

Activity: Reading Graphs

Objective

Practice interpreting graphs and using the following graphing skills: graphing on x - y axes, determining maximum values from data trends, calculating and obtaining statistics, and determining changes in values (delta).

Materials and Equipment

- Data collection system
- Motion sensor
- Meter stick
- Pencils (2)

Procedure – Drawing Graphs

NOTE: Record all work, including tables, data, diagrams, and answers, into your notebook.

- 1. The data in Table 1 represents a person walking forward in a straight line. At time = 0.0 s, the person's position was 0.0 m.
- 2. In your notebook, draw a set of x - y axes. Title the graph "Graph 1" and then plot the data from Table 1 into Graph 1. Time is the independent variable (x -axis) and position is the dependent variable (y -axis).

NOTE: Be sure to label the axes with the measurement name and unit, and connect the data points with lines between them.

- 3. Look at Graph 1; what was the person's minimum position (the data point closest to the x -axis)?
- 4. What was the person's maximum position (the data point furthest from the x -axis)?
- 5. How much time passed when the person's position was between 0.5 m and 1.5 m?
- 6. Determine the person's average (mean) position: Add all of the position data points and then divide the sum by the total number of data points.
- 7. Copy Table 2 into your notebook. Use the position data in Table 1 and the equation below to calculate the person's velocity and enter your results into Table 2.

$$\text{Velocity} = \frac{\text{Change in position}}{\text{Change in time}} \left(\text{or } \frac{\Delta \text{Position}}{\Delta \text{Time}} \right)$$

NOTE: Change in position is the difference between two neighboring position values, and change in time is the difference between two neighboring time values. (A change in a value is commonly indicated by the delta symbol, Δ .)

- 8. In your notebook, draw a new set of x - y axes and plot the data from Table 2 into the graph. Title the graph "Graph 2."
- 9. What was the person's minimum and maximum velocity, and at what times did they occur?
- 10. What is the person's average velocity?

Table 1: Position–walking

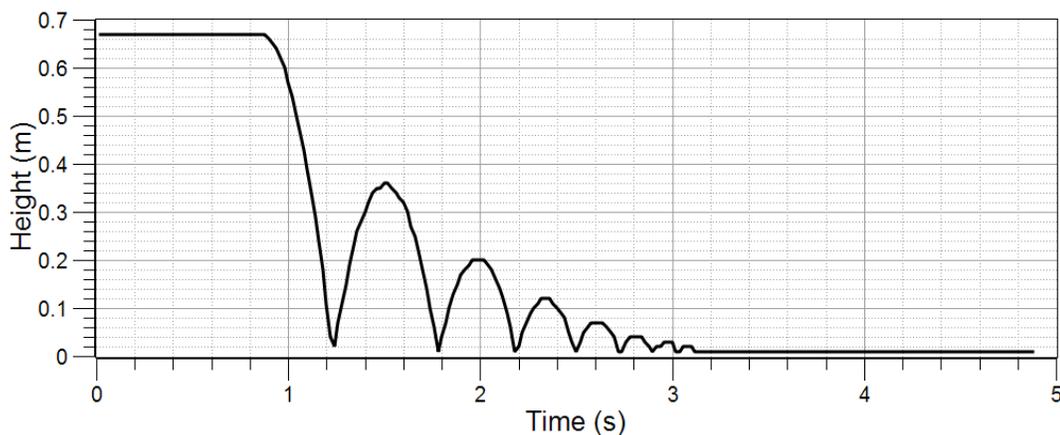
Position (m)	Time (s)
0.0	0.0
0.5	1.0
1.0	2.0
1.5	3.0
1.5	4.0

Table 2: Velocity–walking

Velocity (m/s)	Time (s)
RECORD	0.5
YOUR	1.5
ANSWERS IN YOUR	2.5
NOTEBOOK	3.5

Procedure – Reading Graphs

Graph 3: Height of a ball as it bounces vertically on the floor



Use Graph 3 to perform the next three steps. Use the instructions under each step as a guide.

- 11. Determine the height at which the ball was dropped and record the answer in your notebook.
 - a. Find the first section of the graph where the ball's height was not changing.
 - b. Determine the height, on the y-axis, corresponding to the data points in that region.
- 12. Determine the time it took the ball to stop bouncing once it was released. Record the answer in your notebook.
 - a. Find the data point where the ball stopped bouncing and determine the time, on the x-axis, of that data point.
 - b. Find the data point where the ball was dropped and determine the time of that data point.
 - c. Subtract the time at which the ball was dropped from the time at which it stopped bouncing.
- 13. Determine the maximum height of the ball during each of its 7 bounces. Record the results in your notebook.
 - a. Each bounce looks like a large bump in the graph. Find the data point at the very top of each bump.
 - b. Determine the corresponding height for each of those data points.

Procedure – Reading Electronic Graphs

NOTE: Record all work, including calculations and answers, into your notebook.

- 14. Start a new experiment on the data collection system $\diamond(1.2)$, connect the motion sensor to it $\diamond(2.1)$, show a graph of position versus time $\diamond(7.1.1)$, and then adjust the sample rate to 25 samples per second (25 Hz). $\diamond(5.1)$
- 15. Adjust the switch on the top of the motion sensor to the long range setting (stick figure) and then set the motion sensor on the edge of a table with the sensor pointing horizontally away from the table. Clear all objects from the floor within a straight line 4 meters from the sensor.
- 16. Prepare the area so one group member can walk toward and away from (walking backward) the sensor in a straight line, moving from 1 meter to 4 meters from the sensor, as another group member records data.
 - The person walking should be able to see the screen of the data collection system as they walk.
 - Place a pencil on the floor at 1 m and 4 m from the sensor.
- 17. Begin recording data with the person standing about 1 m away from the sensor. $\diamond(6.2)$ Have the person walking match their motion to this description:
 - a. Walk away from the sensor at a constant pace and stop at 4 m.
 - b. Stand still for a few seconds.
 - c. Walk back toward the sensor at a constant pace and stop at 1 m.
 - d. Stand still for a few seconds.
 - e. Walk quickly away from the sensor and stop at 4 m.
 - f. Walk quickly back toward the sensor and stop at 1 m.
 - g. Stand still for a few seconds.

- 18. Stop recording data. ♦(6.2)
- 19. The data collection system can display statistics like minimum, maximum, and average (mean) for the data in your new graph. Use this functionality to answer the following questions in your notebook. If you are not familiar with these functions, use the Tech Tips as a guide.
 - a. Determine the minimum, maximum, and average distance the person moved from the sensor during the entire trip. ♦(9.4)
 - b. Determine the minimum, maximum, and average position for the first trip away and back. ♦(9.4)
 - c. Determine the minimum, maximum, and average position for the second trip away and back. ♦(9.4) Was the average position the same for the first and second trip away and back?
 - d. Determine the time it took to make the first trip away and back. ♦(9.2)
 - e. Determine the time it took to make the second trip away and back. ♦(9.2) According to the graph, which took less time, the first trip or the second?
- 20. Complete the questions in the Challenge: Egg Drop handout for this activity.