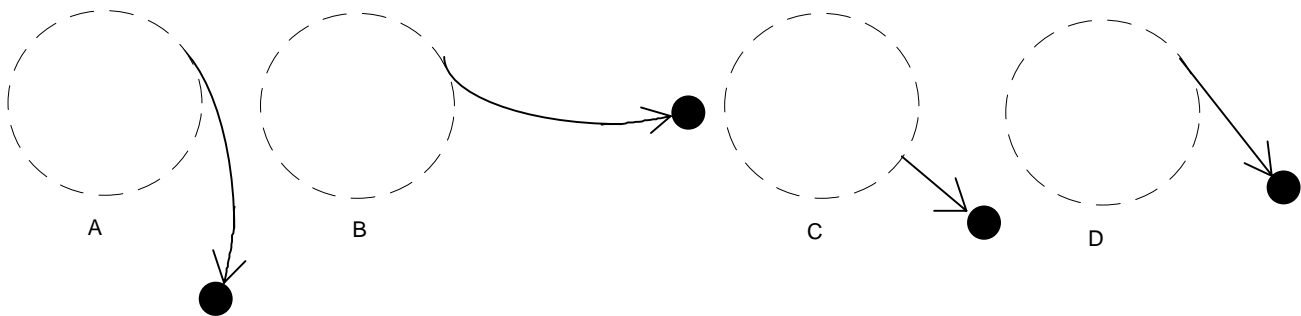
QUESTIONS:

1.　Give BRIEF answers to each of the following. *[5 marks each for 20 total]*

　(a) State Newton's three Laws of Motion. Briefly explain the significance of each one.

　(b) Define weight. Are astronauts in the orbiting Space Shuttle weightless? Explain why or why not. Describe how this situation compares to that of a person in an elevator which is in free fall.

(c) A passenger in a car travelling at 60 km/hour pours a cup of coffee for the tired driver, with it taking the coffee 0.10 seconds to reach the cup. Describe the path of the coffee as it moves from a Thermos bottle into a cup as seen by (i) the passenger, and (ii) someone standing beside the road and looking in the window of the car as it drives past. (iii) What happens if the car accelerates while the coffee is being poured?

(d) A ball is following the dotted circular path shown below, under the influence of a force. At a certain instant of time, the force on the ball changes abruptly to a new force and the ball follows the paths indicated by the solid line and arrow. For each part of the figure, describe the magnitude and direction of the force required to make the ball move in the solid path. If the dotted line represents the path of a ball being whirled on the end of a string, which path does the ball follow if the string breaks.


*[Each of the following five questions is worth 16 marks.]*

2. A rocket is fired vertically upwards with an initial velocity of 80.0 m/s. It accelerates upwards at 4.00 m/s^2 until it reaches an altitude of 1.00 km. At that point, its engines fail and the rocket goes into free flight with acceleration g due to gravity.
    (a) How long is the rocket in motion?
    (b) What is its maximum altitude?
    (c) What is its velocity just before it collides with the Earth?


