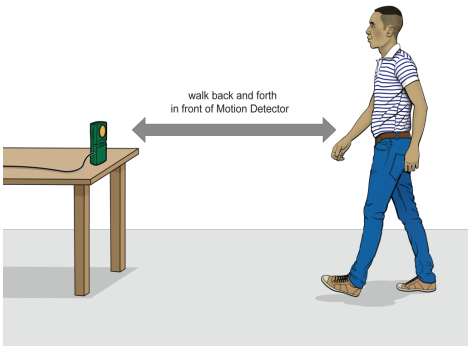
Computer 1

Graph Matching

One of the most effective methods of describing motion is to plot graphs of position, velocity, and acceleration *vs*. time. From such a graphical representation, it is possible to determine in what direction an object is going, how fast it is moving, how far it traveled, and whether it is speeding up or slowing down. In this experiment, you will use a Motion Detector to determine this information by plotting a real-time graph of *your* motion as you move across the classroom. The Motion Detector measures the time it takes for a high-frequency sound pulse to travel from the detector to an object and back. Using this round-trip time and the speed of sound, the interface can determine the distance to the object; that is, its position. It can then use the change in position to calculate the object's velocity and acceleration. All of this information can be displayed in a graph. A qualitative analysis of the graphs of your motion will help you develop an understanding of the concepts of kinematics.



LEARNING TARGETS: I CAN...

- analyze the motion of a student walking across the room.
- predict, sketch, and test position *vs*. time kinematics graphs.
- predict, sketch, and test velocity *vs*. time kinematics graphs.

PRELIMINARY QUESTIONS

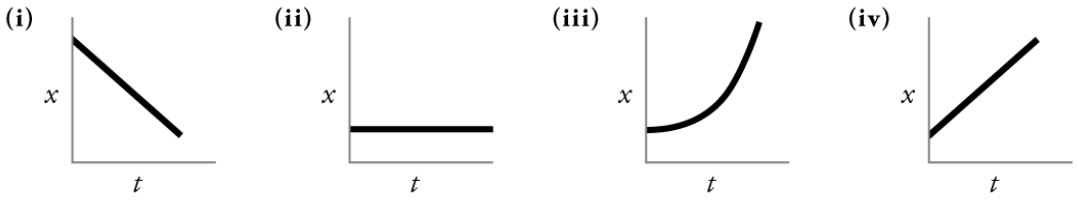
1. Below are four position *vs*. time graphs labeled (i) through (iv). Identify which graph corresponds to each of the following situations and explain why you chose that graph.

   a. An object at rest

   b. An object moving in the positive direction with a constant speed

   c. An object moving in the negative direction with a constant speed

   d. An object that is accelerating in the positive direction, starting from rest



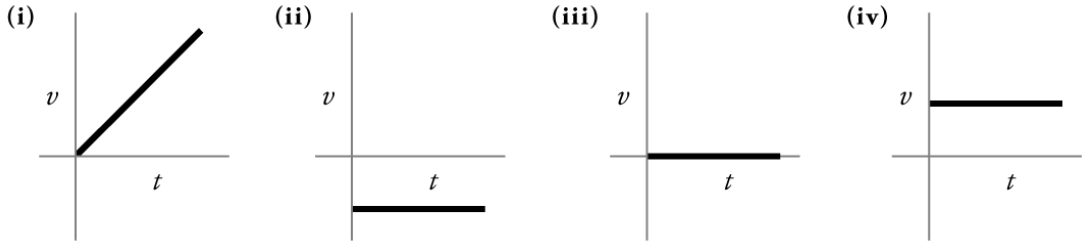
2. Below are four velocity *vs*. time graphs labeled (i) through (iv). Identify which graph corresponds to each of the following situations. Explain why you chose that graph.

   a. An object at rest

   b. An object moving in the positive direction with a constant speed

   c. An object moving in the negative direction with a constant speed

   d. An object that is accelerating in the positive direction, starting from rest



Name:_____ ***Block:***_____

GRAPH MATCHING LAB

Part I Preliminary Experiments

1. Connect the Motion Detector to a USB port of the computer. Set the sensitivity switch to Ball/Walk.

2. Place the Motion Detector so that it points toward an open space at least 3 m long. Use short strips of masking tape on the floor to mark the 1 m, 2 m, and 3 m positions from the Motion Detector.

