Name____Period______Date____________

4A Speed

Can you predict the speed of the car as it moves down the track?

What happens to the speed of a car as it rolls down a ramp? Does the speed stay constant or does it change? In this investigation, you will measure the speed of a car at different points as it rolls down a ramp. Then you will make a graph that describes the motion, and predict the speed of the car somewhere on the ramp.

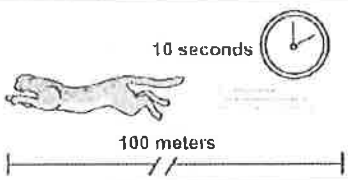
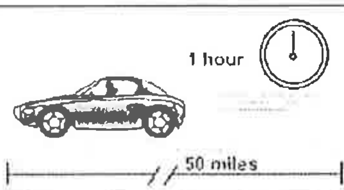
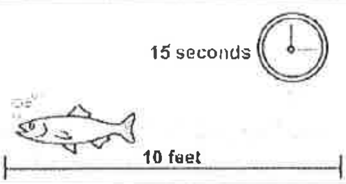
Materials

- Data Collector and 1 photogate
- Energy Car
- Physics stand

1 Describing speed

Suppose you ran in a race. What information do you need to describe your speed? Saying that you ran for 20 minutes would not be enough information. To describe your speed, you need two things:

1. The **distance** you traveled, and
2. The **time** it took you to travel that distance.

Example	Distance	Time	Speed
	100 meters	10 seconds	10 m/s
	50 miles	1 hour	50 mi/hr
	10 feet	15 seconds	0.67 ft/s

Based on the examples above, fill in the boxes to complete the *equation* for calculating speed.

$$\text{speed} = \frac{\square}{\square}$$

2 Making a hypothesis

Where is the car going the fastest on the ramp? Is it going fastest at the top, middle, or bottom?

a. Create a hypothesis about the car's speed on the ramp–where is it the fastest, and why do you think so?

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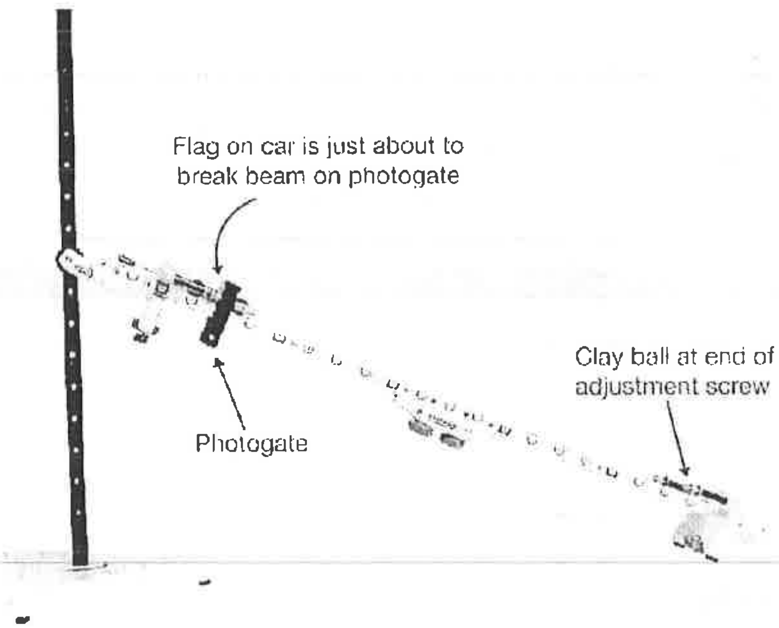
3 Setting up the experiment

