4B Acceleration

What is acceleration?

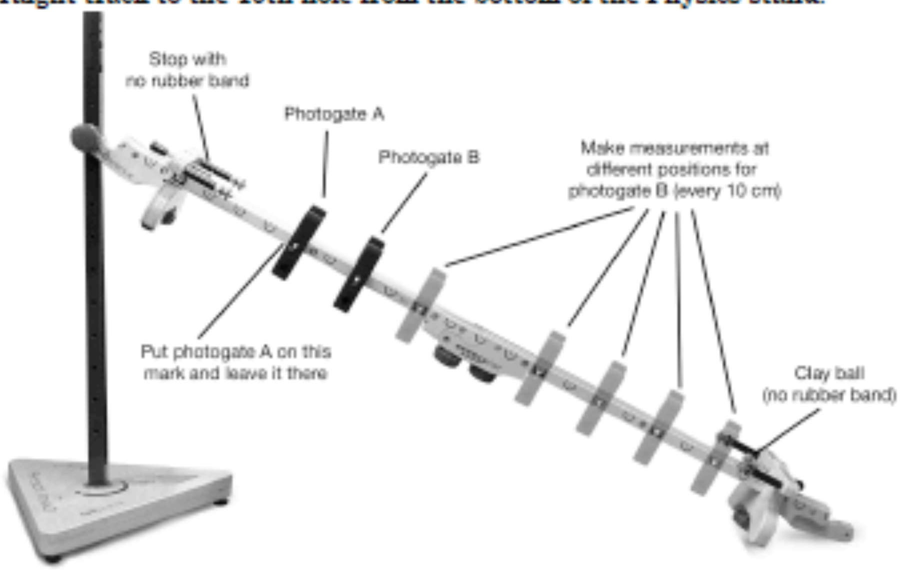
When you turn the track into a sloped ramp, the car can gain speed as it travels down the ramp. The speed of the car is constantly changing. What would a graph of this type of motion look like? Is there more than one way to graph the motion of an object? In this investigation you will learn what acceleration is, what the graphs of associated with acceleration look like, and why they look the way they do.

Materials

- Data Collector and 2 photogates
- Energy Car
- Physics stand

1 Setting up the experiment

Attach the straight track to the 10th hole from the bottom of the Physics stand.



1. Set up the track as a long straight hill. Attach the track to the 10th hole from the bottom of the Physics Stand.
2. Place photogate A at position shown in photo. Keep photogate A in this position.

2 Predicting

A graph is a visual tool that shows how two things (called variables) are related to one another. Release the car from the top of the track and let it roll down the track a few times. Observe how the car's position and speed changes as it rolls down the track.

a. Think about what happens to the car's position as it rolls down the track. Sketch what you think the position (y) vs. time (x) graph will look like for the Energy Car as it moves down the ramp. No need to put any numbers on the axes; just label the axes and place a flat line, diagonal line, or curve on the graph, according to your prediction.

b. Do the same for the speed (y) vs. time (x) graph prediction.

3 Doing the experiment

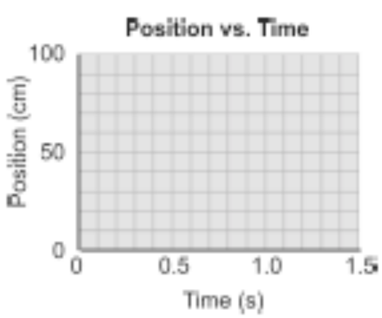
1. Move photogate B to different positions 10 cm apart along the track.
2. For every position of photogate B, release the car and record the time through A and the time from A to B in Table 1.
3. Use the time through A to check the consistency of your release technique. If there is a very different time through A, re-do the trial.

Table 1: Position versus time data

Distance from A to B (cm)	Time through photogate A (s)	Time from photogate A to B (s)
10		
20		
40		
50		
60		
70		

4 Position vs. time graph for acceleration

a. Use your data from Table 1 to make a graph with the *position* (distance from A to B) on the y axis and the *time* it took to go that far (time from A to B) on the x-axis.



b. How does the graph from your experiment data compare to your prediction? What happens to the distance traveled as time goes by for the car on the ramp?

c. How do you know, from looking at the graph, that the car did NOT travel at a constant speed?

5 Speed vs. time graph for acceleration

Another way to describe the car's motion is to show how its speed changes with each new time interval from A to B. Speed is a measurement of how fast or slow an object's position changes. The measurement of how an object's speed changes is acceleration. You will try the experiment again, and use data to calculate the speed of the car as it travels through photogate B.

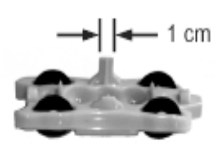
1. Keep photogate A in the same place as it was in part 3.
2. Move photogate B to different positions 10 cm apart along the track.
3. For every position of photogate B, release the car and record the time through A, the time through B, and the time from A to B in Table 2.
4. Use the time through A as a check for the consistency of your release technique. If there is a different time through A, do the trial again.

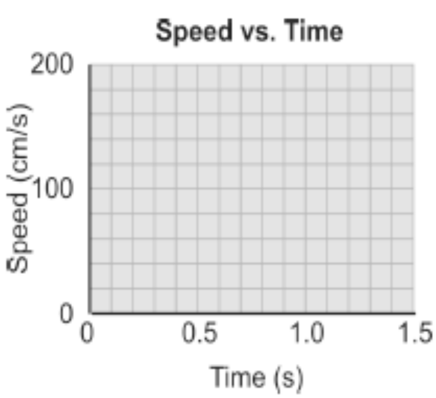
Table 2: Speed vs. Time Data

Distance from A to B (cm)	Time through photogate A (s)	Time through photogate B (s)	Time from photogate A to B (s)	Speed at photogate B (cm/s)
10				
20				
40				
50				
60				
70				

5. How fast is the car going as it travels through B each time? Calculate the speed of the car at each position of photogate B. Record your speeds in Table 2.

$v = \frac{d}{t}$ $\quad v = \frac{1.00 \text{ cm}}{\text{time B}}$





a. Draw a graph with the *speed* (speed through B) on the *y* axis and the *time* it took to go that far (time from A to B) on the *x*-axis.

b. How does the graph from your experiment data compare to your prediction?

c. What happens to the speed as time goes by for the car on the downhill ramp?

6 Applying what you've learned

a. Did the car accelerate as it traveled down the hill? Justify your answer.

b. Use the formula for acceleration to find the average acceleration of your car. Use data from the trial in Table 2 where photogate B was 70 cm from A. The unit for acceleration will be cm/s/s.

$$acceleration = \frac{final\ velocity - initial\ velocity}{time\ elapsed} \qquad acceleration\ of\ car = \frac{speed\ \mathbf{B} - speed\ \mathbf{A}}{time\ \mathbf{A\ to\ B}}$$

c. Use your speed vs. time graph to predict how much time would elapse for the car to reach a speed of 200 cm/s.

d. Use your position vs. time graph to predict where on the track the car would reach a speed of 200 cm/s.

e. Test your predictions with a photogate at your predicted location on the track. Were your predictions accurate? Record your observations.