# 1B Variables in an Experiment

*How do scientists conduct a good experiment?*

Imagine a jumping frog trying to escape from a predator. The frog needs to get the greatest distance out of each jump. What variables affect how far the frog will travel? What about the angle at which the frog aims when it jumps? How do you think the launch angle will affect the distance the frog will travel? In this Investigation, you will try launching *marbles* (not frogs!) at different angles in order to find out how launch angle affects distance traveled. As a result, you'll learn how to conduct a good experiment.

*Materials*

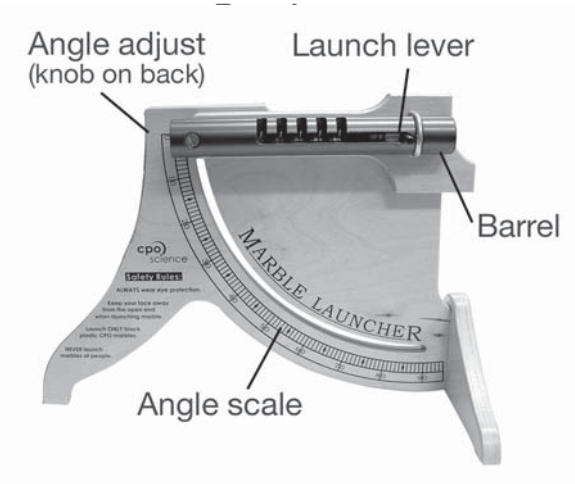
- Marble launcher
- Plastic marbles
- Tape
- Metric tape measure
- Graph paper
- Ruler

**Safety Notes:**

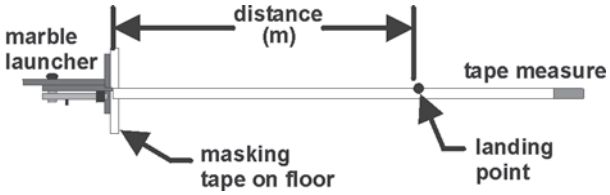
- **Never launch marbles at people.**
- **Wear safety glasses or other eye protection when launching marbles.**
- **Launch only the black plastic marbles that come with the marble launcher.**

## 1 Setting up

1. Identify the parts of the marble launcher.
2. For this experiment, you will use the fifth slot of the barrel to launch the marble for each trial. Pull the launch lever back and slip it sideways into the fifth slot. Put a marble in the end of the barrel. The marble launcher is now ready to launch.




3. You will change the angle for each launch starting at 10 degrees and increasing 5 degrees up to 80 degrees.
4. A minimum of two people are needed per launcher. One person releases the launch lever and the other watches where the marble lands. A few launches should be done at each angle to be sure that the data is accurate. It also takes a few times to accurately find the spot where the marble lands.
5. Use a strip of masking tape on the floor to make sure that the marble launcher is set back in the same place every time. A tape measure laid along the floor provides a good way to measure the distance traveled by the marble.



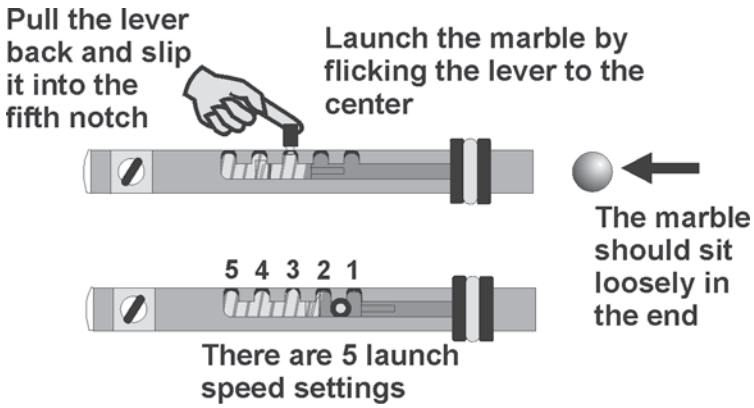
## 2 Stop and think

**a.** At which angle do you think the marble will travel the greatest distance? State your answer to the question as a *hypothesis*.

**b.** What is the *experimental variable* in this experiment? What are the *control variables*?

**c.** Why is it important to make a few practice launches at each angle?

## 3 Doing the experiment




In the table below record your two best trials for each launch angle:

**Table 1: Launch angle and distance data**

| Launch angle (degrees) | Distance (meters) | Distance (meters) | Launch angle (degrees) | Distance (meters) | Distance (meters) |
|---|---|---|---|---|---|
| 10 | | | 50 | | |
| 15 | | | 55 | | |
| 20 | | | 60 | | |
| 25 | | | 65 | | |
| 30 | | | 70 | | |
| 35 | | | 75 | | |
| 40 | | | 80 | | |
| 45 | | | 85 | | |

## 4 Analyzing your data

**a.** There is an angle at which the marble launcher will cause the marble to travel the farthest. The angle may not be obvious from the data you have collected. Graphs help scientists to organize data into patterns that are easier to see. For graphing purposes, which variable is the *independent variable*? Which is the *dependent variable*?

**b.** Make a line graph showing how the distance changes with the launch angle. Plot the independent variable on the $x$-axis and dependent variable on the $y$-axis.

**c.** Look at your graph. At what angle does the marble attain the greatest distance?

**d.** You are challenged to launch a marble to travel a distance of 4.00 meters. At what angle will you set the launcher?

**e.** Referring to your answer for question (d), state another angle that would give you the same result.

**f.** Is the 4.00 meter distance the only distance that you can reach using two different angles? State three other distances and the angles you would use to reach that distance.

**g.** Explain why two angles can be used to reach the same distance.

**h.** Write a paragraph about a situation in which it would be better to use one angle rather than the other.

## 5 Designing your own experiment

**a.** Besides launch angle, which other variables can you change on the marble launcher?

**b.** Choose a different variable you can change. Write a question you have about how that variable affects another variable.

**c.** State your hypothesis to the question.

**d.** Design an experiment to test your hypothesis. List the materials and procedures for your experiment, then get approval from your teacher.

**e.** Conduct your experiment. Be sure to make a good data table before you begin. Get approval from your teacher for your data table design.

**f.** Make a graph of your data and analyze your results.

**g.** State a conclusion to your experiment. Did your results support your hypothesis? If so, explain why. If not, explain how you would change your hypothesis or experiment.

**h.** Present your findings to the class.