

# Working with Variables

It takes many skills to design and carry out good scientific experiments. The scientific method involves asking a good question, making a hypothesis, conducting research, identifying and controlling variables, making observations during testing, collecting data, and drawing conclusions. Using data sheets, diagrams, and graphs helps you organize and present your results. These skills help make your experiments reliable, repeatable, and meaningful.

## Purpose

To identify and control variables within an experiment.

## Process Skills

Observe, measure, collect data, communicate, form a hypothesis, identify and control variables

## Background

For an experiment to be successful, scientists must identify and control the **variables** that are being studied. A variable is something that can change, or vary. In science, there are three main types of variables: independent, dependent, and controlled. The **independent variable** is the variable that changes and is part of the research question. The variable that is being measured is the **dependent variable**. The dependent variable *depends on* the independent variable and is part of the results of your experiment. While you are conducting your experiment, many other potential variables must be kept the same if you want reliable results. These are the **controlled variables**. When you **design** your experiment, all of the variables must be controlled except the independent one that you are investigating. By doing this, you can be sure that your results are valid, and you can draw a strong conclusion.

In this experiment, you will learn how to identify the independent and dependent variables. You will also practice ways to control variables while conducting a simple test using paper towels.

**Time** – 45 minutes

**Grouping** – Small groups

## Materials

(per group)

- 2 types of paper towels (1 generic and 1 brand-name)
- centimeter ruler
- scissors
- 250 ml (1 cup) liquid measuring cup
- water
- stopwatch or clock with second hand
- tweezers
- data sheet  
(one per student)

## Procedure

In this experiment, you should mainly focus on identifying and controlling variables. The information in the boxes will give you the information you need to conduct this experiment. Read this information carefully.

### Background Research:

- Paper towels are made up of absorbent fibers to soak up liquids.
- Brand-name paper towels usually cost more than generic paper towels.
- In order to be sold at a lower price, generic paper towels may not be as absorbent as brand-name paper towels.

### Research Question:

Will a brand-name paper towel absorb more water than a generic paper towel?

### Hypothesis:

*If I compare the absorbency of two kinds of paper towels, then the more expensive brand will absorb more water because it is thicker and has more absorbent fibers.*

### Part 1: Identify the Variables

1. With your group, read the steps for Part 2. Discuss which variable will change (or *vary*) during the experiment. This is the *independent variable*. Record the independent variable on your data sheet.
2. With your group, discuss the results that you will be measuring during the experiment. This is the *dependent variable*. Record the dependent variable on your data sheet.
3. With your group, consider all the other potential variables in this experiment. Which variables might change if you aren't careful to keep them the same? These are the *controlled variables* that must be kept the same in order for the experiment to be successful. Remember that in well-designed procedures, only the independent variable should change. Record your controlled variables on your Data Sheet. (**Hint:** There are at least five controlled variables in the Part 2 procedures.)





### *Part 2: Conducting the Experiment and Controlling the Variables*

1. Using your centimeter ruler and scissors, measure and cut three 10 cm x 10 cm (4 in. x 4 in.) squares of the generic paper towel. Repeat with the brand-name paper towel. Be sure all six squares are the same size.
2. Carefully fill the measuring cup with 250 mL (1 cup) of water.
3. Using the tweezers, completely immerse one generic paper towel square in the water. Keep the paper towel underwater for 5 seconds.
4. Using the tweezers, remove the paper towel. Hold the square over the cup for 10 seconds in order to allow excess water to drip back into the cup. Be sure to catch all of the water in your cup. Set the wet paper towel on the table.
5. Measure the volume of water in mL (or fractions of a cup) that remains in the measuring cup. On scratch paper or in a science journal, subtract the remaining volume from the original 250 mL (or 1 cup) to determine how much water the paper towel absorbed. Record the results on your data sheet.
6. Repeat steps 2–5 with the remaining two squares of generic paper towel. Then find the average volume of water absorbed by the generic paper towels from the three trials. Add the three volumes and then divide the sum by 3. Record the average on the data sheet.
7. Repeat steps 2–6 using the three squares of brand-name paper towel. After recording your data, clean up your work area.
8. Discuss your findings with your class. Compare the answers from your data sheet with the answers from other groups to ensure that you correctly identified the independent, dependent, and controlled variables.

Name \_\_\_\_\_ Date \_\_\_\_\_

**Part 1: Identify the Variables**

**Research Question:** Will a brand-name paper towel absorb more water than a generic paper towel?

**Hypothesis:** If I compare the absorbency of two kinds of paper towels, then the more expensive brand will absorb more water because it is thicker and has more absorbent fibers.

