1.2 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.

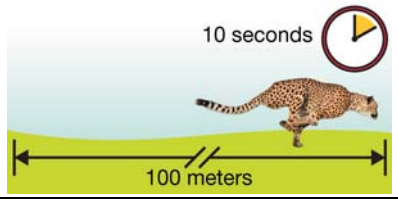
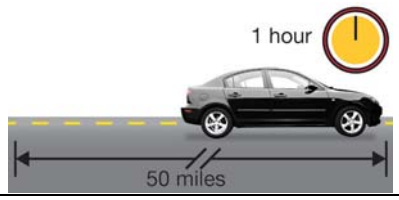
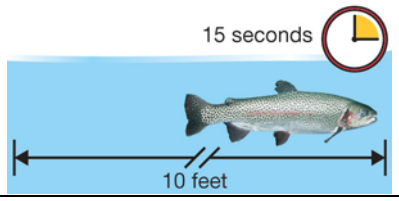
Materials List

- DataCollector
- Photogate
- Energy Car
- SmartTrack
- Physics stand
- Metric ruler

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.

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

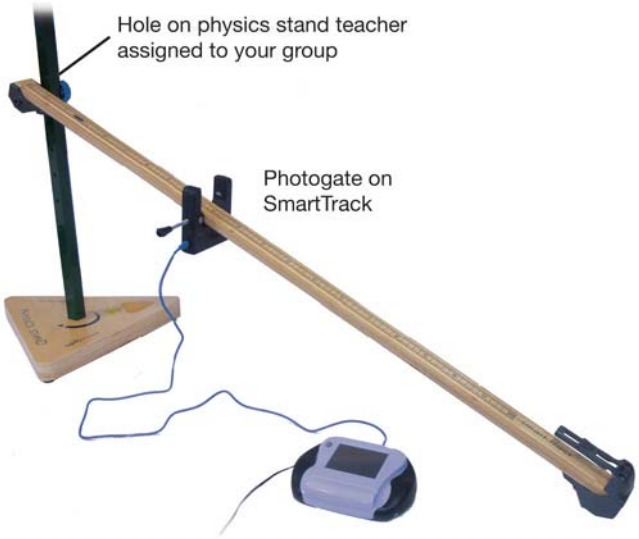
2 Making a hypothesis

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?

3 Setting up the experiment

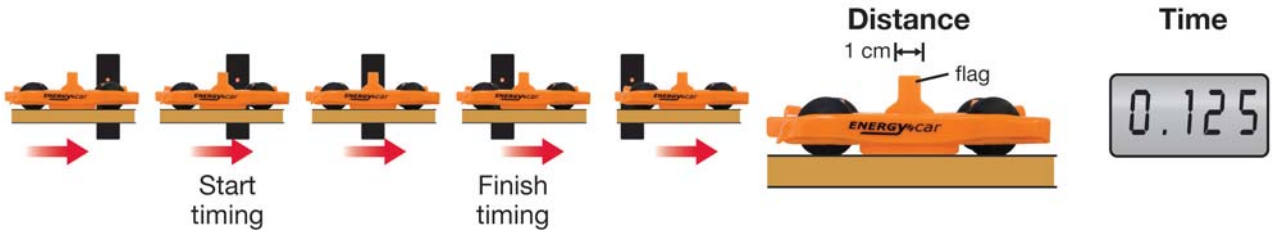
1. Attach the SmartTrack to the physics stand using one threaded knob. Your teacher will tell your group which hole on the stand to use. Hole where ramp is attached: _____
2. Connect the cord so between the photogate and the A input on the top of the DataCollector.
3. Place the photogate on the SmartTrack.
4. Turn on your DataCollector and enter timer mode from the home screen.



4 Using the photogate to measure speed

As the car passes through the photogate, the DataCollector's clock starts and stops. The DataCollector measures the length of time that the light beam of the photogate 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.



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

b. Put the car onto the SmartTrack. Notice how the photogate's light is green. What happens to the green light when the photogates beam is blocked? How can you tell it is no longer being blocked?

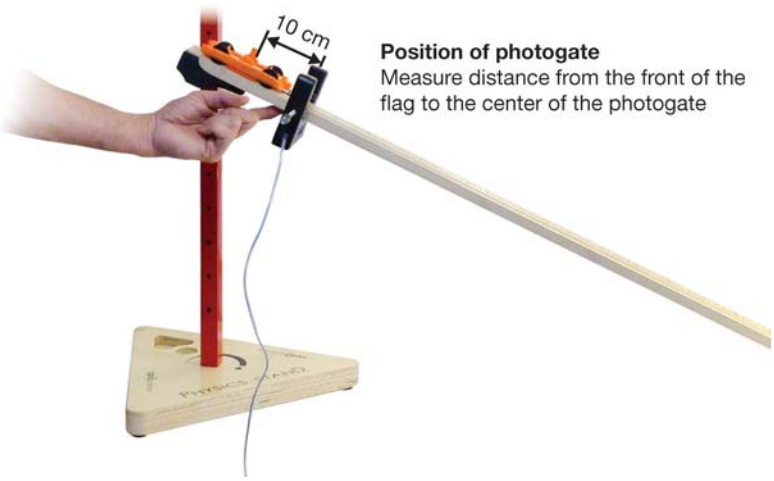
c. Use a ruler to measure how far the car rolls while the flag on the car blocks the beam. How far does the car travel while breaking the photogate's beam?

d. What distance should you use to calculate the car's speed when moving through photogate A?

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

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

5 Doing the experiment



1. Place the car at the top of the ramp and hold it in place by pressing the hold button and resting the front of the car onto the holding pin that comes up through the track.
2. Measure 10 cm from the front edge of the car's flag down the track. Place the photogate so its beam is exactly 10 cm down the hill from the wing of the car. You can tell where the beam is located by finding the crosshairs on the inside and outside of the photogate. Record the photogate's position as 10 cm in Table 1.
3. Release the hold button and allow the car to roll down the hill. Record the time through photogate A at the 10 cm position in Table 1.
4. Calculate the speed of the car using the distance traveled (1 cm) and the time at photogate A.
5. Move the photogate at least 5 cm further down the track. Record the position, time, and speed again in Table 1 at the new position.
6. Repeat the measurements of position, time, and speed for at least six different places on the ramp.

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?

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.

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

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

7 Using your graph

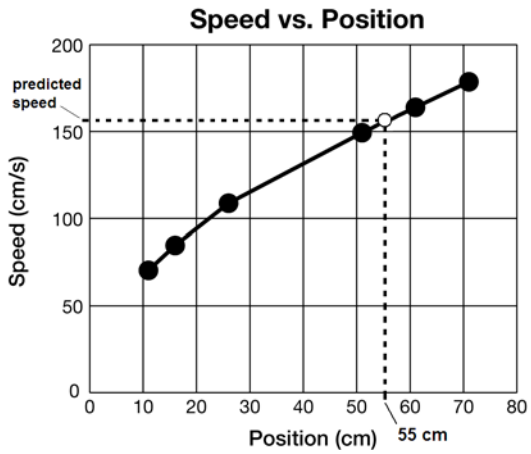
Now that you have gathered, organized, and analyzed your data, it is time to use it to make a prediction. You measured the speed of the car at several places on the ramp as it rolled to the bottom. Now, you will predict what the speed of the car will be at a place you did not measure. There is a way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

Predicted speed – Actual speed = Difference

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

(Difference ÷ Actual speed) × 100 = Percent error

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?