Graphs

A graph is the best way of discovering or exhibiting a functional relationship between two sets of measurable quantities, and should always be drawn when a relationship is expected or sought. The table of data contains the primary data, but it is difficult to perceive any generalities (such as proportionality) from a table. The graph and the table compliment each other.

First, what you regard as the dependent variable should be plotted as ordinate (vertical axis) and the independent variable should be plotted as abscissa (horizontal axis). There is some variation in what is regarded as the independent variable (the mathematical notation is easily invertible), but in a presentation of experimental results it is almost always the variable which is easier to decide the values to investigate. In the relationship between the period of a pendulum and its length, it is much easier to select various lengths and then measure the period associated with each length. So length is almost always selected to be the independent variable. Can you visualize the problem with selecting a period of 2.0 seconds and then trying to determine the length of pendulum that will have that period?

The scales should always start at the lower left comer, at the point (0,0). There is sometimes a good reason for doing otherwise, but none of the good reasons will exist this year.

Graphs should be as large as possible. A graph is too small if it uses less than 50 percent of the horizontal and vertical space allotted. The data points must show. This means two things: you should be able to notice the point at a glance at the same time you accurately position it. The best way to accomplish this is to make a small dot with a sharp pencil, and then surround it with a small circle, triangle, square, etc.

In connecting the points you have plotted, you should draw a graph which best represents the way you think nature is behaving. Draw your graphs intelligently. The best graph does not necessarily pass through every experimental point. A graph which simply connects dot to dot to dot is not an intelligent graph. You should also label the axes, giving the quantity plotted and its units, and give the graph a title (Distance traveled versus Elapsed time, for example).

Graphing Exercises

1) Using your TI calculator, plot each of the following graphs on the same set of axes. In 'Window' set x from -1 to 10 and y from -1 to 10. When done, print the graph and include it with your report.
   (a) y = x
   (b) y = 2x
   (c) y = 0.5x
   (d) y = x+3

   Each of the above graphs should plot as a straight line.

   Calculate the slope of each straight line using 'Calc' and $\frac{dy}{dx}$

   Estimate each y-intercept using 'Trace'. What characteristic do (a), (b), and (c) have that (d) does not?

2) Plot both of the following graphs on the same set of axes. Plot from x = 0 to x = 6 and y = 0 to y = 6.

   (a) $y = x^2$

   (b) $y = 3x^2$

   These are both called quadratic equations. What characteristic do both of these graphs have in common with (a), (b), and (c) in problem 1?

3) Plot each of the following graphs from x = 0 to x = 8. Plot (c) and (d) on the same set of axes.

   (a) $y = x^3$

   (b) $y = 2\sqrt{x}$

   (c) $y = 12/x$

   (d) $y = \frac{12}{x^2}$

   Graphs (c) and (d) are different from I (a), (b), (c) and 2 (a), (b) in two major ways. What are the two ways?

4) All of the above graphs have been plotted values of y versus the corresponding values of x. This is the most common way of plotting graphs, but there are occasionally good reasons for doing something different. The following graphs illustrate the sort of thing we will want to do several times this year. The graphs should be plotted so the range of values of x go from 0 to 10 and y go from 0 to 10.

   (a) $y = 0.5x^2$ Plot values of y versus corresponding values of x^2.

   (b) $y = 2x^3$ Plot values of y versus corresponding values of x^3.

   (c) $y = 4\sqrt{x}$ Plot values of y versus corresponding values of $\sqrt{x}$.

   (d) $y = \frac{12}{x}$ Plot values of y versus corresponding values of $\frac{1}{x}$.

   If you have plotted correctly, you will find that each of these graphs form straight lines that pass through the origin.

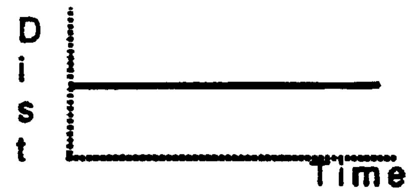
Name ______________________

Lab Partner(s) ______________________

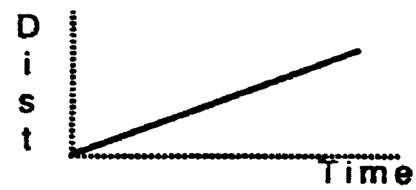
HOMEWORK: INTRODUCTION TO MOTION
Distance(Position)=Time Graphs

Answer the following questions in the spaces provided.

