## **Physics 171** February 28, 2000 Exam # 1

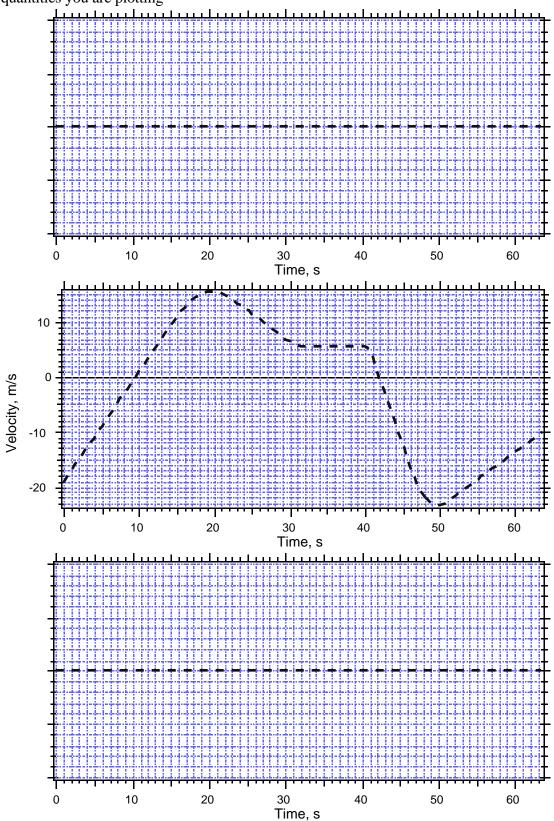
Do the attached problems on the paper provided. Extra paper is available at the front of the room if you need more. Be sure to write your name and the problem number on any extra sheets you use!!

You may use your own pens, pencils, erasers, calculator and <u>one</u>  $8\frac{1}{2}$ " x 11" sheet of paper preprepared with any information you think you might need.

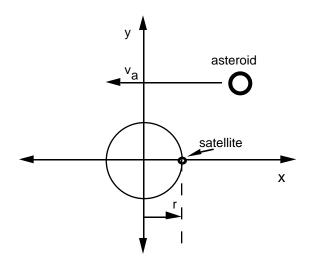
The exam will be graded on the basis of CLARITY of PRESENTATION of your reasoning, as well as correctness of the final answer. You must also show the units on numerical answers to obtain full credit.

Name

1. Draw carefully, and as quantitatively as possible, the acceleration vs. time (on the top graph below) and the position vs. time (on the bottom graph below) for a particle moving with the velocity curve shown. Assume that at t = 0, the position is x = 0 m. Label the axes to show the magnitudes of the quantities you are plotting



2. A satellite is circling the earth at a height above the earth's surface of 230 km, and thus a distance from the earth's center of r = 6600 km. The satellite moves at constant speed and the period of the orbit is T = 88.9 minutes. The satellite is moving counter-clockwise in an xy plane defined to have its origin at the earth's center, as shown in the Figure. An asteroid is traveling in the same plane, in a straight line at constant speed  $v_a = 6.75$  km/s past the earth in the negative x direction as shown in the figure. At time t = 0, the satellite's position is x = r, y = 0.



- a) What is the frequency of the satellite's orbit? What are the velocity and acceleration of the satellite?
- b) Write vector expressions for the velocities (as observed from the earth frame) of the satellite and the asteroid at t = 0, t = T/4 and t = T/2.
- c) Write a vector expression for the velocity of the asteroid as observed by the satellite at time t = T/2. What is the magnitude of the relative speed of the asteroid and the satellite at this time?

- 3. During the eruption of a volcano a chunk of rock is ejected from the summit of the volcano. It lands  $8.4 \times 10^3$  m east, and  $1.8 \times 10^3$  m below the summit. The block was ejected from the summit at a 35° angle from the horizontal.
- a) Write the equations for the x coordinate of the rock as a function of time, and for the y coordinate of the rock as a function of time. Your equations should include the unknown initial speed  $v_0$  as a parameter. Eliminate the time to find the trajectory of the rock, that is its x position as a function of its y position.
- b) Find the initial speed  $v_0$  of the rock.

The magnitude of the acceleration due to gravity is  $g = 9.8 \text{ m/s}^2$ 

- 4. An observer on earth sees a photon and an energetic particle and a second observer, all traveling in the positive x direction, pass by at t = 0. The energetic particle's speed is 0.667c, and the second observer's speed is 0.750 c.
- a) What values does the earth observer measure for the positions of the photon and the energetic particle at t = 10.0 ns after they pass by?
- b) What coordinates (position and time) does the second observer measure for each of the events in part a? (The "events" are the photon and the energetic particle each at the position calculated in (a) at time t = 10 ns in the earth observer's frame.)
- c) What velocity does the second observer find for the photon and the energetic particle based on the result of part b? Explain why your answers are or are not consistent with your expectations based on the laws of relativity and your common sense.