Motion Plots: Guided Inquiry Lab

Overview

When you walk through a park or inside your home, your position and speed are changing constantly as you follow your path and avoid obstacles. In this investigation, you will examine your own motion and use graphs to keep track of your position and speed as a function of time. Likewise, you will explore the differences between position and displacement and between speed and velocity.

Focus on Science Practices

SEP 4 Analyze Data and Interpret Data
SEP 5 Use Mathematical and Computational Thinking

Materials Per Group

- Graphing paper
- Masking tape
- Metric tape or meter stick
- Motion detector
- Motion detector, data collection interface, and software
- Pencil (optional)
- Timer (optional)

Safety 

The materials in this lab are considered nonhazardous. Follow all laboratory safety guidelines. Wear safety glasses when performing this experiment.

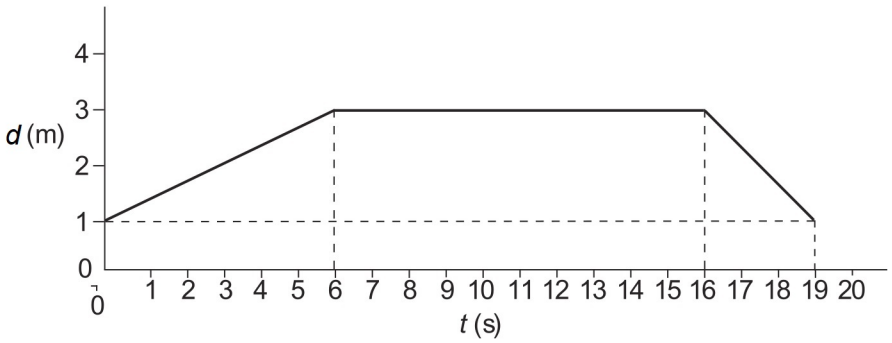
Procedure

1. Place a motion detector on the edge of a tabletop or flat surface, slightly above waist height. Remove potential sources of interference, such as chairs and desks, from the motion detector's path of emitted sound waves.
2. Use a ruler or meter stick to mark distance in one-meter increments from the edge of the table or motion detector. Place masking tape at each 1 m interval, up to 4 m.
3. Connect the motion detector to a computer interface. Select graph mode.
4. Stand in the path of the motion detector at the 1 m mark. Hold a book or other flat surface steady in front of your body to serve as a uniform deflector for the emitted sound waves. This will reduce noise in the motion graphs.
5. Begin collecting data.

6. Collect position vs. time (*d*–*t*) and speed vs. time (*v*–*t*) data for the following types of motion.
    a. Stand motionless at the 2 m mark for 10 seconds.
    b. Quickly walk away from the motion detector at a constant speed for 4 seconds.
    c. Quickly walk towards the motion detector at a constant speed for 2 seconds.
    d. Slowly walk towards the motion detector at a constant speed for 10 seconds.
7. Construct position vs. time (*d*–*t*) and speed vs. time (*v*–*t*) plots for the motions performed in step 6. Draw or insert a picture of all the plots.

8. Examine the position vs. time plot in Figure 1. Following the format in step 6, describe how a person would have to walk or move to generate this motion plot. Then recreate this **motion.**

Figure 1



9. Draw or insert a picture of the *d*–*t* plot obtained when you recreated the motion in Figure 1. Also, make the speed vs. time (*v*–*t*) plot that corresponds to this motion.

Analyze and Interpret

1. **SEP Analyze Data** What information can be found from the slopes of *d*–*t* and *v*–*t* graphs? How does the slope of a *d*–*t* graph relate to speed? Explain.

2. **SEP Construct an Explanation** Does the origin of a *d*–*t* graph always have to be at (0,0)?

3. **SEP Use Graphs** Displacement can be represented as a vector arrow that extends from the initial position to the final position reached by an object in motion. The arrowhead of the displacement vector points in the direction of the motion. Velocity is also a vector, and speed is velocity's magnitude. The magnitude of the velocity vector is proportional to its length. The vector's arrowhead points in the direction of the motion at any given time. Draw a diagram using vectors that indicates the displacement and velocity for each motion performed in step 6.