SAMPLE PROBLEMS FOR MIDTERM TEST #1
PH111, FALL 2006

1. Give the definition, units of measure and a short description of the following physical quantities:

(a) displacement $\mathbf{\Delta x}$;

(b) instantaneous velocity $\mathbf{v}$;

(c) average velocity $\mathbf{v_{avg}}$;

(d) acceleration $\mathbf{a}$;

(e) Cartesian coordinates (x, y, z) of a 3-dimensional position vector $\mathbf{r}$.

2. Convert the units of measure of the following quantities:

(a) l=3 [m]: convert to [mm] and [Mm];

(b) a=2.4 $\cdot 10^4$ [mi h^{-2}]: convert to [m s^{-2}];

(c) ω=3 [rad s^{-1}]: convert to [degree s^{-1}] and [rev hr^{-1}] (one revolution is one full rotation, or 360 degrees);

3. A car travels on a straight highway with constant speed of 30 [mi hr^{-1}]. The driver suddenly applies the brakes, in such a way that the car acquires a uniform (negative) acceleration. The car comes to a stop in 25 [m]. What was the value of the acceleration, and how log did it take for the car to arrive at a complete stop?

4. A person walks on a flat horizontal terrain in the following pattern: first, for 0.2 [mi] north, then for 0.4 [mi] west, and finally for 0.5 [mi] north-west (or 45 degrees west of north, or at an angle of 135 degrees from the easterly direction). Find:

(a) Final position of the person, assuming that it starts at the origin of the coordinate system;

(b) Find the magnitude and position angle of the displacement between the initial and final positions.

5. Two comets in outer space race towards one another with uniform speeds along a straight line. The initial distance between them is 10^4 [km]; comet #1 has v_1=100 m/s, comet #2 has speed v_2=25 m/s. After how many seconds, and at what position, will the collision occur? You may consider the initial location of comet #1 as the origin of the coordinate system, and that the motion takes place along the x axis.

6. A baseball player hits a ball with initial speed of 120 [mi h^{-1}] at an angle of 30 degrees from the horizontal x axis. The fence in the outfield has the same height as the initial position of the hit baseball, and it is located 360 feet away from the player. Will the baseball clear the fence, and therefore the player hit a homerun?

7. Repeat the problem above, with an angle of 60 degrees.

8. A police car starts chasing a speeding vehicle (v=100 [mi h^{-1}]) when the vehicle is 0.2 [mi] in front of the police car. The police car accelerates uniformly from v=0 with a=10 [m s^{-2}], and the speeding vehicle keeps its constant speed. After how many seconds will the police car reach the speeding vehicle? How many miles will occur to complete the chase (start counting at the initial location of the police car)? What is the velocity of the police car at the moment it reaches (and overtakes) the speeding vehicle?

9. Draw the trajectory of a baseball in the x-y plane, according to the following table:

Time [s]	x [m]	y [m]
0	0	0
1	1	3
2	2	8
3	3	12
4	4	14
5	5	12
6	6	8
7	7	3
8	8	0

Find the velocity of the ball along the x axis (v_x), and describe what kind of motion takes place along the x axis. Also, find the peak height and the range of this projectile motion. What is the average velocity along the y axis between times $t = 0$ and $t = 4$ [s]?

10. Consider a uniform circular motion along a circle of radius r =3 [m]. The motion starts on the positive x axis, and follows the usual equations:

$x(t) = r \cdot cos(\omega t)$;

$y(t) = r \cdot sin(\omega t)$;

The constant ω equals $\pi/2$ [rad s^{-1}].

(a) Draw an x-y graph with the position of the object at time t=0.5 [s];

(b) Draw the position at time t=1 [s];

(c) Find a general expression for the velocity and acceleration of the object, and find the numerical value of velocity and acceleration at time t=0.5 [s] and t=1 [s]. Draw the directions of the velocity and acceleration vectors at those two times. You will find that the velocity is always tangent to the path, and the acceleration is directed towards the center of the circle.

11. An object moves along a horizontal line according to the following equation for the position:

$x(t) = 12.0 + 2.2 \cdot t + 2.3 \cdot t^3 + 3.0 \cdot t^4$

(a) Find the velocity and acceleration of the object;

(b) Is the motion uniform, uniformly accelerated, or neither?

12. An object's velocity along the x axis is described by:

$v(t) = 2.0 + 3.2 \cdot t$

(a) Describe what kind of motion this is.

(b) Assume that the object starts at x=0 at time t=0. Find the displacement of the object between times t=0 and t=4 [s].