$g = -9.81 \text{m/s}^2$

1.00 km

$a = 4.00 \text{m/s}^2$
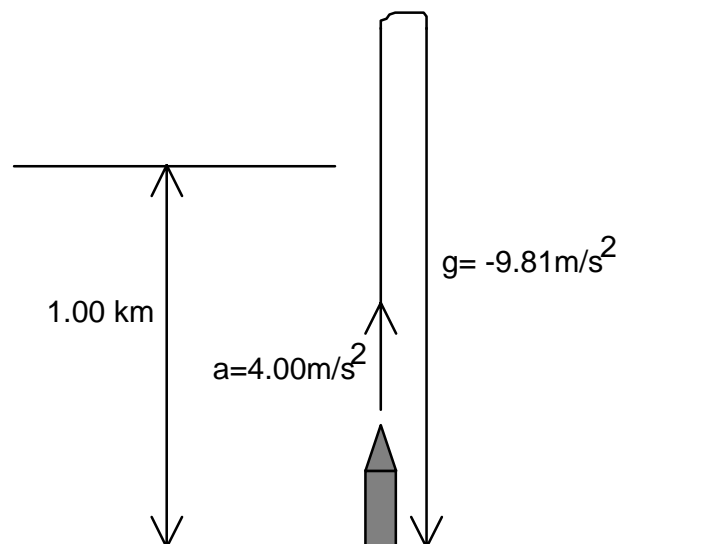
3. A person throws a rock from the top of a tower at speed V and at angle of 40.° above the horizontal. The rock is in flight for 3.5 seconds and hits the ground 22 m from the base of the tower.
   (a) What is the speed V?
   (b) How high off the ground is the top of the tower?
   (c) What is the magnitude and direction of the rock's velocity just before it hits the ground?
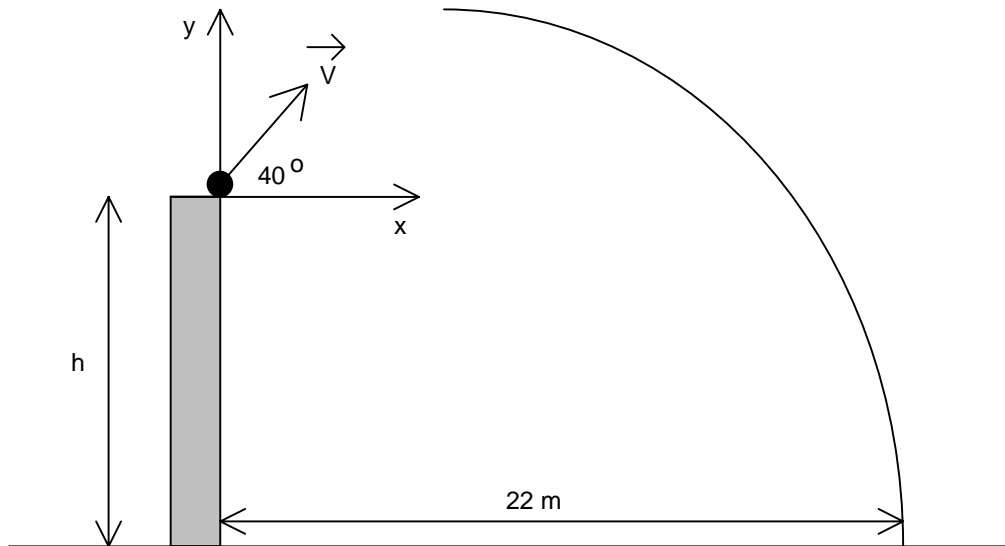
4. A small sphere of mass m is attached to the end of a cord of length R which rotates counter-clockwise in a vertical circle about a fixed point O as shown. Define θ as the angle that the cord makes with the vertical.
   (a) Draw the free-body diagram for mass m when it is at points: (i) A - the bottom of the circle, (ii) B - the top of the circle, and (iii) C – at angle θ as shown.
   (b) What are the radial and tangential components of the acceleration?
   (c) Find an expression for the tension in the cord at time t in terms of the speed of the sphere, v(t), θ(t), m, and R.
   (d) What is the minimum magnitude of the tension and at what position does it occur? What is the maximum magnitude of the tension and at what position does it occur?
   (e) At what position is the cord most likely to break if the speed increases? Why?
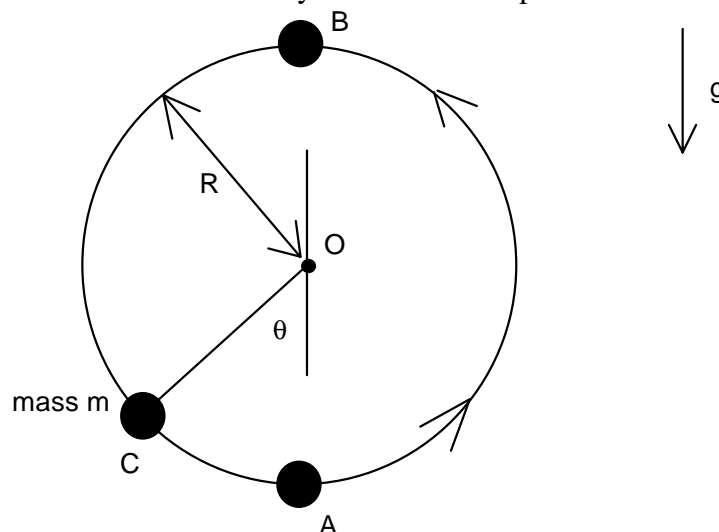
5. A block of mass M and height h slides down a frictionless slope as shown below. The slope is inclined at angle θ from the horizontal. Connected to the top of the box is an object of mass m. The object is directly above point A on the floor of the box, as shown.
    (a) Draw free-body diagrams for mass m and for mass M and identify all forces acting on each.
    (b) If mass m drops from the top of the box, where will it fall relative to A when it reaches the floor, and how long will it take to fall?
    (c) Repeat (a) for the case in which the coefficient of kinetic friction between the box and the slope is μ_k.
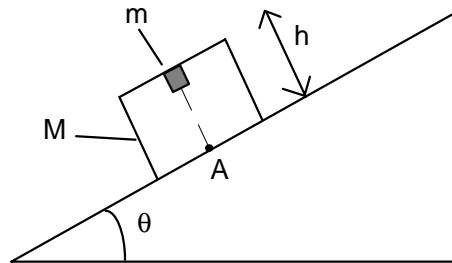
6. A block of mass m is on a level table top. It is pulled by means of two strings, aligned in the x and y directions, respectively. The tensions in the two strings have equal magnitudes T. The coefficient of kinetic friction between the block and the table top is μ_k. Under the influence of the two strings and friction, the block moves with a uniform velocity along the 45° line between the x and y axes. The mass is displaced between an initial point (0,0) and a final point (L,L).
    (a) What is the magnitude T?
    (b) What is the work done on the block by each of the forces acting on it?
    (c) What is the net work done on the block? Comment on this result.

view looking down on table top