

Lesson Plan 6 – Motion Sensors

Background

The goal of this lesson is for students to experiment with motion sensors, their limitations, and how they can be used to determine position, velocity, and acceleration. The activity builds on the kinematics lessons that provided relationships between X , v and t .

Student Learning Objectives	NYS Standards
Students can graph position, velocity and acceleration as a function of time	
Students can use a data logger to measure and record X , v , a and down load information for additional analysis	
Students can estimate v from X vs. t graph and a from v vs. t graph	

Key Terms

Motion Sensor	Device that can detect and return the distance to the nearest object to it. Usually only works up to a certain distance threshold.
Position	The location of a given object with respect to a particular reference frame.
Velocity	The speed of an object in a specific direction.
Acceleration	The rate of change of velocity.
Data acquisition	The use of a sensor to measure and record data that can later be retrieve or viewed for data analysis and interpretation
Coordinate systems	X , Y , Z spatial coordinates measured from some datum and time (temporal) coordinate.

Activities

- Begin the lecture with a brief introduction to what we are doing that day. Explain that this lesson will provide hands on opportunities for students to apply the kinematic equations.
- Introduce the vocabulary/key terms that you will be using in the class, and have the students copy down the definitions, as they will be responsible for knowing and using the terms correctly.

- Set up motion sensor in corner of the room (follow instructions with sensor unit)
- Demonstrate the use of the motion sensors and describe their limitations. Such as, they can only detect motion in a straight line, so that means students must always walk in a straight line either towards or away from the sensor.
- Hand out the motion sensor activity, and have them work through it until the end of class. This class may run over so be aware of the time, if that is the case then give students time to finish up during the next class.
- Optional Homework to hand out to reinforce concepts

Supply list

- Activity Sheets
- Motion Sensors - Xplorer GLX Data Logger - (http://www.pasco.com/middle/physical/amusement_park.html) (see also instruction manual: <ftp://ftp.pasco.com/Support/Documents/english/PS/PS-2000/012-07784C.pdf>)

Activity - Motion Sensors

Purpose

The purpose of this activity is to familiarize you with describing and graphing position over time graphs through the use and experimentation of motion sensors.

Equipment

1. Motion Sensors (one for each group) (Xplorer GLX Data Logger)
2. Pencil

Procedure

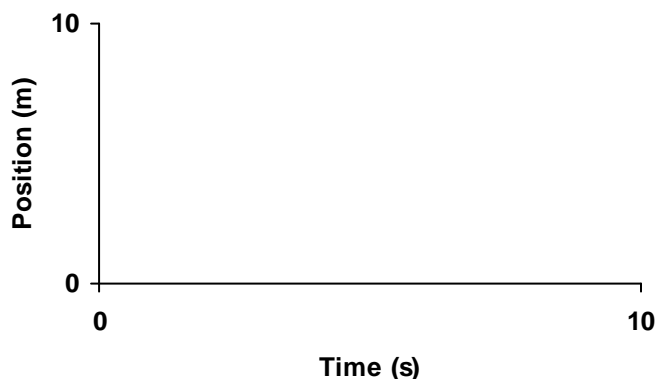
Part 1: Interpreting position graphs.

Using the motion sensor, have team members walk

- At various speeds along the straight line provided.
- Towards the sensor and away from the sensor at approximately the same speed

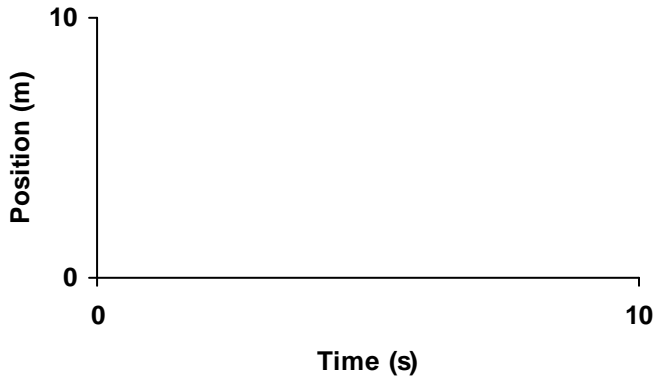
Copy the graphs that are displayed on the data logger onto the graphs below and describe your motion in words. (Copy the graph as precisely as possible, include more numbers as appropriate on the X and Y axes.