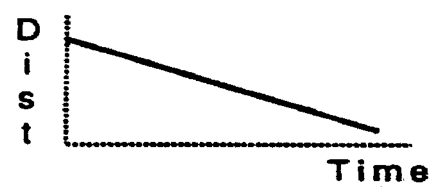
1. What do you do to create a horizontal line on a distance-time graph?



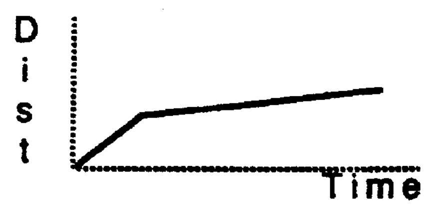
2. How do you walk to create a straight line that slopes up?



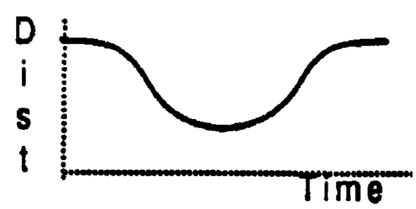
3. How do you walk to create a straight line that slopes down?



4. How do you move so the graph goes up steeply at first, and then continues up gradually?



5. How do you walk to create a U-shaped graph?



Answer the following about two objects, A and B , whose motion produced the following distance (position) -time graphs.

6. a) Which object is moving faster–A or B? _____

b) Which starts ahead? _____
Define what you mean by "ahead."
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c) What does the intersection mean?
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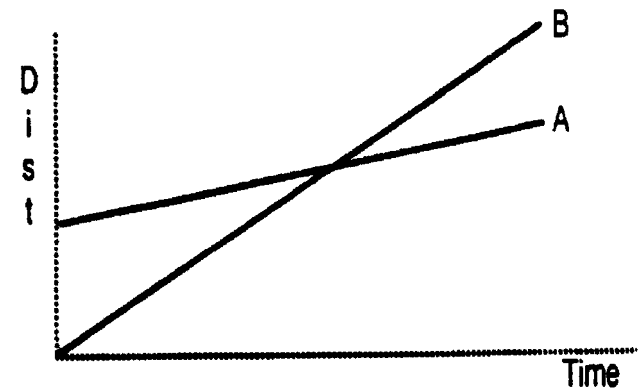
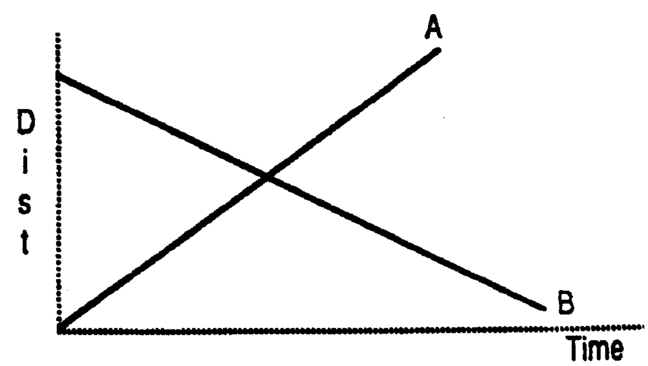
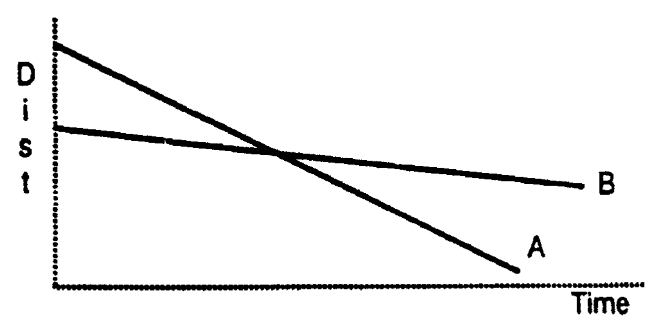


7. a) Which object is moving faster? _____

b) Which object has a negative velocity according to the convention we have established? _____

