Name: ___________________________________

Partner(s): ________________________________

1114 section: _______

Desk # _____________

Date: _________________

One Dimensional Motion

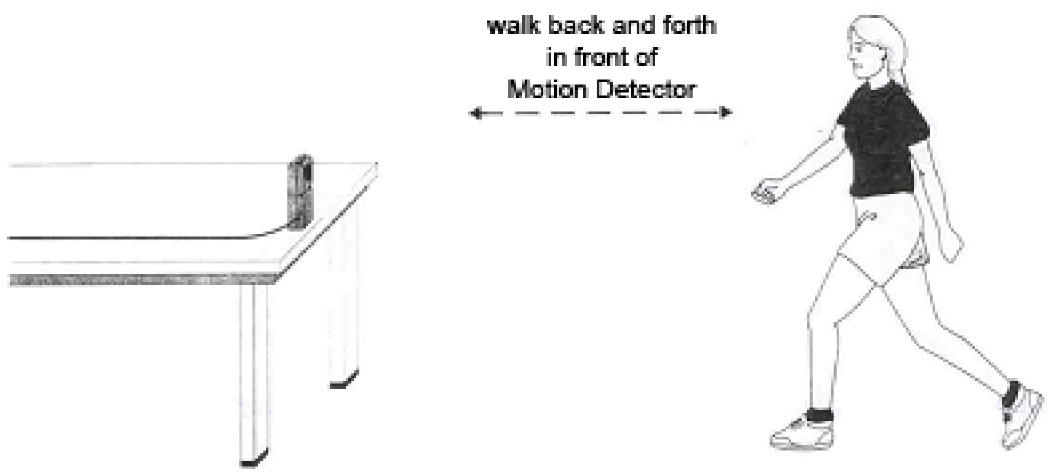
This lab is due at the end of the laboratory period.

Purpose

1) Analyze the motion of a student walking across the room.
2) Predict, sketch and test position vs. time kinematics graphs.
3) Predict, sketch and test velocity vs. time kinematics graphs.

Introduction and Theory

One of the most effective methods of describing motion is to plot graphs of position, velocity and acceleration vs. time. From such graphs, it is possible to determine in what direction an object is going, how fast it is moving, how far it has traveled and whether it is speeding up or slowing down. In this experiment, you will familiarize yourself with these graphs, by plotting the real-time graphs of your motion as you move across the lab room with a motion detector.



The motion detector detects the position of an object in front of it. It does so by sending out high frequency sound pulses and measuring the time it takes for the pulses to bounce back from the object. The computer then determines the distance of the object to the detector, or the object's position, from the round-trip time and the speed of sound. The computer program then uses the change in position to calculate the object's velocity and acceleration. All of this information can be displayed either as a table or a graph. A qualitative analysis of the graphs of your motion will help you understand the concepts of kinematics: position, velocity and acceleration.

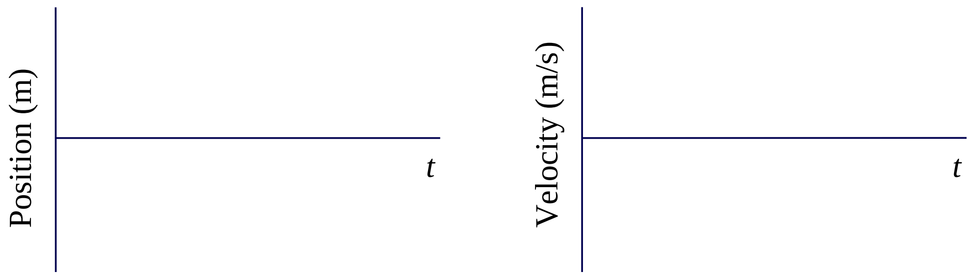
One important thing about this motion detector: it can only measure distances between 0.5 m to 3.5 m.