3. Open Logger Pro then from the File menu open the file "01a Graph Matching" from the *Physics with Vernier* folder. Monitor the position readings. Move back and forth and confirm that the values make sense.

4. Use Logger *Pro* to produce a graph of your motion when you walk away from the detector with constant velocity. To do this, stand about 1 m from the Motion Detector and have your lab partner click ▸ Collect. Walk slowly away from the Motion Detector when you hear it begin to click.

5. Examine the graph. In the margin of this page sketch a prediction of what the position *vs.* time graph will look like if you walk faster. Check your prediction with the Motion Detector.

Part II Position *vs.* Time Graph Matching

6. Open the experiment file "01b Graph Matching." A position *vs*. time graph with a target graph is displayed.

7. Describe in general how you would walk to produce this target graph:

8. To test your prediction, choose a starting position and stand at that point. Click ▸ Collect to start data collection. When you hear the Motion Detector begin to click, walk in such a way that the graph of your motion matches the target graph on the computer screen.

9. If you were not successful, repeat the process until your motion closely matches the graph on the screen. Using the papers your teacher gives you, sketch the graph with your best attempt showing both the target graph and your motion data.

10. Open the experiment file "01c Graph Matching." A new target graph is displayed. Repeat Steps 7–9 using the new target graph.

11. Read the Analysis questions for Part II at the end, but delay answering them until after you finish Part III**.**

Part III Velocity *vs.* Time Graph Matching

12. Open the experiment file "01d Graph Matching." A <u>velocity</u> *vs*. time graph is displayed.

13. Describe generally how you would walk to produce this target graph:

14. To test your prediction, choose a starting position and stand at that point. Click ▸ Collect to start data collection. When you hear the Motion Detector begin to click, walk in such a way

that the graph of your motion matches the target graph on the screen. It will be more difficult to match the velocity graph than the position graph. Repeat the process until your motion closely matches the graph on the screen. Using the papers your teacher gives you, sketch the graph with your best attempt showing both the target graph and your motion data.

15. Open the experiment file "01e Graph Matching." A new target graph is displayed. Repeat Steps 13–14 using the new target graph.

16. Remove the masking tape from the floor. Then proceed to the Analysis questions. You may not be able to finish these today, but make the attempt.

ANALYSIS

Part II Position *vs.* Time Graph Matching

1. How did you walk in order to match the position-time graphs?

2. Explain the significance of the slope of a position *vs*. time graph. Include a discussion of positive and negative slope.

3. What specific type of motion is occurring when the slope of a position *vs*. time graph is zero?

4. What specific type of motion is occurring when the slope of a position *vs*. time graph is constant?

5. What specific type of motion is occurring when the slope of a position *vs*. time graph is changing?

Part III Velocity *vs.* Time Graph Matching

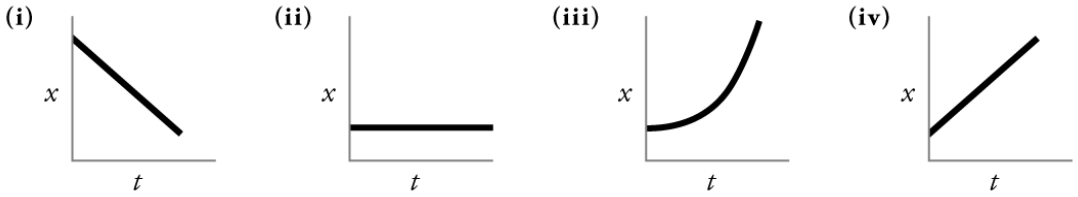
6. How did you walk in order to match the velocity-time graphs?

7. What specific type of motion is occurring when the slope of a velocity *vs*. time graph is zero?

8. What specific type of motion is occurring when the slope of a velocity *vs*. time graph is not zero?

9. Below are four position *vs*. time graphs labeled (i) through (iv). Identify which graph corresponds to each of the following situations and explain why you chose that graph.

   e. An object at rest
   f. An object moving in the positive direction with a constant speed
   g. An object moving in the negative direction with a constant speed
   h. An object that is accelerating in the positive direction, starting from rest



10. Below are four velocity *vs*. time graphs labeled (i) through (iv). Identify which graph corresponds to each of the following situations. Explain why you chose that graph.

   e. An object at rest
   f. An object moving in the positive direction with a constant speed
   g. An object moving in the negative direction with a constant speed
   h. An object that is accelerating in the positive direction, starting from rest