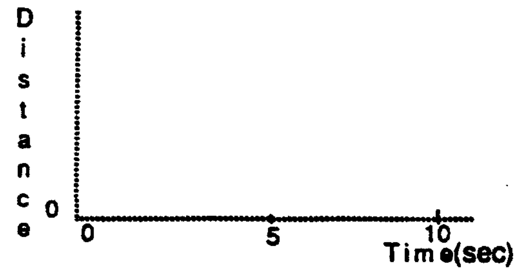


8. a) Which object is moving faster? _____
b) Which starts ahead? _____
Explain what you mean by "ahead."
____
____
____

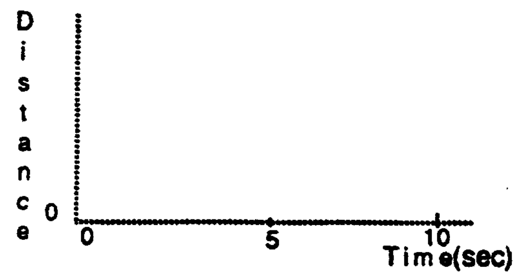


Sketch the distance (position)-time graph corresponding to each of the following descriptions of the motion of an object.

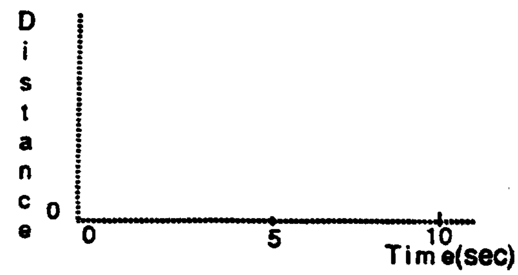
9. The object moves with a steady (constant) velocity away from the origin.



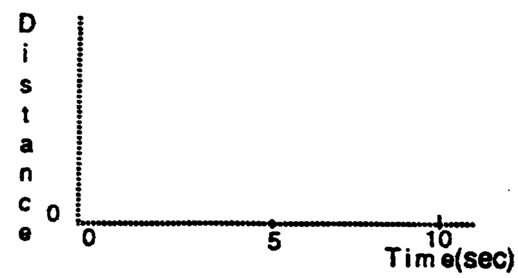
10. The object is standing still.



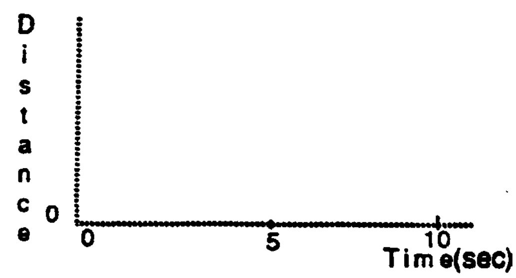
11. The object moves with a steady (constant) velocity toward the origin for 5 seconds and then stands still for 5 seconds



12. The object moves with a steady velocity away from the origin for 5 seconds, then reverses direction and moves at the same speed toward the origin for 5 seconds.



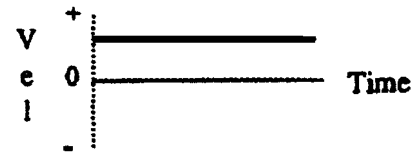
13. The object moves away from the origin, starting slowly and speeding up.



Velocity-Time Graphs

After studying the velocity-time graphs you have made, answer the following questions:

1. How do you move to create a horizontal line in the positive part of a velocity-time graph?



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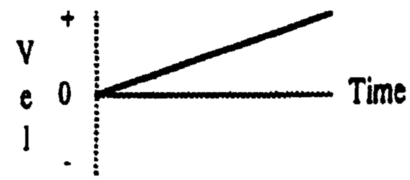
2. How do you move to create a straight-line velocity-time graph that slopes up from zero?



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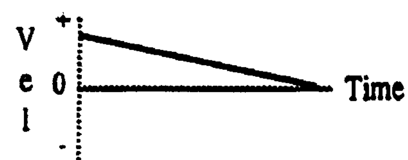
3. How do you move to create a straight-line velocity-time graph that slopes down?



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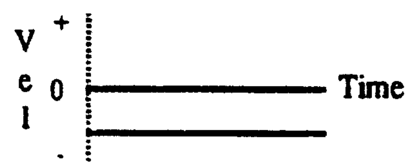
4. How do you move to make a horizontal line in the negative part of a velocity-time graph?



