Position vs. Time – Understanding Motion

Fall 2023

Name: _____

Partners:

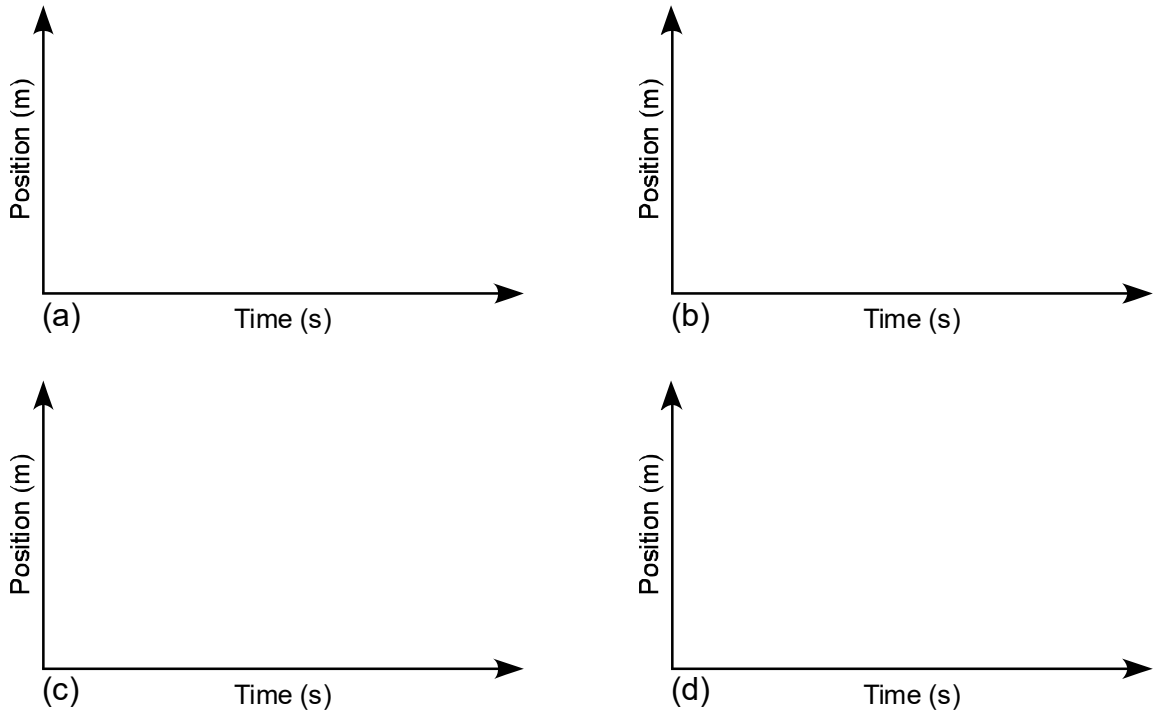
Introduction

We can understand position as a function of time with the aid of a motion sensor attached to a computer. In this experiment, you will observe the relationship between the motion of an object and a graph of position vs. time for the object. *You* will be the object in motion! The goal of this experiment is to use the motion of your body to understand the difference between a *constant velocity* (moving at a steady rate) and *acceleration* (moving at a changing rate). **WRITE YOUR ANSWERS IN COMPLETE SENTENCES AND DIRECTLY ON THESE INSTRUCTIONS**. **EACH PERSON IN YOUR GROUP WILL HAND IN THEIR OWN COPY OF THIS EXPERIMENT**.

The apparatus consists of a *Vernier© Motion Detector* (a device which emits and receives sound waves) connected to a computer via a *Vernier© LabPro* interface. The computer will be running experiments created in *Logger Pro*. During each experiment, you will see various target graphs of position as a function of time. As you move away from or towards the motion detector, a plot of your movements will appear on the screen. The goal is to try to match the graph of your motion to the one you see in the target graph.

Preliminary Questions

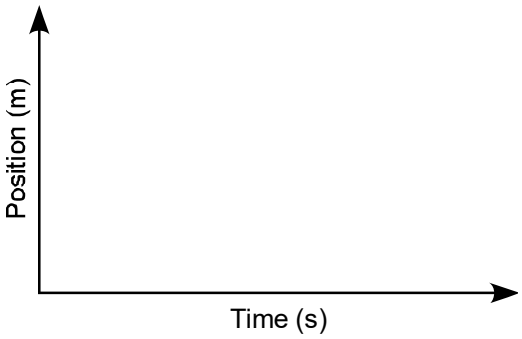
1. Coordinate axes for position vs. time graphs appear below. In the axes provided, sketch a graph for each of the following situations:
    a. An object at rest 1-meter away from the motion detector
    b. An object moving away from a motion detector with a constant velocity
    c. An object moving toward a motion detector with a constant velocity
    d. An object that is accelerating (*increasing velocity*) away from a motion detector, starting from rest
2. **Label each line you drew '*Predicted*'.**



Experiment

Part I: Preliminary Experiments

1. Begin by clicking the "Logger Pro" icon (at right) that appears on the task bar.
2. All the experiment files are found on the *Teaching Drive (T:)* in the "PHYS103" folder. Open *Position and Time 1*. A blank position vs. time graph will appear.
3. Using Logger Pro you will now produce a graph of position vs. time for your motion when you walk away from the motion detector with a constant velocity. To do this, stand about 1 *m* away from the motion detector and have your lab partner click the **Collect** button. Data collection will begin, and automatically stop after 10 seconds. Walk <u>slowly</u> away from the motion detector at a constant rate when you hear it begin to click (move slowly enough so that the motion detector sees you for the entire 10 seconds.)
4. Sketch this run in the axes at right and label the run '*walking slowly*'.
5. Click on the *Experiment* menu, and choose *Store Latest Run*. This will keep the run you just made on the screen when you try another.
6. Sketch in the axes at right what the position vs. time graph will look like if you walk quickly at a constant rate (faster than before); label this run '*walking fast*'. Check your prediction with the motion detector: repeat step 3, this time moving away faster.
7. Describe the difference between the two lines on your graph. <u>Explain</u> why the lines are different.

