

Investigation 1.3

Systems, Experiments, and Variables

Why do we control variables in an experiment?

We do experiments to collect evidence that allows us to unravel nature's puzzles. You can think of an experiment as asking a question about the universe: "What would happen if I did this?" If your experiment is well planned, the results of the experiment provide the answer you are looking for. If your experiment is not planned correctly, you will still get results but you may not know what they mean. In this investigation, you will experiment with the car and the ramp. Only by paying careful attention to the variables can you make sense of your results.

1 Setting up the experiment

The faster you go, the shorter the time it takes to reach your destination. With two photogates you can measure time it takes the car to go from one place to another very accurately.

Set up the ramp and car as instructed by your teacher. Each group in the class will have a different ramp angle. The angle is determined by which hole in the stand you use to attach the ramp.

Put two photogates on the ramp so that you can measure time for the car. Plug the photogate closest to the top of the ramp into input A of the DataCollector and the other photogate into input B.

- a. Look around the class and note which hole each group is using for its ramp. With your group, make a prediction as to which group will have the fastest car, and therefore the shortest time from A to B. This prediction is your group's hypothesis. Write down this hypothesis so you can compare it to your results.

- b. Roll the car down the ramp and record the time it takes to go from photogate A to photogate B. Be sure you look at the A-to-B time as displayed on the DataCollector.

- c. Compare your results with other groups'. Did the times that everyone measured agree with your hypothesis about how the angle of the ramp would affect the speed? Why or why not?

- d. Is there a better way to test how the ramp angle impacts the speed of the car? Explain how you would redo this experiment so the results make sense.

2 Variables in an experiment

Variables are the factors that affect experimental results. In part 1, each group did the experiment with too many differences, instead of only changing the angle of the ramp. Just about everything was different from group to group, there was no consistency. That made it hard to compare results scientifically. In an experiment, you have to keep everything the same, and only change one variable at a time. If you only change one thing at a time, when you get a result that is different you know that difference was caused by the one variable you changed.

What variables affect how fast the car moves down the ramp? List all the variables discussed by your group.

3 Doing a controlled experiment

In this part of the investigation, you will repeat the time measurements of the car, but as you will see, each group will attach the photogates in the same way. This will allow groups to more accurately compare results.

1. In the table, record any variables you think should be controlled to make the experiment a comparison of how cars behave on ramps of different angles. Write values for these variables in the table. These values will not change during the experiment.
2. Develop a good technique for rolling the car down the ramp so you get three times that are within 0.001 seconds of each other.
3. Using your new technique and setup, record the time it takes the car to travel from photogate A to photogate B.

Table 1: The values for the variables in the experiment

Variable	Chosen value

Once you have your new results, compare them with the results of the other groups.

- a. Did your times agree with your hypothesis about how they would change with the angle of the ramp?

- b. In one or two sentences describe why this experiment was better or worse than your first experiment. Your answer should talk about cause and effect relationships and variables.

4 Applying what you have learned

- a. It is often easy to confuse cause and effect. When we see something happen, we think up a reason for why it happened, but we don't always get the right reason. If you drop a piece of paper and a steel weight at the same time, which one hits the ground first? If the paper is flat, the steel always hits first. Why does the steel hit first? Is it because heavier objects fall faster, or is there another reason? In your answer give at least one other reason why a steel weight might fall faster than a flat sheet of paper.

- b. Plan and perform another experiment to test the effect of one of the other variables on the speed of the car. Create a data table and a procedure for controlling the variables you don't want to change.