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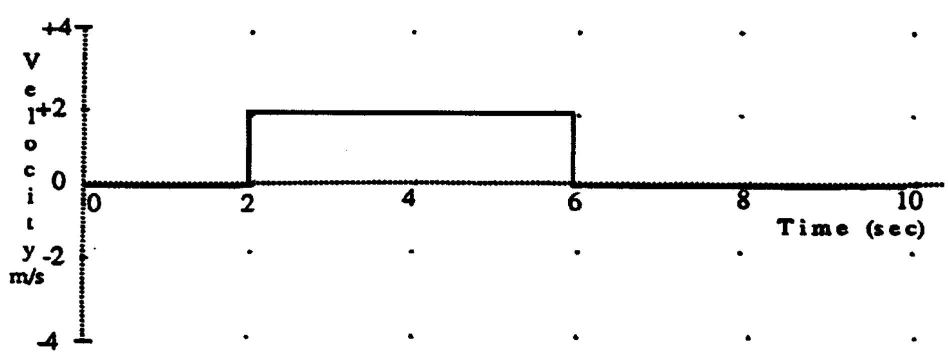
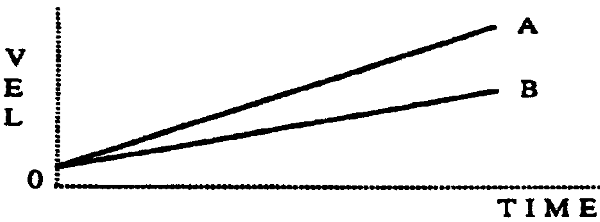
5. The velocity-time graph of an object is shown below. Figure out the total *distance* traveled by the object. Show your work. Distance = ____________ meters.



6. Both of the velocity graphs below, 1 and 2, show the motion of two objects, A and B. Answer the following questions separately for 1 and for 2. Explain your answers when necessary.

a) Is one faster than the other? If so, which one is faster? (A or B)
b) What does the intersection mean?
c) Can one tell which object is "ahead"? (define "ahead")
d) Does either object A or B reverse direction? Explain.

1



a) ______________________
b) ______________________
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c) ______________________
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____
d) ______________________
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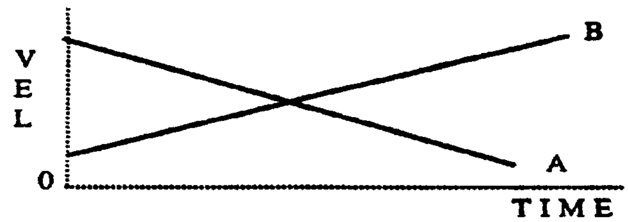
2



a) ______________________
b) ______________________
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c) ______________________
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d) ______________________
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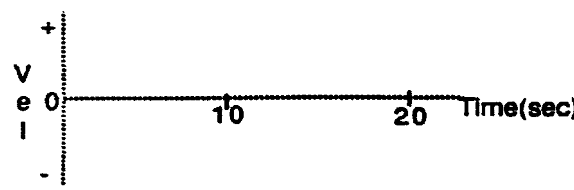
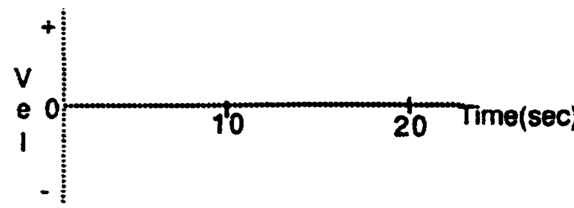
Sketch the velocity-time graph corresponding to each of the following descriptions of the motion of an object.

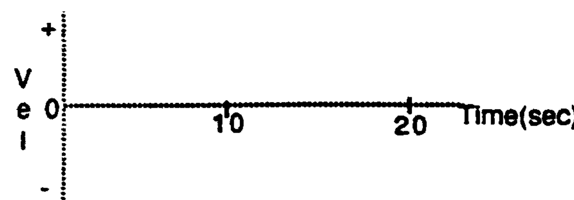
7. The object is moving away from the origin at a steady (constant) velocity.