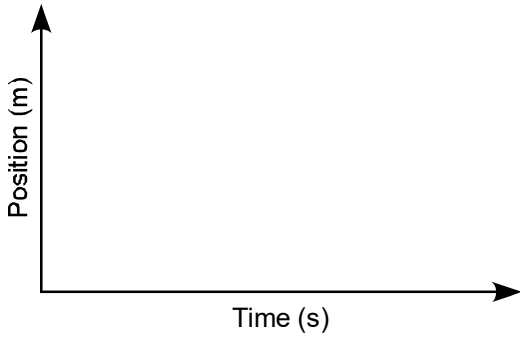


8. Move as indicated in the *Preliminary Questions* section (1a – 1d) by walking in front of the motion detector. Sketch your <u>actual</u> motion on the same graphs (on page 1), labeling each as 'actual'.
9. ***How well did your predictions (step 1a – 1d) match with your actual motion (step 8)?***

Part II: Position vs. Time Graph Matching

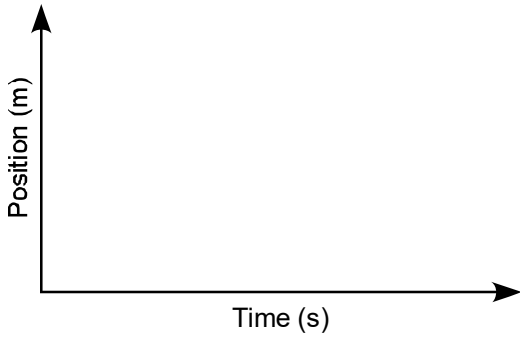
10. Open experiment file *Position and Time 2* from the *T: drive* (you don't need to save the previous graphs). A position vs. time graph will appear containing the motion to be matched. In the space below, sketch the <u>target</u> graph, and describe how you would move to produce this motion: specify your direction (towards or away) and motion (was your velocity increasing, decreasing or constant?), the approximate distance covered (in meters), and the approximate time (in seconds) to cover each distance interval.

My Score: _____ Partner's Score: _____



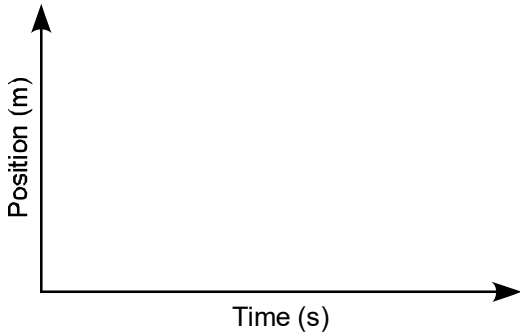
11. To test your prediction, choose a starting position and stand at that point. Start data collection by having your partner click the **Collect** button. When you hear the motion detector begin to click, walk in such a way that the graph of your motion matches the target graph on the computer screen. Your score will appear on the screen in the box next to *RMSE*: the lower the number, the better your motion matched the target graph.
12. If you were not successful (or you wish to improve your score), repeat the process until your motion closely matches the graph on the screen (*if you repeat, you needn't keep your previous run; it will disappear when you click the **Collect** button*). Record your best score, and that of your lab partners, next to the graph.
13. Open the experiment file *Position and Time 3* from the *T: drive*. Repeat steps 10 through 12.

My Score: _____ Partner's Score: _____

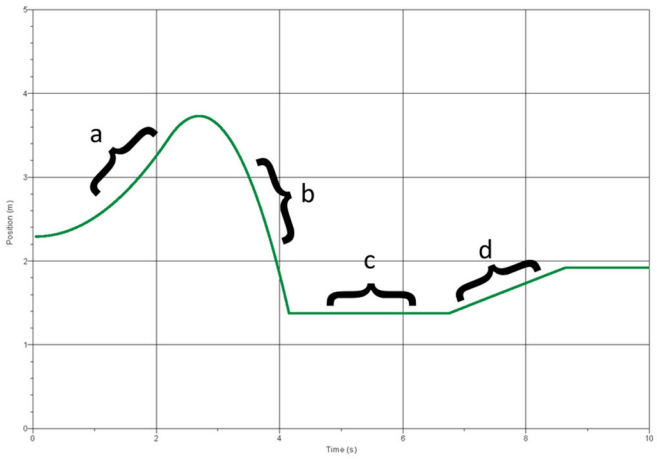


14. Open the experiment file *Position and Time 4* from the *T: drive*. Again, repeat steps 10 through 12.

My Score: _____ Partner's Score: _____



15. Open the experiment file *Position and Time 5* from the *T: drive*. This target graph, drawn below, will test the motion skills you have just acquired. Choose the terms from the "Direction" and "Rate" columns below to describe your motion for each section indicated (*a* through *d*). Do your best to match the target graph motion. Which member of your group received the best score?



Direction	Rate
Towards	Accelerating – speeding up
Away	Accelerating – slowing down
Standing still	Constant velocity
	Stopped (zero velocity)

Section	Direction	Rate
a		
b		
c		
d		

My Score: _____ Partner's Score: _____