Physics 103

Relating Velocity and Acceleration

An Introduction to Computer Based Data Collection

Introduction

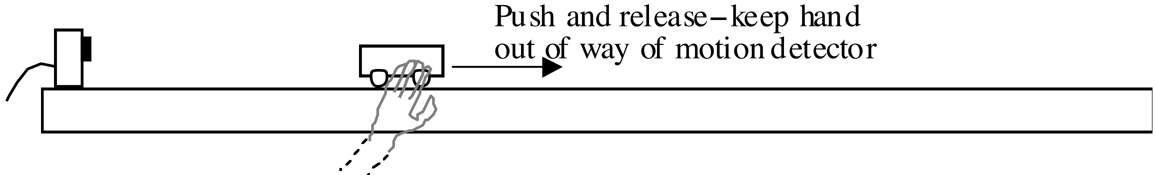
In this lab you will learn to use a motion detector and computer based data collection system to study motion. You should come to understand how the shape of position vs. time graphs, velocity vs. time graphs and acceleration vs. time graphs are related to real motions and each other.

Materials

Low friction track, cart, motion sensor, LabPro analog to digital converter and a computer. In addition, you need the following cords: power cord for LabPro, cord to connect motion sensor to LabPro, cord to connect LabPro to computer

Procedure

1. **Constant velocity motion away from the detector**. Start the cart ½ meter from the motion detector and give the cart a quick, push away from the detector then let it go. After you let the cart go, the cart will move with (approximately) constant velocity.



For motion #1 described above, do the following:

A) On your own, sketch three prediction graphs. Take 1 or 2 minutes to sketch an **individual prediction** of *position versus time*, *velocity versus time* and *acceleration versus time graphs for the motion described*. **After** you have made your own predictions, talk to your group about your ideas and questions. Prediction graphs are not graded for correctness but must be done BEFORE collecting data. Be sure to label the horizontal and vertical axes of your graphs with words (numbers are not needed but show the zero and +/-). Also give the set of graphs an overall title that describes the motion like "Constant velocity motion away from the detector".

Important!!

Friction is so small that it can be ignored.

Do not include any data in the graphs you record other than that associated with the motion described. The push and stop of the cart should not be recorded.

Open the file called **“pos,vel,acc.mbl”** that is in the PHY230 folder on your computer desktop. You open the file by double clicking on it.

B) Collect data and sketch the correct graphs. Set up the equipment as shown above. Practice the motion until you are comfortable with it. Make sure that you are pushing and stopping the cart from the end of the cart farthest away from the detector so that the cart is detected rather than your hand. Be sure to keep the nearest part of the cart at least ½ meter away from the motion detector and keep everything but the cart out of the line between the detector and cart.

Once you think you are ready to collect data, use the cursor to click on the “collect” icon (green arrow) at the top of the page. Wait until you hear a clicking noise. Then, start the motion. The data collection will stop automatically. Do not stop the data collection manually. The parts of the graphs that correspond to your motion should be nice smooth lines and curves. Find those parts of your graphs. If you are unsure, ask your teacher or try the motion again.

Record the RELEVENT PARTS of the actual data as *position versus time*, *velocity versus time* and *acceleration versus time graphs*. The parts of the displayed graphs that correspond to your motion will be either sloping lines, horizontal lines, or smooth curves. Record only these parts of your displayed graphs as position vs. time, velocity vs. time and acceleration vs. time graphs. These graphs may be graded for correctness. Be sure to label the horizontal and vertical axes of your graphs with words (numbers are not needed but show 0 and +/-). Also give the set of graphs an overall title that describes the motion like “Constant velocity motion away from the detector”.

Data is automatically erased when you click the “collect” icon again. You do not need to erase it manually.

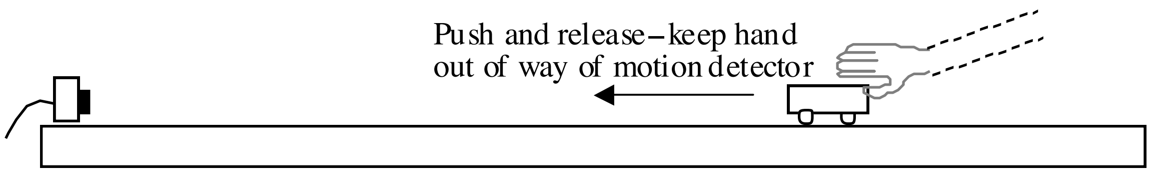
C) Compare your predictions and the actual data. Answer the following question: Do the relevant aspects of your prediction graphs and actual graphs agree? If not, one of them is wrong. If you question the actual data, repeat the measurement. You do not need to correct your prediction if that was wrong.

D) State in words what the graphs indicate. Write three sentences, one for each graph in Part B, that describe the position, velocity and acceleration vs. time graphs. Use words like horizontal line, upward sloping line, downward sloping line or curve to describe the general shape of the graph and state whether the values of position, velocity and acceleration are positive, negative or zero.

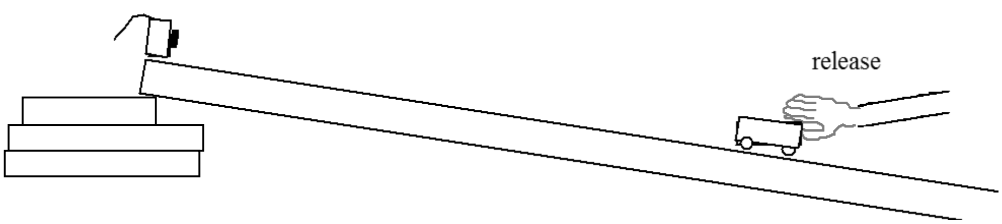
Example sentences might be “The velocity vs. time graph is an upward sloping line with negative values.” Or “The acceleration vs. time graph is a horizontal line at a value of zero.”

Repeat all four of these steps (A-D) for each of the motions below.

2. **Constant velocity toward the detector**. Start the cart at the end of the track. Give the cart a quick, hard push toward the detector but stop the cart before it gets within ½ meter of the detector. The cart will move with (approximately) constant velocity.



3. **Speeding up at a steady rate away from the detector.** Put several books under the end of the track near the wall (the end with the motion detector). The cart should be raised about 4 inches on the one end. Hold the cart ½ meter from the motion detector. Start collecting data and release the cart from rest. Pull your hand out of the view of the motion detector. The cart will move away from the motion detector and speed up at a steady rate. Reach back into stop it at the far end of the track.



Questions

4. Complete the following sentence and write it on your paper: The slope of a position vs. time graph for an object is the object's ________.
5. Complete the following sentence and write it on your paper: The slope of a velocity vs. time graph for an object is the object's ________.
6. What does the sign on velocity tell you?
7. Consider motion #1 (motion away from the detector at constant velocity). Suppose that your cart moved with twice as much speed. How would the position vs. time graph change? How would the velocity vs. time graph change? How would the acceleration vs. time graph change?

Challenge Question:

8. As you did on your pre-lab, draw "ticker-tape" diagrams for motions #1 and #3 above.