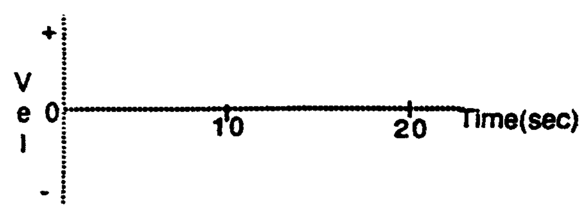
8. The object is standing still.



9. The object moves toward the origin at a steady (constant) velocity for 10 seconds, and then stands still for 10 seconds.

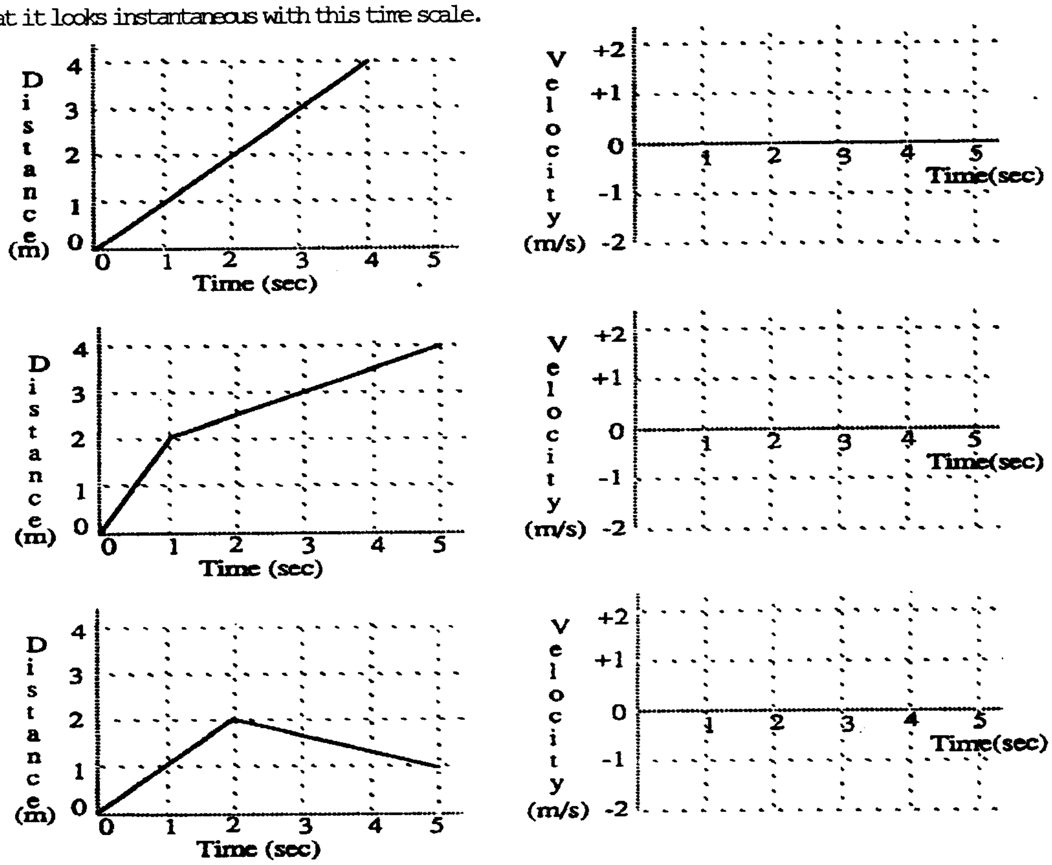


10. The object moves away from the origin at a steady (constant) velocity for 10 seconds, reverses direction and moves back toward the origin at the same speed for 10 seconds.



11. Draw the velocity graphs for an object whose motion produced the distance–time graphs shown below on the left. Distance is in meters and velocity in meters per second. (That is, the velocity is the number of meters the object would move in one second.)

Note: Unlike most real objects, you can assume these objects can change velocity so quickly that it looks instantaneous with this time scale.