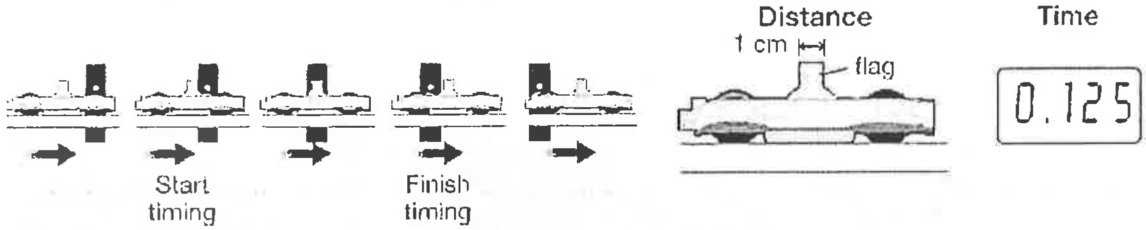


1. Join the two ends of the ramp that say "Energy Car" to each other. The ramp should be straight, without a bend in the middle. Use two threaded knobs to connect the two parts.
2. Attach the ramp to the physics stand using one threaded knob. Your teacher will tell your group which hole on the stand to use. Hole where ramp is attached: _____
3. Place a bumper at each end of the ramp. Place a clay ball on the end of the thumb screw at the bottom of the ramp to stop the car. The thumb screw at the top of the ramp will be the place where you start the car.
4. Attach a photogate to input A of the Data Collector.
5. Place the photogate so its screw is on the round mark that is closest to the front of the car.

4 Using the photogate to measure speed

As the car passes through the photogate, the Data Collector clock starts and stops. The Data Collector measures the length of time that the light beam is broken. Speed is equal to the distance traveled divided by the time taken. What distance do you use?

If you look at the car you will see a small "flag" on one side. This is the part of the car that blocks the photogate's light beam. The distance the car moves while the light is blocked is the width of the flag, 1 cm.



a. What is the *distance* traveled by the car in the example?

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b. What is the *time* taken by the car in the example?

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c. What is the *speed* of the car in the example?

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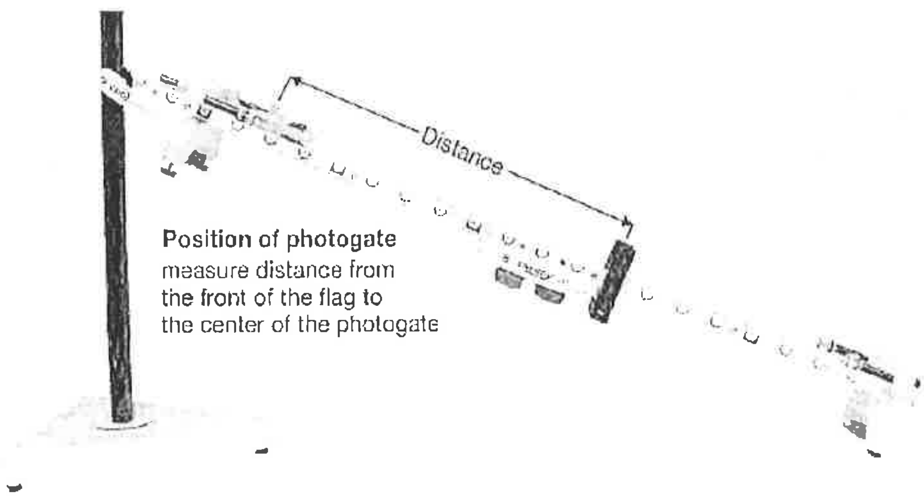
5 Doing the experiment



1. Place the car at the top of the ramp. Place the photogate 10 cm down the hill from the car. Measure the distance from the front edge of the car's flag to the middle of the screw that holds the photogate to the track. If you line up the car's flag over one of the

circular markings, measuring is made easier, since each mark is 5 cm away from each other. Record the photogate's position in Table 1.

2. Release the car without pushing it. Record the time through photogate A in the table.
3. Calculate the speed of the car using the distance traveled (1 cm) and the time at photogate A.
4. Move the photogate 10 cm down the track. Record the position, time, and speed.
5. Repeat the measurements of position, time, and speed for six different places spaced along the ramp. You will have to skip some places in the middle of the track where the photogate won't attach.

Table 1: Position, time and speed data

Position of photogate A (cm)	Time through photogate A (s)	Distance traveled by the car (cm)	Speed of the car (cm/s)
		1.00	
		1.00	
		1.00	
		1.00	
		1.00	
		1.00	

6 Analyzing the data

a. From your measurements, what can you say about the car's speed as it moves down the ramp?

