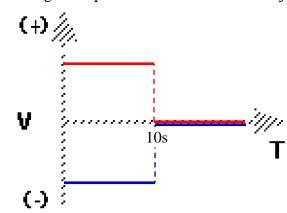## Unit 2 Kinematics Worksheet 1:
Position vs. Time and Velocity vs. Time Graphs

Sketch velocity vs. time graphs corresponding to the following descriptions of the motion of an object:

1. The object moves toward the origin at a steady speed for 10s, then stands still for 10s.
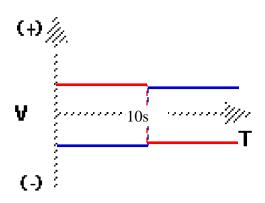
   There are 2 possibilities:
   a) (in red) object moves toward origin in positive direction so it starts on negative side of origin
   b) (in blue) object moves toward origin in negative direction so it starts on positive side of origin
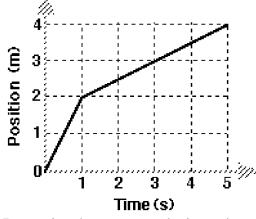
2. The object moves away from the origin at a steady speed for 10s, reverses direction and moves back toward the origin at the same speed.
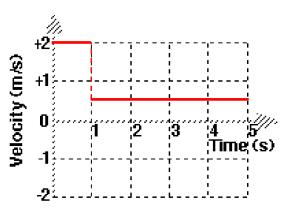
   There are 2 possibilities:
   a) (in red) object moves away from origin in positive direction, then back in negative direction
   b) (in blue) object moves away from origin in negative direction

3. a) Draw the velocity vs. time graph for an object whose motion produced the position vs time graph shown below at left.
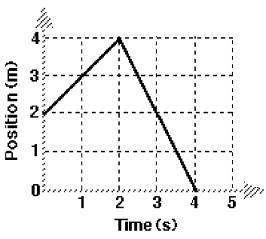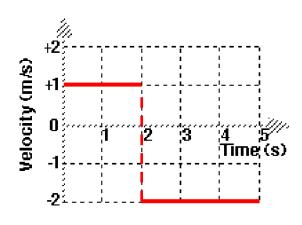
   b) Determine the average velocity and average speed for the entire trip.

$$\vec{v}_{av} = \frac{\Delta \vec{x}}{t} = \frac{x - x_0}{5} = \frac{4}{5} = 0.8 m/s \qquad s_{av} = \frac{d}{t} = \frac{4}{5} = 0.8 m/s$$

4. a) Draw the velocity vs. time graph for an object whose motion produced the position vs time graph shown below at left.

b) Determine the average velocity and average speed for the entire trip

$$\vec{v}_{av} = \frac{\Delta \vec{x}}{t} = \frac{x - x_0}{4} = \frac{-2}{4} = -0.5 m/s \qquad\qquad s_{av} = \frac{d}{t} = \frac{6}{4} = 1.5 m/s$$
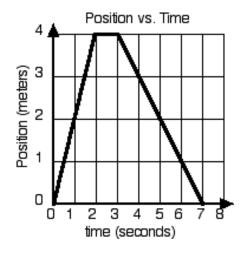
5. For many graphs, both the **slope** of the plot and the **area** between the plot and the axes have physical meanings.

    a. What does the slope of a position time graph tell you about the motion of an object?

    It is the average velocity over the interval of time the slope is taken

    b. Looking at the velocity time graphs (Questions 4 and 5), determine the units for a square of area on the graph.

    units of the area under v-t curve are (m/s) x (s) = m

    c. What quantity does the area under the velocity-time graph tell you about the motion of an object?

    Displacement

6. Describe the motion in words given the following position vs. time graph:

Position vs. Time

Verbal Description

- Starting at the origin, object moves in positive direction, at a constant speed of 2m/s for 2 seconds. At the end of 2s, object is at 4 m.
- It then stays still at 4 m for 1 s
- It then moves back to the origin, in neg direction at a slower speed of 1m/s for 4 s
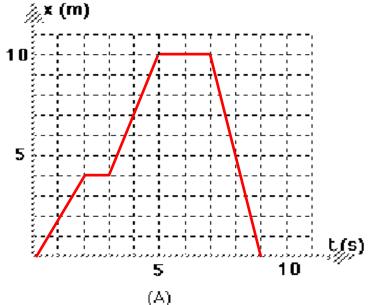
7. Given the following verbal description draw a position vs. time graph.

