A. STUDENT OBJECTIVES for KINEMATICS

1. MOTION in ONE DIMENSION

a. You should understand the general relationships among position, velocity, and acceleration for the motion of a particle along a straight line, so you can:

i. Given a graph of one of the kinematic quantities, position, velocity, or acceleration, as a function of time, you can recognize in what time intervals the other two are positive, negative, or zero, and can identify or sketch a graph of each as a function of time.

b. You should understand the special case of motion with constant acceleration so you can:

i. Write down expressions for velocity and position as functions of time, and identify or sketch graphs of these quantities.

ii. Use the equations of motion:

$v = v_o + at$

$x = x_o + v_o t + (1/2)\, at^2$

$v^2 - v_o^2 = 2a(x - x_o)$

to solve problems involving one-dimensional motion with constant acceleration.

2. MOTION in TWO DIMENSIONS

a. You should know how to deal with displacement and velocity vectors so you can:

i. Relate velocity, displacement, and time for motion with constant velocity.

ii. Calculate the component of a vector along a specified axis, or resolve a vector into components along two specified mutually perpendicular axes.

iii. Add vectors in order to find the net displacement of a particle that undergoes successive straight line displacements.

iv. Subtract displacement vectors in order to find the location of one particle relative to another, or calculate the average velocity of a particle.

v. Add or subtract velocity vectors in order to calculate the velocity change or average acceleration of a particle, or the velocity of one particle relative to another.

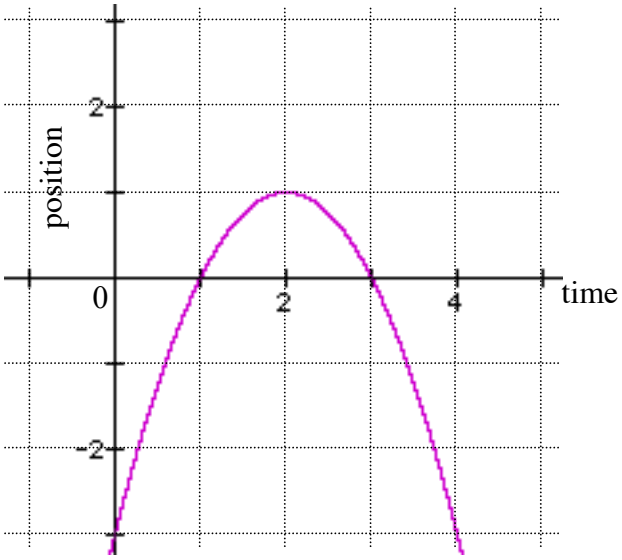
b. You should understand the motion of projectiles in a uniform gravitational field so you can:

i. Write down expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch or identify graphs of these components.

ii. Use these expressions in analyzing the motion of a projectile that is projected above level ground with a specified initial velocity.

GRAPHICAL ANALYSIS of MOTION

1. The figure below is a graph of the position (y) vs. time (x) for a particle confined to one-dimensional motion.



(i) At time t = 0, what is the sign of the particle's position?

Is the particle's velocity positive, negative, or zero at
(ii) t = 1 s
(iii) t = 2 s
(iv) t = 3 s?
(v) How many times does the particle go through the point x = 0?

2. At t = 0, a particle moving along the x axis is at position X_0 = -20 m. The signs of the particle's initial velocity v_0 (at time t_0) and constant acceleration, a are, respectively, for four situations:

(1) +, + (2) +, - (3) -, + (4) -, -

In which situation or situations will the particle
(i) Undergo a momentary stop
(ii) Definitely pass through the origin (given enough time)
(iii) Definitely not pass through the origin?

3. The initial and final velocities, respectively, of a particle in four situations are:

(i) v_o = 2 m/s, v_f = 3 m/s (ii) v_o = - 2 m/s, v_f = 3 m/;
(iii) v_o = - 2 m/s, v_f = - 3 m/s (iv) v_o = 2 m/s, v_f = - 3 m/s

The magnitude of the particle's constant acceleration is the same in all four situations. Rank the situations according to the magnitude of the particle's displacement, greatest first, during the change from initial to final velocity.

PROCEDURE for SOLVING PROBLEMS INVOLVING KINEMATICS

The kinematic equations of motion may be used to solve any problem in one dimensional motion with constant acceleration. The best way to gain confidence in the use of these equations is to work a number of problems. Many times you will discover that there is more than one method for solving a given problem.