Preliminary Questions

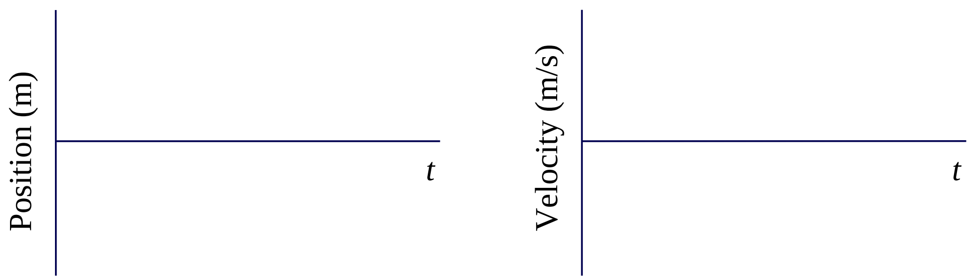
Sketch the position vs. time graph (position graph) and velocity vs. time graph (velocity graph) for each of the following situations. Note that “moving in the positive direction” means the position gets more positive (less negative), but the position values may be negative themselves.

(Your sketches do not need to be exact, but should show the basic features of the motion.)

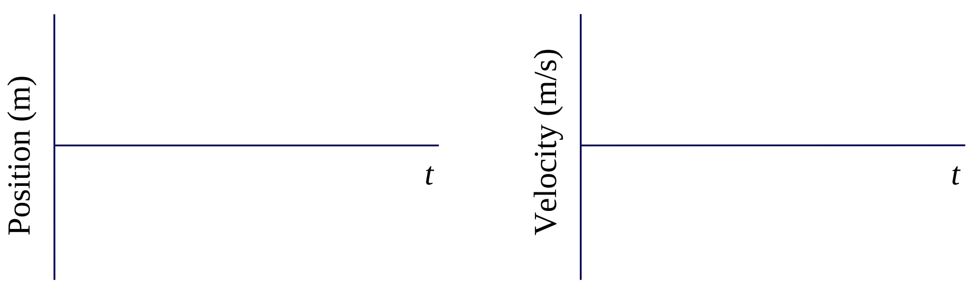
(1) an object staying at rest, whose position is 1.0 m:



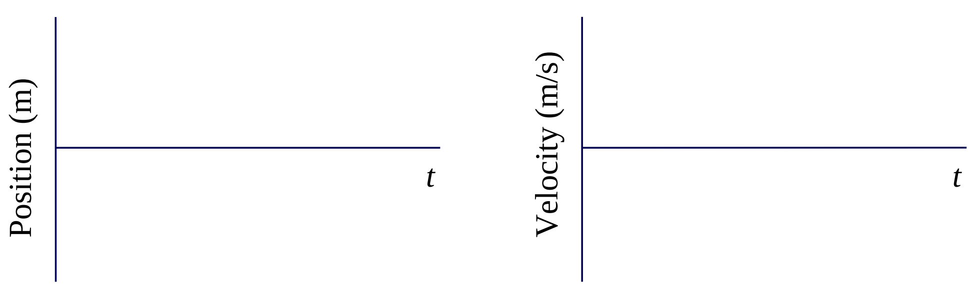
(2) an object moving in the positive direction at a constant speed, passing the origin at $t = 0$:



(3) an object moving in the negative direction at a constant speed, whose position is 2.0 m when $t = 0$:



(4) an object moving in the positive direction, starting from rest at origin and accelerating:



Apparatus Computer, motion detector, Vernier interface box, meter stick

Data

Note: to describe a motion, you should give your direction of movement (move away or toward the detector), your speed (fast, slow, or at rest) and how your speed changes (increasing, decreasing, or constant).

To describe a graph, you should state whether it is a straight line or a curve, and where the line is drawn. For straight lines, state whether the slope is positive (angled up), negative (angled down), or zero (flat), and whether the straight line is steep or not.

Part 1: Preliminary Experiments

(1) Plug the motion detector into the DIGI/Sonic 1 channel on the Vernier interface box. Place it on the desk, so that it points toward an open space 3 to 4m long.