**Independent Variable:** (Which variable are you investigating?)

\_\_\_\_\_

**Dependent Variable:** (What will the results measure?)

\_\_\_\_\_

**Controlled Variables:** (What things will you make sure stay the same during the experiment?)

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

**Part 2: Conducting the Experiment and Controlling the Variables**

**Collect Data**

Volume of Water		
	Generic	Brand-name
Test 1		
Test 2		
Test 3		
Average		

**Observations:** Write about your results. Was the hypothesis supported by the results? Which kind of paper towel was more absorbent?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Name \_\_\_\_\_ Date \_\_\_\_\_

### Critical Thinking

1. Explain the difference between an independent and a dependent variable.
2. Did controlling the variables in this experiment help you analyze your results? Explain why or why not.
3. Why is it important to control the variables in a science experiment?
4. Why do you think you were asked to test each paper towel three times and find the average?
5. If your teacher asked you to design an experiment about candy bars and heat, what would be your independent variable, dependent variable, and controlled variables?

# Working with Variables

## TEACHING TIPS

*This process activity will help students understand how to identify and control variables within a science experiment. Conclusions drawn from the results of an experiment are only as good as the experimental design. Well-thought-out procedures are designed to identify the independent and dependent variables and to control all other aspects of the experiment. By controlling the variables, scientists are able to draw strong conclusions about the relationship between the independent and dependent variables. Students will learn how to differentiate between independent, dependent, and controlled variables by analyzing a simple experiment on paper towel absorption. As they work through their experiment, students may come to appreciate the importance of identifying and controlling variables as an essential part of scientific research.*

## SET-UP AND PROCEDURES

- Throughout the activity, keep students focused on the skill of identifying and controlling variables, even though the subject of absorption may be interesting to them.
- Review with students the definitions of independent, dependent, and controlled variables. Have students read the *Quick Read Identify and Control Variables* found in the Identify and Control Variables unit.
- Consider assigning jobs for each student within a cooperative group prior to the activity. Examples include getter, cutter, dipper, measurer, reporter, and cleaner.
- To ensure that students control for the amount of time that each paper towel stays immersed in the water, have them wait for your cue to begin.
- If your classroom does not have a sink, have a large tub available for students to pour their water into during cleanup.
- It is likely that you will have to remind students that their results should reflect the amount of water that was absorbed—not the amount of water that was left in the measuring cup after the paper towels were immersed. They will need to subtract the amount that remained in the measuring cup from the original amount (250 ml or 1 cup) in order to obtain the results.

## MATERIALS

- To save time, use a paper cutter to precut paper towels into 10 cm x 10 cm (4 in. x 4 in.) pieces. However, allowing students to do this step will help them to understand that size is an important variable to control in this experiment. Discuss with students why using different sizes of paper towel pieces could skew the results.
- Make sure to have plenty of extra paper towels on hand in case of spills.

## EXTENSIONS AND VARIATIONS

- Graduated cylinders or small beakers may also be used. Many districts have a science resource center to contact if supplies (such as liquid measuring cups) are not readily available at the school. Another option is to weigh the paper towels before and after immersion in water and record weights before and after.
- *Variation/Math*: Provide graph paper and have students graph their results. Discuss with the class whether there were any discrepancies in data collected by different groups. If so, ask students if the discrepancies can be accounted for by examining the variables within the experiment. If all of the data are similar, discuss how controlling the variables made this outcome possible.
- *Variation*: Run a different experiment to observe how quickly water will evaporate from the two different kinds of paper towels. Allow students to dip a generic and a brand-name paper towel in water and let excess water drip off. Place wet paper towels on a nonabsorbent surface (such as a foam plate) and put the paper towels in the sun. Have students identify the dependent, independent, and controlled variables in this new experiment. Observe how long it takes for each of the paper towels to dry. Discuss with students how the results are related to the first experiment.
- *Writing*: Have students create a Venn diagram comparing the similarities and differences between generic and brand-name paper towels. Ideas include comparing prices, textures, weight, size, and absorbency.
- *Guest*: Invite a research scientist to talk with the class about some experiments that he or she has done and the importance of identifying and controlling variables as part of experimental design.
- *Critical Thinking*: Provide students with two different conclusions from the same experiment. For example, one group may have reported that the hypothesis was supported—that the brand-name paper towel absorbed more water—but another group may have reported that the brand-name paper towel absorbed less water. Discuss how different conclusions may be the result of not controlling variables during an experiment.
- *ELL/ESL*: Create a word wall. Include content vocabulary such as *experiment*, *scientific method*, *research question*, *hypothesis*, *observation*, *data*, *results*, *dependent variable*, *independent variable*, and *controlled variables*. Also include vocabulary relevant to the lesson, such as *absorption*, *immerse*, *saturated*, *paper towel*, *brand-name*, and *generic*. For more vocabulary resources, visit [VocabularyA-Z.com](http://www.VocabularyA-Z.com).
- *Home Connection*: Challenge students to conduct their own experiment at home. Ask them to identify and explain the variables and their results to the class.