An object starts at 5 meters and moves to the left at constant speed for 3 seconds. The object stops for 2 seconds and then continues in the same direction and speed as before for 2 more seconds. The object stops for 2 seconds and then moves to the right for 2 seconds at a greater speed.

Position vs. Time

5m

Position (meters)

2   4   6   8   10
time (seconds)

8. From the position vs. time data below, answer the following questions.

a. Construct a graph of position vs. time.
b. Construct a graph of velocity vs. time.

t (s)	x (m)
0	0
1	2
2	4
3	4
4	7
5	10
6	10
7	10
8	5
9	0

x (m)

10

5

5   10   t (s)

(A)

c. Determine the displacement from t = 3.0s to 5.0s. Check it by using graph A. using graph B.
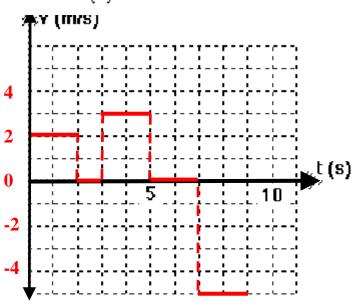
GraphB: Area under v-t =
$\Delta x = (3m/s)(2s) = 6m$

GraphA: $\Delta x = x_{5s} - x_{3s} = 10\text{-}4 = 6m$

d. Determine the displacement from t = 7.0 s to 9.0s using graph B. Check it by using graph A.

Area under v-t =
$\Delta x = (\text{-}5m/s)(2s) = \text{-}10m$

GraphA: $\Delta x = x_{9s} - x_{7s} = 0\text{-}10 = \text{-}10m$

Y (m/s)

4

2

0   5   10   t (s)

-2

-4

(B)
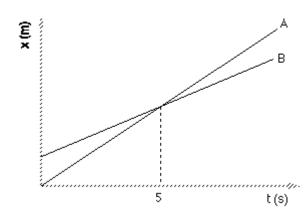
e. Determine the average <u>velocity</u> from t = 0 s to 9.0 s.

$$\bar{v} = \frac{\Delta x}{t} = 0$$

f. Determine the average <u>speed</u> from t = 0 s to 9.0 s.

$$\bar{s} = \frac{20}{9} = 2.2 m/s$$

9. Consider the position vs. time graph at at left for cyclists A and B.
a. Do the cyclists start at the same point? How do you know? If not, which is ahead?

No, they do not have the same y-axis intercept. B starts ahead of A.

b. At t= 7s, which cyclist is ahead? How do you know?

At 7 s, A is ahead since A's position is farther away from the start or origin.

c. Which cyclist is traveling faster at 3s? How do you know?

At 3 s, A is traveling faster since the slope of line A is steeper
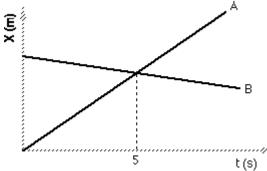
d. Are their velocities equal at any time? How do you know?

Their velocities are NEVER equal, The velocity is represented by the slope of the x-t curve,. Since the 2 plots have entirely different and constant slopes, the velocities are distinct

e. What is happening at the intersection of lines A and B?

Runner A and B are in the same place at the same time

10. Consider the position vs. time graph below for cyclists A and B.

a. How does the motion of the cyclist A in this graph compare to that of A in the previous graph?
Motion of A is similar to the last graph

b. How does the motion of cyclist B in this graph compare to that of B in the previous graph on page one?
Motion of B is in the opposite direction

c. Which cyclist has the greater speed? How do you know?
  A has greater speed since the curve is steeper

d. Describe what is happening at the intersection of lines A and B.
    Runner A and B are in the same place at the same time

 e. Which cyclist has traveled further during the first 5 seconds? How do you know?

    Runner A has traveled farther since the difference between A's final and initial positions
    (displacement) is greater than that of B