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Bon Appétit: Explorations in Food Chemistry

Experiment

What's the Difference Between Baking Soda and Baking Powder?

- Go Direct pH Sensor
- Go Direct CO_2 Gas Sensor

Workshop Presenter

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What's the Difference between Baking Soda and Baking Powder?

Everything you use to prepare food is made from chemicals. In the kitchen, a number of white powders are used in many recipes—sugar, table salt, baking soda, baking powder, cream of tartar, flour, and starch are a few examples. All of these substances are chemicals.

Two white powders that are sometimes misunderstood are baking soda and baking powder. Both are used in the kitchen, but what is the advantage of one over the other? In this activity, you will answer this question while investigating some of the physical and chemical properties of baking soda, baking powder, and cream of tartar.

In Part I, you will measure the pH of solutions made from each chemical. The pH of a solution tells you whether the substance is an acid, base, or neutral. It may surprise you to learn that many of the substances that you eat are acids and bases.

In Part II, you will learn about the difference between baking soda and baking powder and when it is advantageous to use one over the other in cooking. Baking soda and baking powder are *leavening agents*, compounds that release carbon dioxide gas to create bubbles when used in baking. You will measure and compare the amount of carbon dioxide produced by both substances. Finally, you will make your own baking powder and test how it compares to commercial baking powder.

OBJECTIVES

- Measure the pH of solutions made from powdered substances used in the kitchen.
- Learn about the chemical difference between baking soda and baking powder by graphing the amount of carbon dioxide produced when each is mixed with water.

PRE-LAB ACTIVITY

1. Look up the chemical names and formulas for the substances in Table 1.
2. Draw a structural formula for each substance.
3. From what you already know about these substances, predict if each is *acid*, *base*, or *neutral*.

Table 1				
Substance	Chemical name	Chemical formula	Structural formula	Prediction: Acid, base, or neutral?
Baking soda				
Cream of tartar				

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct pH Sensor
Go Direct CO_2 Gas Sensor
goggles
balance
3 test tubes, 16 × 150 mm
test tube rack
10 mL graduated cylinder
250 mL Nalgene® bottle
stirring rod
distilled water
wash bottle
baking soda
baking powder
cream of tartar

PROCEDURE

Part I Acid, base, or neutral

1. Obtain and wear goggles.
2. In separate, labeled test tubes, dissolve about 0.1 g of each powder in enough distilled water to cover the bulb at the end of the pH electrode. Stir with a clean stirring rod.
3. Launch Graphical Analysis. Connect the Go Direct pH Sensor to your Chromebook, computer, or mobile device.

4. Click or tap View, . Turn on Meters and turn off Graph and Data Table (if displayed). Then, dismiss the View menu.

5. Measure the pH of each solution and record the value in Table 2. Rinse the pH sensor with distilled water between measurements.

6. Dispose of the waste as directed by your instructor. Rinse all the test tubes thoroughly.

7. Rinse the pH sensor and return it to the pH storage solution.

Part II The Difference Between Baking Soda and Baking Powder

8. Click or tap Sensors, , and disconnect the pH sensor. Then, connect to the Go Direct CO_2 Gas Sensor.

9. Click or tap File, , and select New Experiment.

10. Set up the data-collection mode.

    a. Click or tap Mode to open Data Collection Settings.
    b. Change End Collection to 300 s. Click or tap Done.

11. Prepare the bottle for data collection.

    a. Weigh 1.0 g of baking soda on a piece of weighing paper.
    b. Place 10 mL of distilled water into the 250 mL bottle.
    c. Place the baking soda into the bottle.

12. Place the shaft of the CO_2 gas sensor in the opening of the plastic bottle. Gently push the sensor down into the bottle until the sensor fits snugly. The sensor is designed to seal the bottle without the need for unnecessary force.

13. Wait 10 seconds, then click or tap Collect to start data collection. Data will be collected for 300 seconds.

14. Rename the data set.

    a. Tap the y-axis label, CO_2 Gas, and choose More Options, , for Data Set 1.
    b. Select Rename Data Set.
    c. Enter **Baking Soda** as the name, and click or tap Rename.

15. Remove the CO_2 gas sensor from the bottle. Fill the bottle with water to force out the gas. Discard the water and dry the bottle with a paper towel.

16. Wait for the CO_2 reading to return to a reading close to one at the beginning of the graph. To speed up the process, you can gently wave the sensor in the air, but do not blow air (exhale) into the sensor.

17. Repeat Steps 11–16 using baking powder. When you rename the data set, enter **Baking Powder** as the name.

18. Now you will make homemade baking powder. Baking powder is simply a combination of baking soda and a dry acid such as cream of tartar:

    a. Weigh 0.9 g of baking soda. Place the baking soda in a clean, dry test tube.
    b. Weigh 0.1 g of cream of tartar. Place the cream of tartar in the same test tube as the baking soda.
    c. Tap the lower side of the test tube to completely mix the baking soda and cream of tartar.

19. Repeat Steps 11–15 with your homemade baking powder. Enter **Homemade** as the name for this data set.

20. Save your data.

DATA TABLE

Table 2

Powder	pH of solution	Acid, base, or neutral?
Baking soda		
Baking powder		
Cream of tartar		

DATA ANALYSIS

1. Acids and bases are commonly characterized by measuring pH. The pH scale runs from values of 1 to 14. Substances with pH values lower than 7 are considered acids and ones with pH values above 7 are considered bases. Substances with pH values near 7 are considered neutral. In Table 2, indicate if the substances are acid, base, or neutral.

2. Write the balanced equations for the following chemical reactions:

    a. The reaction of baking soda with vinegar.
    b. The reaction of baking soda with cream of tartar.

3. Compare the previous two chemical reactions.

    a. How are the reactions similar?
    b. How are the reactions different?

4. Compare the data for baking soda and baking powder. What can you conclude about the amount of carbon dioxide produced?

5. When baking soda is mixed with cream of tartar, very little, if any, reaction occurs. Why must water be present for baking soda to react with cream of tartar?

6. Why is cream of tartar a needed ingredient in baking powder?

7. What additional tests on the powders could also be performed?