

# Falling Flat

## TEACHER'S PREPARATORY GUIDE

### Purpose

Based on the results of the scientific investigation, students will be able to identify sources of error.

### Advance Preparation

You will need a microwave oven for this activity. Make sure that there is an outlet and/or adapter to accommodate the microwave in your classroom. You will also need to create “muffin supports” from small paper cups. Do so by trimming the sides of each cup, leaving a 2.5 cm wall. Each student group will need one set of supports labeled 1-4. To determine the amount of dry mix and wet mix to prepare, multiply the quantities listed on this page by the number of groups.

To determine the baking time for a plate of muffins, you may wish to prepare a sample of batch #3 from student worksheet the day before the experiment. Each group will cook a batch of four muffins, so choose a standard batch size of 8 or 12 muffins based on the size of the plate you are using. In a 650 watt microwave oven, six 50 mL samples of batter will cook in 1 ½ to 2 ½ minutes. Bake for 1 ½ minutes, then insert a wooden toothpick into the center of one of the muffins. If batter sticks to the toothpick, continue baking, and test the muffins again every 30 seconds. Note the total cooking time. Successful test batches can be brought to class.

The muffins that rise are edible. You may wish to have some additional edible muffins on hand for students to enjoy after the activity.

### Additional Materials

#### Dry Mix

- 225 mL (1 cup) of flour
- 55 mL (¼ cup) of sugar
- 1.2 mL (¼ tsp) of salt

#### Wet Mix

- 1 egg
- 55 mL (¼ cup) of oil
- 55 mL (¼ cup) of milk

### Safety Information

Instruct students to allow muffins to cool before handling them. Students should use oven mitts or potholders when handling the hot plates.

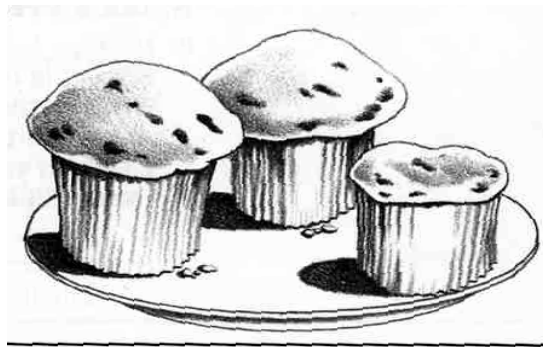
### Teaching Strategies

If performed in the classroom, this activity works best in groups of 3-4 students. Cream of tartar produces tartaric acid when moistened. This acid then reacts with baking soda ( $\text{NaHCO}_3$ ), a base, to release carbon dioxide gas ( $\text{CO}_2$ ). Heating also causes the baking soda to release carbon dioxide. The carbon dioxide forms bubbles in the batter that expand as the batter is heated, making the muffins light and fluffy. Baking powder, a common leavening agent, is made up of baking soda and tartaric acid. The acid and the base in baking powder do not interact until the powder is moistened.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Class: \_\_\_\_\_

## Falling Flat

How do muffins rise in the morning? Like us, they usually need a little help. But instead of an alarm clock, like we use, they rely on a simple chemical reaction. Sodium bicarbonate (baking soda) and an acid combine to produce carbon dioxide gas. What would happen if you left these ingredients out? If you're not afraid of your experiment "falling flat," go ahead and try it!



### Materials

- 10 mL graduated cylinder
- water
- 2 test tubes
- 1.2 mL ( $\frac{1}{4}$  tsp) of baking soda (sodium bicarbonate)
- 0.6 mL ( $\frac{1}{8}$  tsp) of cream of tartar (tartaric acid)
- 4 paper muffin liners
- 4 prelabeled muffin supports
- 4 – 100 mL beakers
- 25 mL graduated cylinder
- 4 – 50 mL beakers
- 4 forks
- microwavable plate
- microwave oven
- 2 oven mitts
- metric ruler

### Ask a Question

What are the effects of combining a base (sodium bicarbonate) with an acid (tartaric acid) in the making of muffins?

### Make Observations

1. Measure 3 mL of water in the 10 mL graduated cylinder, and pour the water into a test tube.
2. Add the baking soda to the tube, and swirl the mixture.

Describe what you see.

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3. Add the cream of tartar to 3 mL of water in the second test tube, and swirl the mixture.  
What do you see?
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4. Now pour the contents of the second tube (tartaric acid) into the first test tube.  
Describe and explain what happens.
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## Make a Prediction

5. In steps 1-3, you observed the effects of a chemical reaction involving baking soda, cream of tartar, and water. Now you will mix these three substances in various combinations into muffin batter to see how they affect the baking of muffins. Based on your observations from steps 1-3, predict what you think will happen to the muffins as they are baked.
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## Conduct an Experiment

6. Number and label each paper muffin liner with the name of one person in your group. Place each liner in a support.
7. Each member of your team should mix one of the four batches given below by following these steps:
- Measure and level 40 mL of dry ingredients in a 50 mL beaker by tapping the beaker lightly on the desk. Pour the ingredients into a 100 mL beaker.
  - For batches 1-3 only, measure baking soda and/or cream of tartar and mix with the dry ingredients using a fork.
  - Make a well in the center of the dry mixture.
  - Measure 22 mL of liquid mix in the 25 mL graduated cylinder, and pour the liquid into the well you made in the dry ingredients.
  - Stir only enough to moisten the dry ingredients.
  - Measure a beakerful of batter with a 50 mL beaker. Level off the batter by scraping the beaker with a fork, and pour the batter into the corresponding liner. Discard the remaining batter in a designated trash bag.

### For each batch:

- 40 mL (2 tbsp + 2 tsp) of dry mix
- 22 mL (1 tbsp + 1½ tsp) of wet mix

### To batch #1 add:

- 5 mL (1 tsp) of cream of tartar

### To batch #2 add:

- 1.8 mL ( $\frac{3}{8}$  tsp) of baking soda

### To batch #3 add:

- 5 mL (1 tsp) of cream of tartar
- 1.8 mL ( $\frac{3}{8}$  tsp) of baking soda

### To batch #4 add:

- no additional ingredients

You are now ready to begin baking

8. Keep all four samples together. Your teacher will coordinate the baking of the batter samples. Baking will take 1.5 to 2.5 minutes.
9. Once your muffins are baked and have cooled for 5 minutes, collect your group's samples.
10. Record and compare the height of your four muffins in the table below.

**Table 1.a: Muffin Height Data Chart**

<b>Batch</b>	<b>Baking soda</b>	<b>Cream of tartar</b>	<b>Height (cm)</b>
<b>1</b>	<b>no</b>	<b>yes</b>	
<b>2</b>	<b>yes</b>	<b>no</b>	
<b>3</b>	<b>yes</b>	<b>yes</b>	
<b>4</b>	<b>no</b>	<b>no</b>	

**Analyze the Results**

11. Compare your results with your prediction, and explain any differences.

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