To be successful in a physics course it is necessary to be able to solve problems.
The following procedure should prove helpful in solving the physics problems assigned.
First, as a preliminary step, read the appropriate topic in the textbook.
Do not attempt to solve the problems before doing this.
Look at the appropriate illustrative examples to see how they are solved.
With this background, now read the assigned problem.
Now continue with the following procedure.

1. Draw a small picture showing the details of the problem. This is very useful so that you do not lose sight of the problem that you are trying to solve.
2. List all the information that you are given.
3. List all the answers you are expected to find.
4. From the summary of important equations, list the equations that are appropriate to this topic.
5. Pick the equation that relates the variables that you are given.
6. Place a check mark over each variable that is given and a question mark over each variable that you are looking for.
7. Solve the equation for the unknown variable on the LHS of the equation.
8. Plug in the known variables.
9. Compute the answer.
10. When the answer is obtained, check to see if the answer is reasonable.

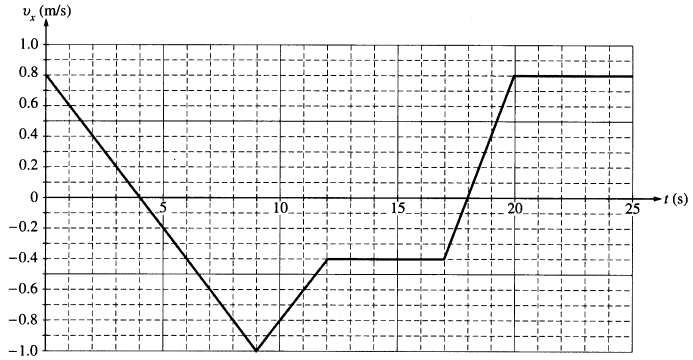
Problem-Solving Strategy Accelerated Motion

The following procedure is recommended for solving problems involving accelerated motion:

1. Make sure all the units in the problem are consistent. That is, if distance is measured in meters, be sure that velocities have units of meters per second and accelerations have units of meters per second per second.
2. Chose a coordinate system.
3. Make a list of all the quantities given in the problem and a separate list of those to be determined.
4. Select from the list of kinematic equations the one or ones that will enable you to determine the unknowns.
5. Construct an appropriate motion diagram, and check to see if your answers are consistent with the diagram.

1) Free Response Problem 1

A 1.50 kg cart moves on a straight horizontal track. The graph of velocity *v* versus time *t* for the cart is given below.

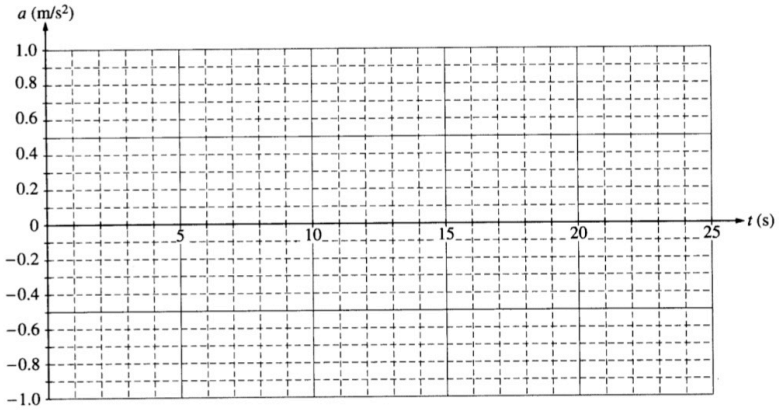


a. Indicate every time t for which the cart is at rest.

b. Indicate every time interval for which the speed (magnitude of velocity) of the cart is increasing.

c. Determine the horizontal position x of the cart at t = 9.0 s if the cart is located at x = 2.0 m at t = 0.

d. On the axes below, sketch the acceleration a versus time t graph for the motion of the cart from t = 0 to t = 25 s.



e. From t = 25 s until the cart reaches the end of the track, the cart continues with constant horizontal velocity. The cart leaves the end of the track and hits the floor, which is 0.40 m below the track. Neglecting air resistance, determine each of the following:

i. The time from when the cart leaves the track until it first hits the floor

ii. The horizontal distance from the end of the track to the point at which the cart first hits the floor

iii. The kinetic energy of the cart immediately before it hits the floor