Sketch of graph:



Description of motion:

Sketch of graph:



Description of motion:

Sketch of graph:



Description of motion:

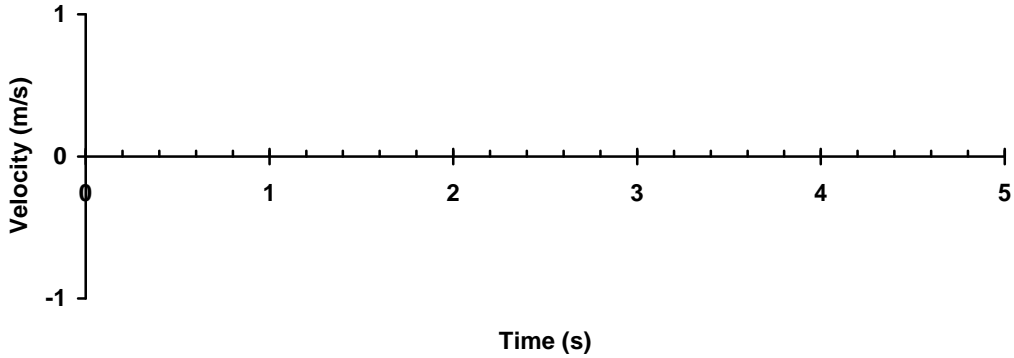
Describe the difference between the plot made by walking *away slowly* and the plot made by walking *away quickly*.

Describe the difference between the plots made by walking *towards* the sensor and the ones made by walking *away* from the motion sensor.

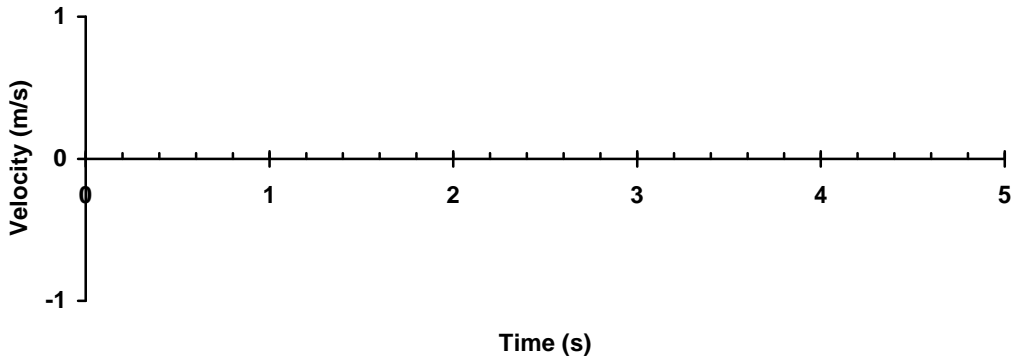
Estimate the velocity that you walk in each case based on the slope of the above position versus time graphs ($v = \Delta x / \Delta t$)

Part 2: Interpreting velocity graphs.

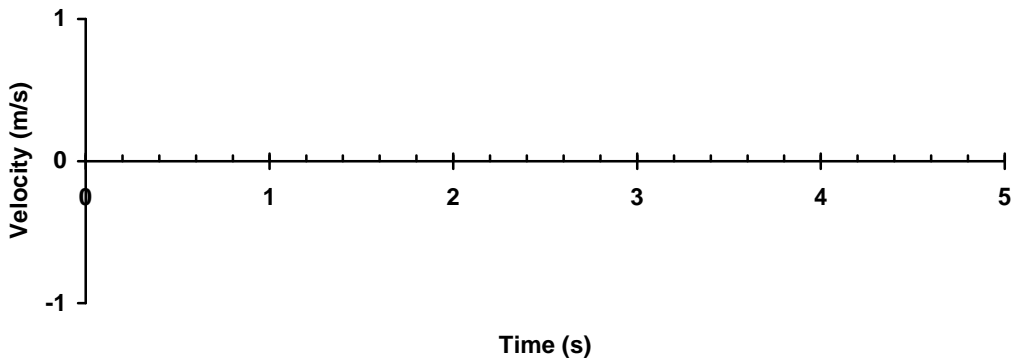
Using a motion sensor, make a *velocity vs. time* graph by walking *away* from the sensor *slowly*. Copy the graphs that are displayed on the data logger



