POSITION, DISTANCE, AND DISPLACEMENT

What is the difference between distance, position, and displacement?

Objectives

- Experience motion as a change of position.
- Interpret a position versus time graph.
- Learn the difference between position, distance, and displacement and be able to apply that knowledge.

Materials and Equipment

- Data collection system
- Wireless Motion Sensor
- Object to hold (textbook etc. (optional)
- Rod stand for motion sensor (optional)

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Make sure you have at least 2 meters of clear space in front of the motion sensor to avoid tripping or bumping into things while walking backwards.

Procedure

1. Connect the wireless motion sensor to the data collection system and then create a graph display of Position on the *y*-axis with Time on the *x*-axis.

2. Place the motion sensor on a table or rod stand such that you have at least two meters of clear space in front of the sensor and the face of the sensor is level with your midsection.

3. Position yourself approximately 40 cm in front of the motion sensor. You may want to hold a book or binder in front of you as a better target for the sensor.

4. Have your lab partner start recording a run of data.

5. Stand completely still for 2 seconds, and then carefully move backwards as smoothly as possible (away from the motion sensor) for a few seconds.

6. Stand still for 2 more seconds, and then have your lab partner stop recording data.

7. Sketch your graph of Position versus Time on Graph 1 in the Data Collection section.

8. Annotate your graph in the Data Collection section with descriptions of your motion at different parts of data collection.

9. Find your initial and final positions and write them on your graph. Label the initial position as X_1 and your final position X_2.

10. Position yourself approximately 40 cm in front of the motion sensor. You may want to hold a book or binder in front of you as a more easily controlled target.

11. Have your lab partner start recording a run of data.

12. Carefully move backwards as smoothly as possible (away from the motion sensor) for a few seconds, then stand still for 2 seconds.

13. Carefully move approximately half way back toward the motion senor, and then have your lab partner stop recording data.

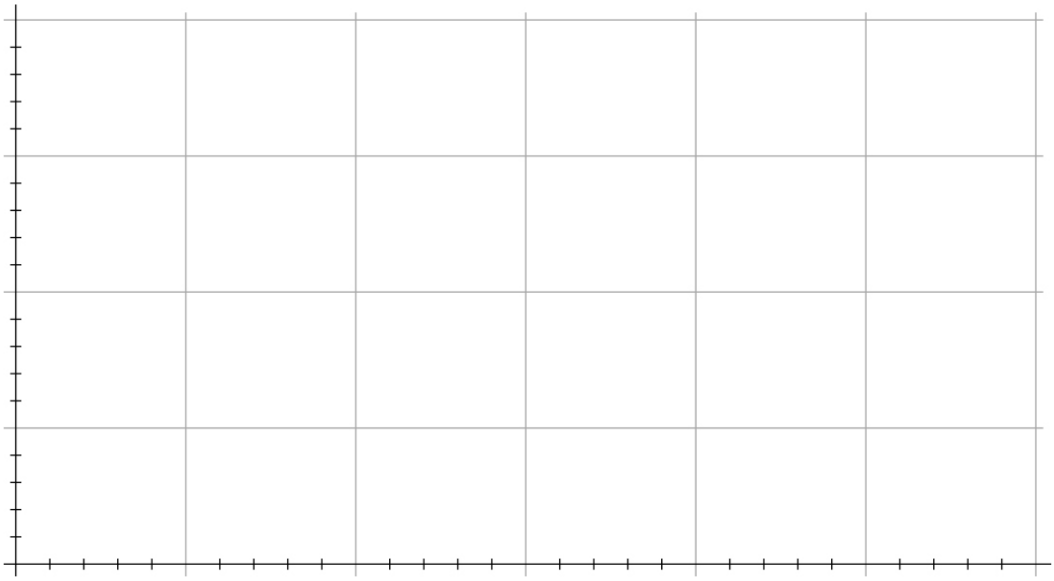
14. Sketch your graph of Position versus Time on Graph 1 in the Data Collection section. Use a different color or other method to distinguish it from your first graph.

15. Annotate your second graph on Graph 1 in the Data Collection section with descriptions of your motion at different parts of data collection.

16. Find your initial and final positions and write them on your graph. Label the initial position as X_1 and your final position X_2.

Data Collection

Graph 1: Position vs Time



Questions and Analysis

1. Position is your location relative to an origin. In this experiment the origin is the motion sensor and your position is what you graphed. Using your first graph, identify the value of your initial position and final position below.

2. The distance is the total distance you walked. It is like the odometer reading in a car, it is always increasing as the car travels in any direction. What was the distance walked when you made the first graph?

3. Using your second graph, identify the value of your initial position and final position below.

4. What was the largest position you reached when making your second graph? What was the distance walked when you made your second graph? How does it compare to the distance walked in the first graph?

5. The displacement, Δx, is the difference between your final position, X_2, and your initial position, X_1. The equation for displacement Δx is: $\Delta x = x_2 - x_1$

   Using this equation, find the displacement for your first graph.

6. Find the displacement for your second graph. How does it compare to the displacement of your first graph?

7. Another student repeats the experiment. They start 0.5 m from the motion sensor and walk 2.5 m away from the motion sensor and stop. What was their initial position? What was their final position? What was their distance? What was their displacement?

8. Another student repeats the experiment. They start 0.5 m from the motion sensor and walk 2.5 m away from the motion sensor, stop, then walk back 2 m toward the sensor. What was their initial position? What was their final position? What was their distance? What was their displacement? It might help to make a sketch of this position graph.