12. Draw careful graphs below of distance and velocity for a cart that–

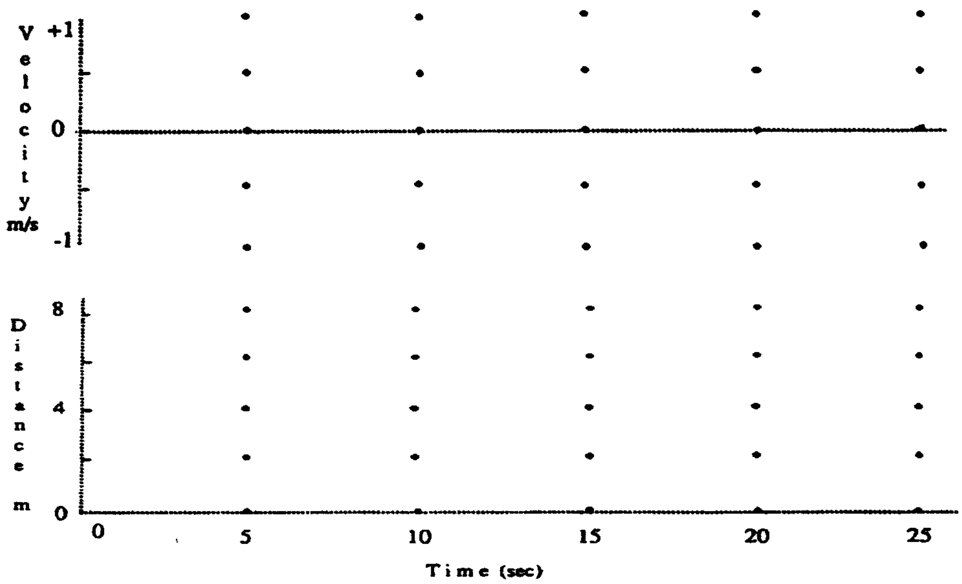
a moves away from the origin at a slow and *steady* (constant) velocity for the first 5 seconds.

b moves away at a medium-fast, steady (constant) velocity for the next 5 seconds.

c stands still for the next 5 seconds.

d moves toward the origin at a slow and *steady* (constant) velocity for the next 5 seconds.

e stands still for the last 5 seconds.



Comment

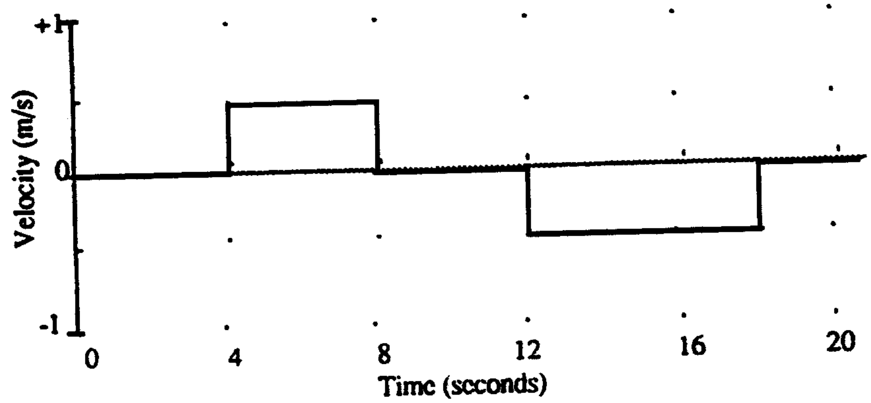
How fast you move is your speed, the rate of change of distance with respect to time. Velocity implies both speed and *direction*. As you have seen, for motion along a line (the positive x axis) the sign (+ or −) of the velocity indicates the direction. If you move away from the detector (origin), your velocity is positive, and if you move toward the detector, your velocity is negative.

The faster you move *away* from the origin, the larger positive number your velocity is. The faster you move *toward* the origin, the "larger' negative number your velocity is. That is −4 m/s is twice as fast as −2 m/s and both motions are toward the origin.

Activity 2 Matching a Velocity Graph

In this activity, you will move to match a velocity graph shown on the computer screen.

1. Display the velocity graph on the screen. Pull down the File Menu and select Open, Then double click on Velocity Match. The velocity graph below will appear on the screen.



2. Move so as to imitate this graph. You may try a number of times. Work as a team and plan your movements. Get the times right. Get the velocities right. Each person should take a turn.

   Draw in your group's best match on the axes above.

Questions

Describe how you moved to match each part of the graph.

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Is it possible for an object to move so that it produces an absolutely vertical line on a velocity time graph? Explain.

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