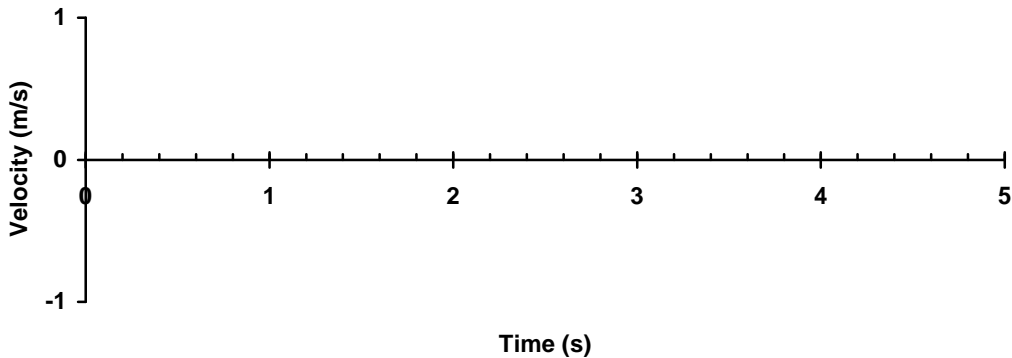
Make a *velocity vs. time* graph by walking *away* from the sensor at a *medium speed*. Copy the graphs that are displayed on the data logger



Make a *velocity vs. time* graph by walking *towards* the sensor *slowly*. Copy the graphs that are displayed on the data logger



Make a *velocity vs. time* graph by walking *away from* the sensor, initially slowly but with increasing speed. Copy the graphs that are displayed on the data logger



What is the most important difference between the graph made by walking *away slowly* and the one made by walking *away more quickly*?

How are the *velocity vs. time* graphs different for moving *away from* and moving *towards* the sensor?

Estimate the acceleration for each case based on the slope of the v vs. t curve ($a = \Delta v / \Delta t$). Are the results as expected? How fast did you accelerate in the last trial? How does this compare to the acceleration of gravity?

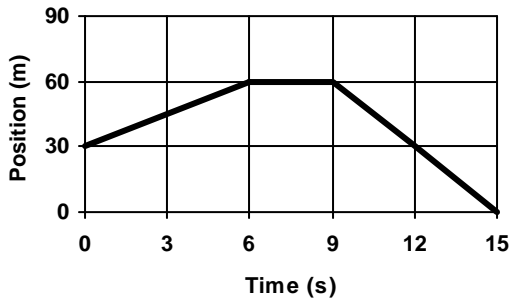
Repeat the last trial and display the acceleration data. How does the data logger information compare to your estimate based on velocity? What approach do you think is the most accurate for determining acceleration? Explain.

Homework: Position, Velocity and Acceleration Graphs

Name: _____

1. How could you represent the speed and direction of a car if you were able to measure its *position vs. time*?

Answer the following questions using the *position vs. time* graph below.

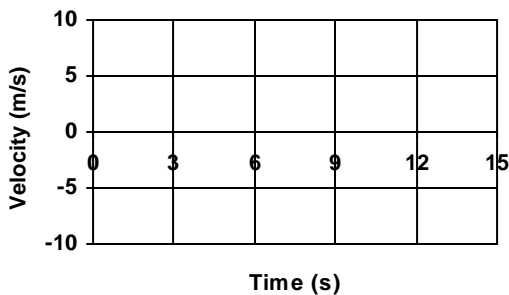


What is the speed of the car between 0 and 6 seconds? What is its direction?

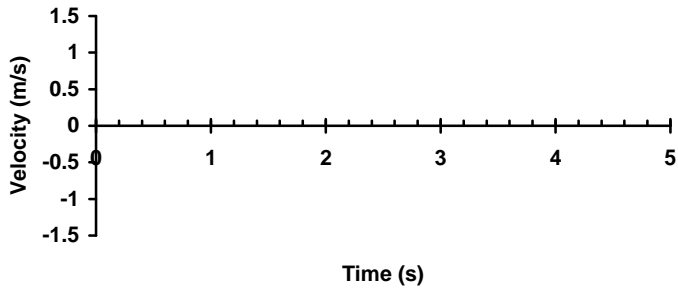
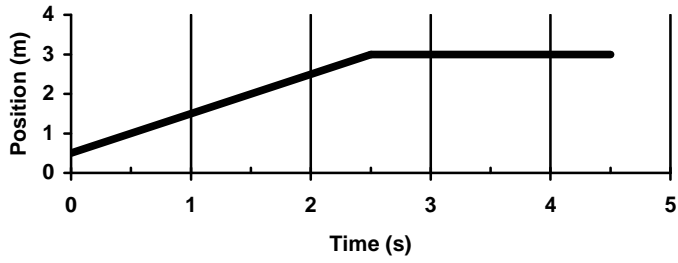
What is the speed of the car between 6 and 9 seconds? What is its direction?

What is the speed of the car between 9 and 15 seconds? What is its direction?

Use the information above to sketch a *velocity vs. time* graph for the car:



2. Given the *position vs. time* graph below, sketch a plot of the *velocity vs. time* graph.



How would the *position* graph be different if you moved *faster*? *Slower*?

How would the *velocity* graph be different if you moved *faster*? *Slower*?