## ANSWER KEY

EXPERIMENT

Science Skills—Working with Variables Data Sheet

Name \_\_\_\_\_ Date \_\_\_\_\_

**Part 1:** Identify the Variables

**Research Question:** Will a brand-name paper towel absorb more water than a generic paper towel?

**Hypothesis:** If I compare the absorbency of two kinds of paper towels, then the more expensive brand will absorb more water because it is thicker and has more absorbent fibers.

**Independent Variable:** (Which variable are you investigating?)

*The independent variable is the type of paper towel—generic or brand-name.*

**Dependent Variable:** (What will the results measure?)

*The dependent variable is the amount of water that is absorbed by the paper towels.*

**Controlled Variables:** (What things will you make sure stay the same during the experiment?)

- 1. The paper towels are cut to the same size.*
- 2. All towels are completely submerged in the water.*
- 3. The paper towels are submerged in the same amount of water each time.*
- 4. The paper towels are left submerged in the water for the same period of time.*
- 5. The paper towels are allowed to drip excess water back into the cup for the same period of time.*

**Part 2:** Conducting the Experiment and Controlling the Variables**Collect Data**

	Volume of Water	
	Generic	Brand-name
Test 1	<i>Results will vary, depending on which brands of paper towels are used. Check to make sure that results for the three trials of generic paper towels are similar to one another and that the results for the three trials of brand-name paper towels are similar to one another. You may also want to chart each group's results so that they can be compared with the class results. This will let you know if any one group has obtained results that are dramatically different from the others.</i>	
Test 2		
Test 3		
Average		

**Observations:** Write about your results.

Was the hypothesis supported by the results? Which kind of paper towel was more absorbent?

*Results will vary, depending on which paper towels are used. Generally, brand-name paper towels will be more absorbent than generic paper towels. However, it is possible that some generic brands will perform just as well or even better than the brand-name in terms of absorbency.*



**ANSWER KEY AND EXPLANATIONS****Critical Thinking**

1. Explain the difference between an independent and a dependent variable.

*The independent variable is the variable that changes in an experiment. The dependent variable is what is measured during an experiment. The dependent variable depends on the independent variable. In this experiment, the independent variable was the kind of paper towel, and the dependent variable was the volume of water each kind of paper towel absorbed.*

2. Did controlling the variables in this experiment help you analyze your results? Explain why or why not.

*Answers will vary, but students should base their response on their knowledge of the controlled variables in this experiment. Students may suggest that if you don't control the variables in an experiment, then you won't know for sure whether the results are due to the independent variable or due to something else that changed during the experiment.*

3. Why is it important to control the variables in a science experiment?

*Controlling for unintended variation within an experiment must be included in the experimental design. By following these steps, one can be sure that the results of the experiment are due to changes in the independent variable and not to some other variable that changed during the experiment. For example, in this experiment, if the brand-name paper towels were found to be more absorbent than the generic ones, but were also cut larger, then students could not draw a valid conclusion. The result could be due to fact that the brand-name towels are actually more absorbent or because the surface area was larger and therefore could absorb more water.*

4. Why do you think you were asked to test each paper towel three times and find the average?

*One purpose of controlling variables within a science experiment is to reduce unintended differences within the data. However, even in the best experiments, results may vary from one trial to the next. In order to reduce the effect that this variation has on the conclusion that can be drawn, scientists often average the results from many trials of the same experiment.*

5. If your teacher asked you to design an experiment about candy bars and heat, what would be your independent variable, dependent variable, and controlled variables?

*Results will vary, depending on the type of experiment the student designs. The experimental design should demonstrate that students understand the difference between the independent and dependent variables. Students should also include ideas for controlling variables within the experiment.*