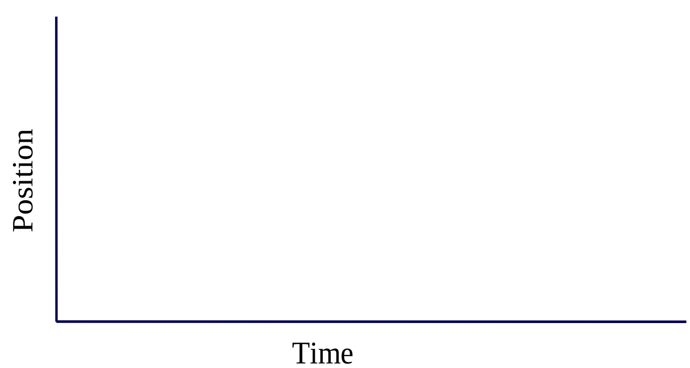
(2) Turn on the computer and start the LoggerPro program. The program will automatically determine that the motion detector is attached, and will display 2 graphs on the screen: position vs. time and velocity vs. time. We do NOT want these graphs. Open the file: *_Physics with Vernier\01a Graph Matching.cmbl.* This file will display one position vs. time graph.

(3) Use the motion detector to graph your positions as you walk slowly away from the detector with constant velocity. To do this, stand about 1m from the motion detector and have your lab partner start the data collection by pressing the <Collect> button. Walk slowly and steadily away from the motion detector until you are between 3 and 4m away.

(4) In the space below, predict what the position vs. time graph will look like if
(4a) you walk *slowly* and steadily *toward* the motion detector, starting from 3 m away:

(4b) you walk *fast* and steadily *away* from the motion detector, starting from 0.5 m away:

Get all partners to move in front of the motion detector to check the predictions above. Then, in the space below, draw and label 3 lines for: situation (3), situation (4a) and (4b).



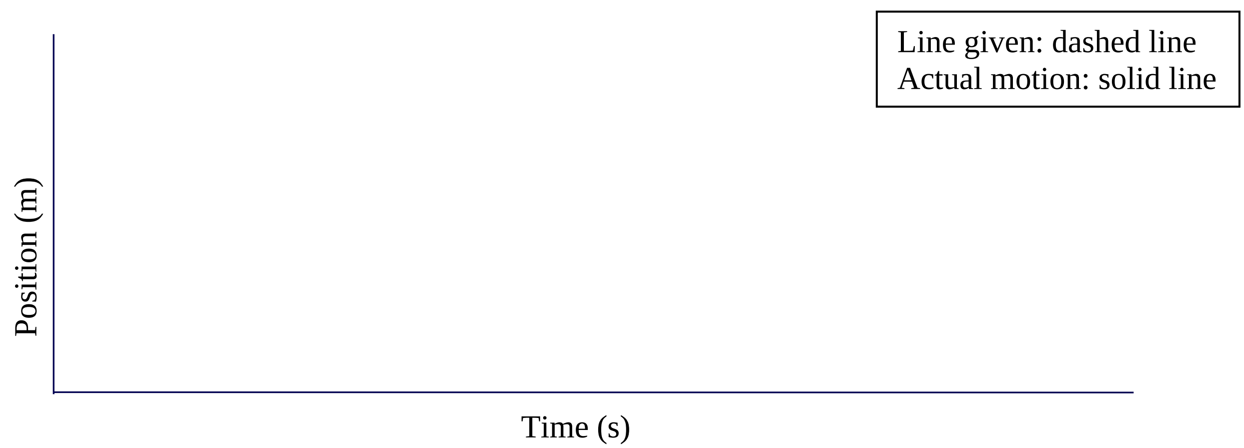
Part 2: Position vs. Time Graph Matching

(1) In this section, you will try to match the motion described by the computer on a position vs. time graph. Open the file *_Physics with Vernier\01b Graph Matching.cmbl*. (Do not save any changes for the previous file.)

(2) In the space below, sketch the given graph with a dashed line. Be sure to include scale numbers on both axes.

(3) On each segment of the graph, predict in words how you would walk for this segment, remember to give the direction, the speed and how the speed changes.

(4) Now test your prediction. Choose a starting position. Have your partner start data collection. Move based on your prediction so that the graph of your motion matches the target graph on the computer screen. You may have to walk backwards, facing the computer screen, to do this. If you were not successful, repeat the process until your motion closely matches the graph on the screen. On the same sketch, draw a solid line to represent your best match.



