

Visualizing Motion with PASCO's Motion Sensor

Royal High School Physics, Fall 2007

Purpose

The purpose of this activity is to visualize motion with the PASCO motion sensor and to use the sensor to match graphs of position versus time using the student as the object in motion.

An important skill to have is to be able to look at a graph and to tell what it is communicating. An excellent way to get practice with this is to make your own graphs. Graphs are an excellent way to tell a lot of information without using a lot of words. We will look at some graphs of position versus time. If the position stays the same, we see a horizontal line on the graph. If the position changes, the line is tilted or curved, depending on how it changes over time. The change in position over time is referred to as "velocity" or "motion". We will ultimately investigate position, velocity, and acceleration and see how they are related to each other. However, we will stick to position for this exercise.

This activity meets State of Texas TEKS requirements from §112.42, IPC (c)(4)(A),(C); §112.47, Physics, including items (c)(4)(A), (C), and (E). <http://www.tea.state.tx.us/teks/>. More details about these and other national science education teaching standards can be found at websites such as <http://www.nsta.org/>

Equipment

The following will be needed to perform the experiment successfully.

- ◆ PASCO X-plorer GLX handheld data logger
- ◆ Digital adaptor for the datalogger
- ◆ Meter stick
- ◆ PASCO motion sensor
- ◆ Several sheets of graph paper
- ◆ Stopwatch or timer

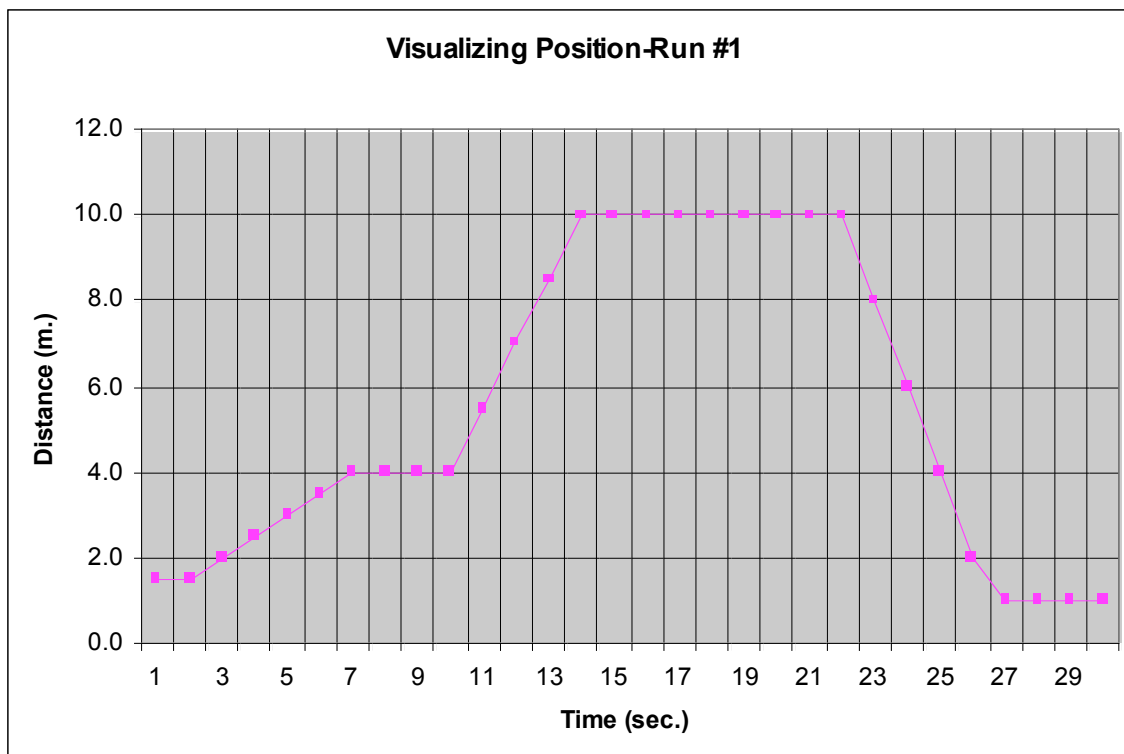
Procedure

The Motion Sensor works by putting out pulses of sound and converting the travel times to distance. It works with the knowledge of the speed of sound in air (331.4 m/sec.) and the fact that the round-trip travel time multiplied by this speed value divided by two gives the distance to an object. The object reflects the sound pulses back to the Motion Sensor which makes it possible to calculate the distance to the object. The device makes 10 measurements per second and usually plots these values on a distance versus time graph.

