3.2 Position, Velocity, and Time Graphs

How are graphs used to describe motion?

A graph presents information in a format that can be understood easily once you know how to interpret it.

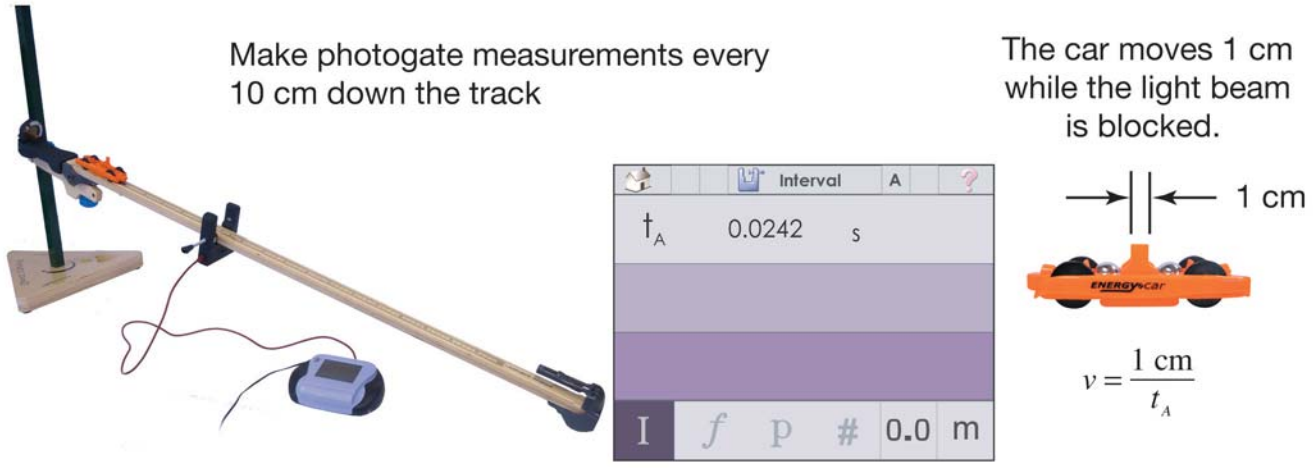
In this investigation, you will:

- create graphs of velocity versus position and time.
- create a predictive model for the velocity of cart rolling down a hill.

Materials List

- DataCollector
- SmartTrack
- Energy Car
- Photogate
- Physics Stand
- Distance-Velocity sensor

1 Velocity measurements



1. Set up the track with the distance-velocity sensor attached. Use the 5th position from the bottom of the stand. Set the DataCollector to timer mode and plug one photogate into input A.
2. Place the photogate 10 cm from the top of the track. This will be the location of your first trial. You will perform several trials by moving the photogate further down the track in 10 cm increments for each new trial. Record the photogate position and the time it takes the one centimeter flag to break the light beam for each trial you perform in Table 1.

Table 1: Time and velocity data

Photogate position (cm)	Time through A (s)	Velocity (cm/s)

2 Analyzing your results

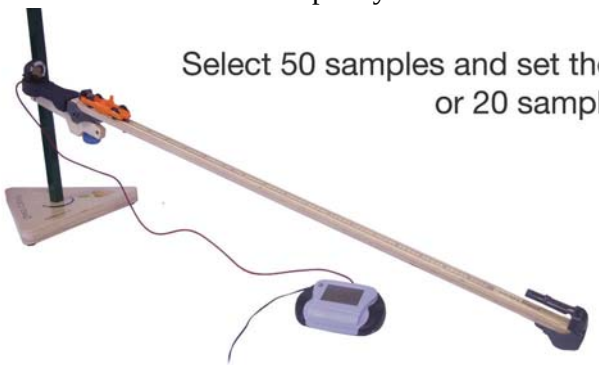
a. Calculate the velocity of the car in cm/s, and record the results in the Table 1.

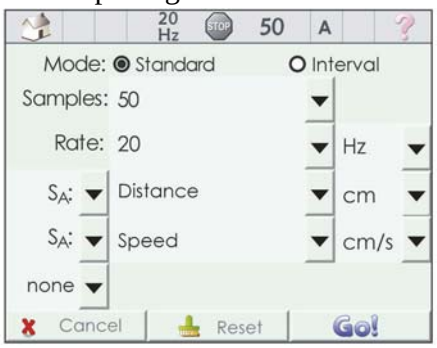
b. Do the velocities increase or stay about the same along the ramp?

c. Repeat the time measurement five times at one of the locations you measured. Calculate the velocity for each of the five trials. What is the precision of the average? Are the differences between your velocities significant? Justify your conclusion based on the estimated error in your measurements.

3 The velocity versus time graph

In the next part of the investigation you are going to use the graphing capability to generate the graph of velocity versus time for the track and compare your data with the data you collected with the photogate.





1. Switch the cord from the photogate to the velocity sensor and remove the photogate. Without changing the angle of your ramp, start a new experiment in data collection mode. Select the setup tab at the bottom of the screen and set the samples to 50 and the rate to 20Hz. Click back to meter view to see the time, distance, and velocity.
2. Attach the target to the back of the car.
3. Put the car at the top of the track, then hit the go button, then release the car.

4 Analyzing the data

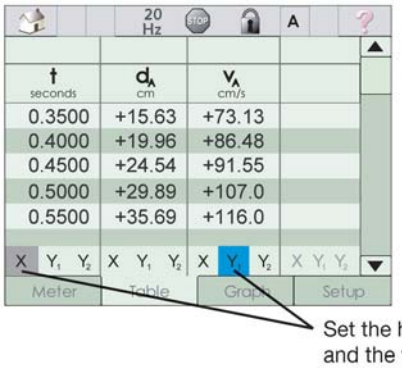
a. Once the DataCollector takes all 50 samples, switch to table view using the table tab on the menu bar at the bottom of the screen.

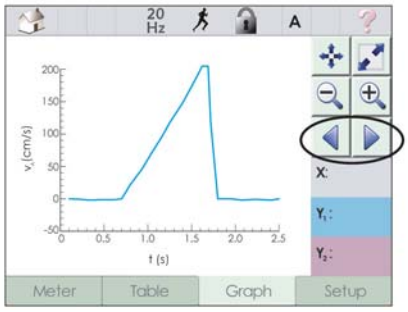
b. Scroll through the position, velocity, and acceleration data. Set the time column to be X and the velocity column to be Y1. Switch to graph view.

c. Describe the graph you see. Is it a straight line or a curve? Does it get steeper with time or shallower?

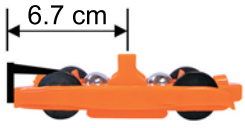
d. Is there acceleration in the motion of the car? How do you know form the velocity versus tine graph?

e. Go back to table view and set position to be X and velocity to be Y1. Return to graph view and observe the graph you see. Is it a straight line or a curve? Does it get steeper with time or shallower?





f. Move the cursor to a position on the graph that is as close as possible to a position where you made a photogate measurement of velocity. Write down the value of both position and velocity. (*Note*: To compare values you must subtract 6.7cm from the position to find the velocity at the same location for the car.)



g. Compare the graph values with the photogate calculation you did at the same position in part 2.

h. Derive a formula that will give you the photogate time if you know the velocity and the distance traveled. Use the cursor to choose a point on the graph and test your formula. (*Note*: don't forget that you need to be consider when in time your car started moving.)