(5) Repeat above steps with *_Physics with Vernier\01c Graph Matching.cmbl* except this time, you do not need to sketch the graph.

Describe the motion based on a position vs time graph:

When the slope of a position vs. time graph is zero, then the object is ____________________________.

When the slope is constant but not zero, the object is ____.

When the slope is positive, the object is ____.

When the slope is negative, the object is ____.

When the slope is steep, the object is ____.

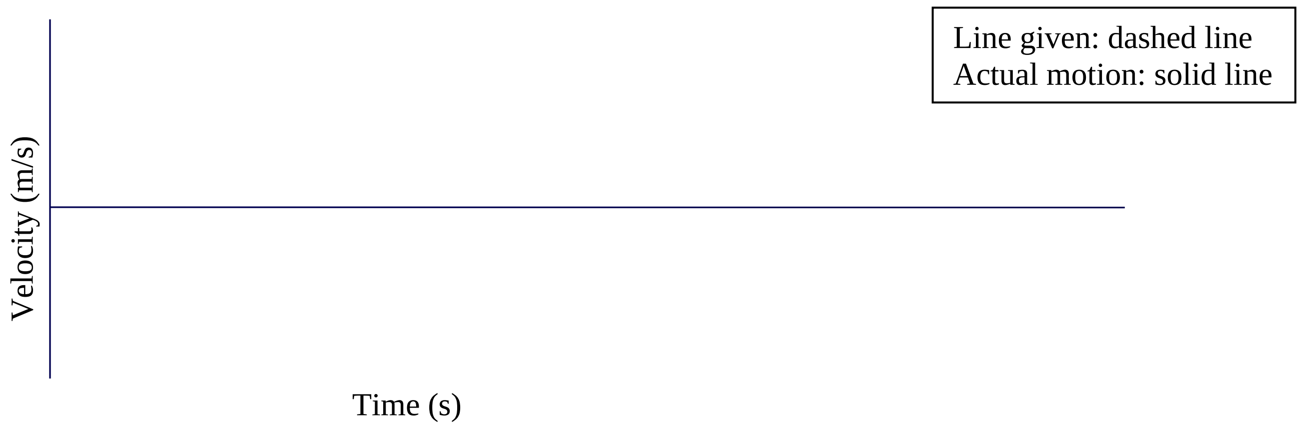
When the slope is not so steep, the object is ____.

To summarize, the slope of the position vs. time graph is the _______________ of the motion.

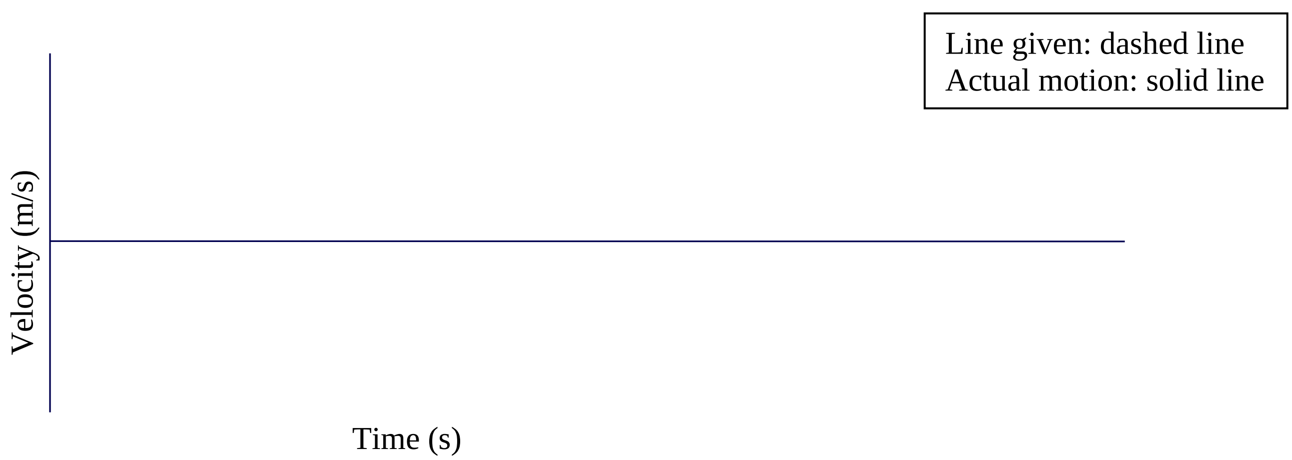
Part III: Velocity vs. Time Graph Matching