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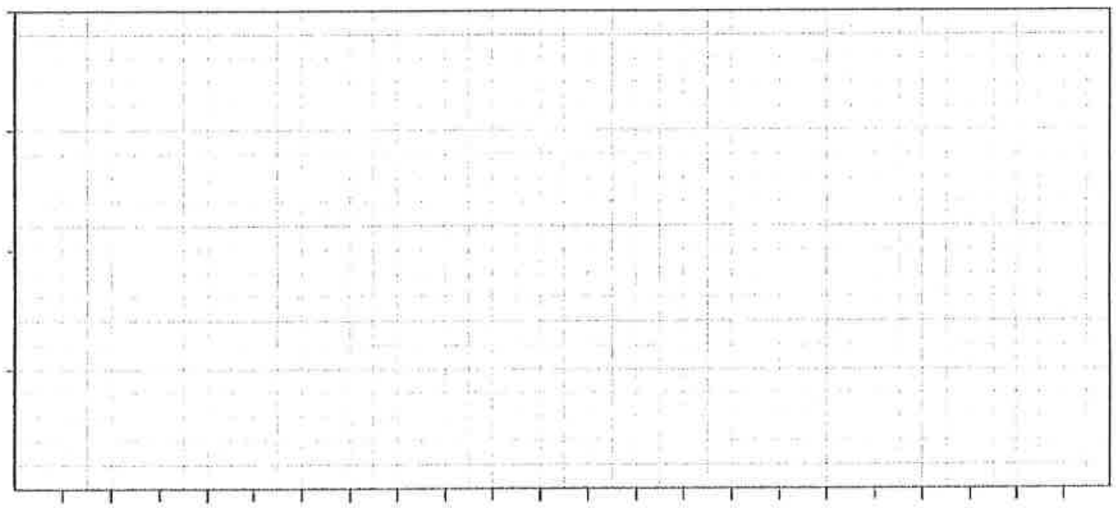
b. Use your data to make a graph which shows how the car's speed changes as it rolls down the ramp. Put speed on the *y-axis* and position of the photogate on the *x-axis*. Be certain to label the axes with the correct variable and the proper unit of measurement. Give the graph a descriptive title. Include the number of the hole you used to connect the ramp to the stand in your title.

Title: ____



y-axis: ____________________

x-axis: ____

c. Describe what the graph shows about how the speed of the car is changing as it moves down the ramp.

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d. Compare your graph with that of students who connected their ramps at different heights on the stand. Explain any differences you see.

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7 Using your graph

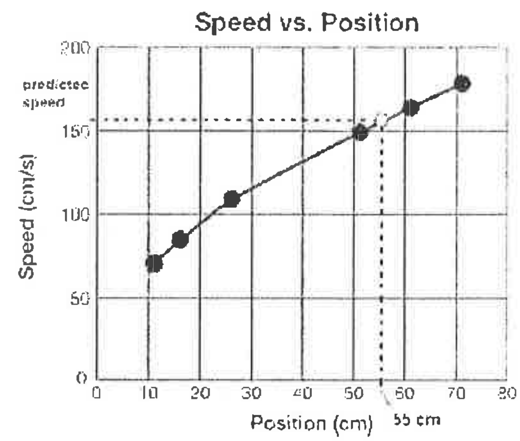
Now that you have gathered, organized, and analyzed your data, it is time to use it to make a prediction. You measured the speed of the car at several places on the ramp as it rolled to the bottom. Now, you will predict what the speed of the car will be at a place you did not measure. There is a way to do this with the information represented by your graph.

1. In Table 2 record a position on the ramp where you did not measure the speed of the car. The position should be between two places where you did measure the speed.

Table 2: Predicted speed data

Selected position (cm)	Predicted speed at selected position (cm/s)	Actual speed at selected position (cm/s)	Percent correct of prediction

2. Use your graph to find the predicted speed of the car at the selected position. To do this, start on the x-axis at the position you have selected. Draw a line straight up until it intersects with the speed vs. position line on your graph. At the intersection point, draw a line horizontally over to the y-axis where the speed is recorded. This is the speed that corresponds to your predicted location. The graph to the right uses a position of 55 cm as an example. Use a different position. Record your predicted speed in Table 2.



3. Place the photogate at the position you selected in step 1 and record the time it takes for the car to pass through the photogate.
4. Use the wing length (1.00 cm) and the time to calculate the speed. Record the actual speed in Table 2.
5. How does the predicted speed compare with the actual measured speed? What does this tell you about your experiment and measurements?

8 Calculating percent error

a. Find the difference between the predicted speed and the actual speed you calculated.

Predicted speed – Actual speed = Difference

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b. Take this difference and divide it by the predicted speed, then multiply by 100.

(Difference ÷ Predicted speed) × 100 = Percent error

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c. Use the percent error to calculate percent correct. Record percent correct in Table 2.

100 – Percent error = Percent correct

d. What do you think can account for any error you may have had?