

Activity 5.6

Change in temperature—Exothermic reaction

Can the temperature increase during a chemical reaction?

In *Activity 5.4*, students saw that the temperature decreased during the chemical reaction between baking soda and vinegar. In this activity, students will add calcium chloride to a baking soda solution and observe an *increase* in temperature along with the production of a gas and a white precipitate. A change in temperature is a clue that a chemical reaction has occurred. A reaction that results in an increase in temperature is called an *exothermic* reaction.

Materials

| | | |
|----------------------|---|-----------------|
| Baking soda solution | Thermometer | 2 Small cups |
| Calcium chloride | Graduated cylinder, 50 ml | Waste container |
| Water | $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$ Teaspoons | Paper towels |

Notes about the materials

- **Be sure you and the students wear properly fitting goggles.**
- Calcium chloride is sold in hardware stores as a moisture absorber under the name DampRid®. It is also available through the chemical supplier your school or district uses. If the container is sealed tightly, calcium chloride will keep for many uses.
- The bulb of the thermometer needs to be completely submerged in the baking soda solution. Due to the small amount of baking soda solution suggested in the initial procedure, you may need to have students tilt their cups of baking soda solution so that the bulb of the thermometer is completely submerged. If your thermometers have a plastic backing, you may be able to “lower the bulb” by clipping the plastic backing so that it is even with the bottom of the bulb.

Preparing materials

- Label 2 small cups **calcium chloride** and **baking soda solution**.
- Place about 1 rounded tablespoon of calcium chloride in its labeled cup for each group. If using DampRid® place about 2 tablespoons in the calcium chloride cup.
- Make the baking soda solution for the entire class by adding $\frac{1}{4}$ cup of baking soda to 2 cups of water. Stir until the baking soda is as dissolved as possible. It's ok if some is left undissolved.
- Pour about $\frac{1}{4}$ cup of baking soda solution in its labeled cup for each group.

Activity sheet



Copy *Activity sheet 5.6—Change in temperature: Exothermic reaction*, p. 284, and distribute one per student when specified in the activity.

Assessment

An assessment rubric for evaluating student progress during this activity is on pp. 305–307. For this formative assessment, check a box beside each aspect of the activity to indicate the level of student progress. Evaluate overall progress for the activity by circling either “Good”, “Satisfactory”, or “Needs Improvement”.

Activity 5.6

Change in temperature—Exothermic reaction

Question to investigate

Can the temperature increase during a chemical reaction?

1. Have students observe and record the temperature change of calcium chloride reacting with a baking soda solution.



Distribute *Activity sheet 5.6—Production of a gas.*

Note: If using DampRid®, have students use 1 teaspoon of DampRid® instead of the ½ teaspoon of calcium chloride specified in the procedure.

Procedure

1. Use a graduated cylinder to measure 10 ml of baking soda solution and pour it into a clear plastic cup.
2. Place a thermometer in the baking soda solution. Read the thermometer and record the temperature on the activity sheet.



3. While the thermometer is in the cup, add ½ teaspoon of calcium chloride.
4. Watch the thermometer to observe any change in temperature. Record the highest temperature on the activity sheet.



Expected results: The temperature of the solution increases from about 20 °C (about 70 °F) to about 45 °C (about 110 °F). Carbon dioxide gas is produced and a white cloudy precipitate, calcium carbonate, is formed.

2. Discuss with students what they might change to make the reaction get even hotter.

Ask students what they might change to increase the temperature by another 5 °C or about 10 °F. Students may suggest increasing the amount of calcium chloride or baking soda solution or both. Discuss whether it makes sense to change the amount of both at the same time or if it would be better to change the amount of just the calcium chloride or baking soda solution first. Try to have students understand that dealing with one variable at a time is a good strategy at first. That way, students can see how much each variable affects the result.

3. Have students conduct their trials.

Remind students that the goal is to increase the temperature by 5 °C or about 10 °F, not as much as possible. You may choose to limit students to a maximum of three tries or let them experiment further if time and supplies allow.

Procedure

Students should follow the same procedure as before except adjust the amounts of calcium chloride or baking soda solution. As expected, increasing the amount of calcium chloride increases the temperature of the reaction. However, if students try increasing the amount of baking soda solution, they will find that the temperature does not increase as much. This is because any possible advantage gained by adding more baking soda is counterbalanced by the additional volume of solution that needs to be heated. It may not be intuitive; but *decreasing* the amount of baking soda solution is actually one way to increase the temperature of the reaction.



Expected results: Adding $\frac{3}{4}$ teaspoon of calcium chloride instead of $\frac{1}{2}$ teaspoon is one way to reach the target temperature. Using 5 mls of baking soda solution instead of 10 is another way to reach the target temperature.

Once students have discovered the effect of changing the amount of each of the reactants, they may try increasing the amount of calcium chloride while also decreasing the amount of baking soda solution.