(1) Open the graph overlay file *01d Graph Matching.cmbl*. You will see a velocity graph. In the space below, sketch the *01d Graph Matching.cmbl* graph with a dashed line, including scale numbers on the axes. Describe on the graph how you would walk to produce this target graph, for the time period 0—2s, 2—5s, 5—7s and 7—10s.

(2) To test your prediction, walk in such a way that the graph of your motion matches the target graph on the screen. Note that it will be more difficult (impossible?) to match the velocity graph than it was to match the position graph. Sketch, with a solid line, your best fitting run.



(3) Repeat steps (1) and (2) for the file *01e Graph Matching.cmbl*: make a sketch of *01e Graph Matching.cmbl* in the space below and predict the motion for the time period 0—4s, 4—5s, 5—8s and 8—10s.



Answer following questions:

(1) Is it possible to tell your starting and ending positions from a velocity vs. time graph?

Yes No

(2) Is it possible to tell how far you move from the starting to the ending position from a velocity vs. time graph?

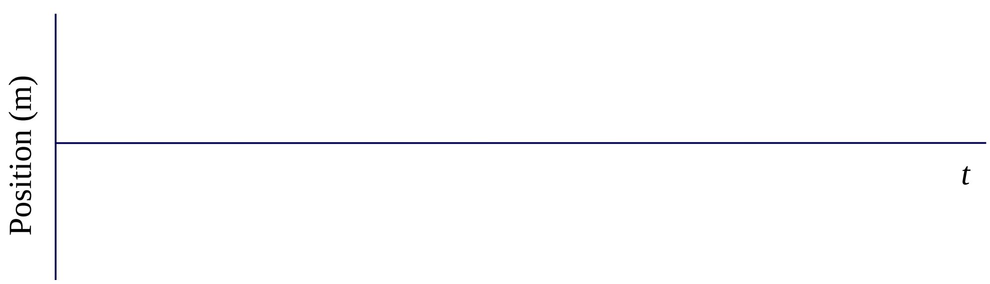
Yes No

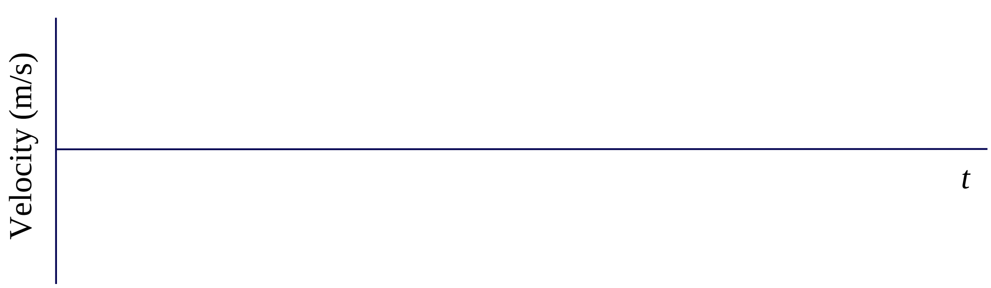
(3) On a velocity vs. time graph, what does the area between the velocity line and the time axis represent?

(4) On a velocity vs. time graph, what does the slope represent?

(5) As a final review/test of this lab, graph this motion: A student started by standing still at 3 m away from the motion detector. After 1 second, he moved toward the motion detector at a constant speed, ending 1m away from the detector at $t = 5$ s. He stopped for 3 seconds. At $t = 8$ s, he moved away from the detector, starting from rest, and moved faster and faster till $t = 10$ s.

Draw his motion between 0 and 10 seconds in the space below. You may draw either graph first.





Exit LoggerPro with *File...Exit*. Shut down the computer. You're done!