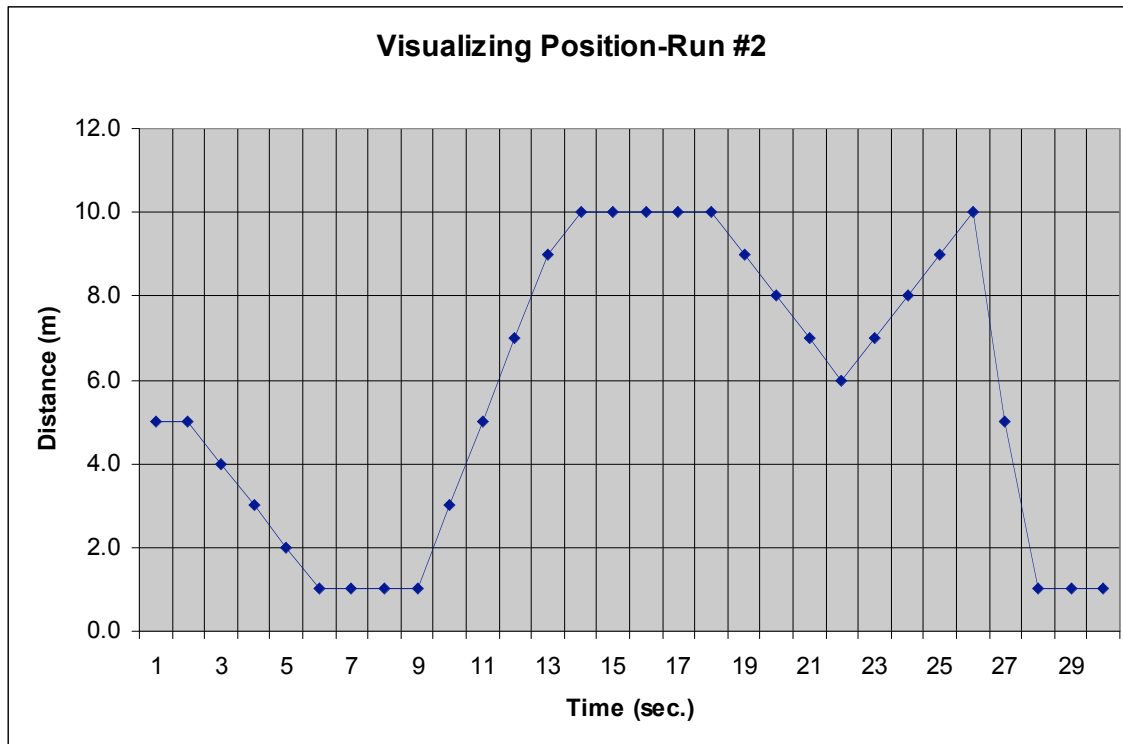
The software that works with the motion sensor can also calculate velocity by taking the differences between each consecutive reading of position and converting that to a velocity value. It can also display acceleration by taking the differences between consecutive velocity values. You will be studying the relationship between position, velocity and acceleration in class, but we will start with position in this exercise.

It may be helpful to play around with the motion sensor for a few minutes before starting this exercise. That way, you can get a feel for how it works and how changing your position changes the appearance of the graph (of distance versus time) as it is being plotted. Also, study the graphs, which both span 30 seconds, and plan how to move in order to match these graphs

Match graph #1 with your own motion, holding the motion sensor so that it points toward a wall (which will serve as the “object” which will reflect the sound waves, thus gauging your distance from the wall). It may be helpful to have someone time you with a stopwatch, calling out the time every five seconds (e.g. “5...10...15...20...”) so that you can maintain your pace with the graph. Compare your results with the actual plot below.



Repeat the procedure, now using Run #2 (below). Notice that this one is a bit more complicated and will necessitate quick moves on your part.



Finally, make similar graphs for each other to follow, using pencil and ruler and graph paper. Be challenging enough to make it interesting but be realistic as well (the motion sensor has a range of 11.0 meters, and people can run only so fast...). When you are finished with all this activity, answer the following questions (your teacher may have additional questions to go with these).

Results and Conclusions

1. Comment on how difficult, or easy, it was to match the graphs that were provided with this exercise and also by your classmates.

2. What was happening when the line was horizontal? Why?

