# Lesson 2: Endothermic and Exothermic Reactions, adapted from Vernier Science Education and the American Chemical Society

## Objective:

The objective of this investigation is for students to explore energy changes during chemical reactions, heat of reaction, and the connection between energy changes and chemical changes.

This investigation introduces or reinforces the concepts of enthalpy of reaction in the context of endothermic and exothermic reactions. In this investigation, students will observe and measure the temperature changes in two chemical reactions using a Sci-VoiceTM Talking LabQuest connected to a temperature probe, calculate the change in temperature (Δt) of the reaction, and identify the reaction as either endothermic or exothermic.

## NGSS:

PS1A: Structure and Properties of Matter PS1B: Chemical Reactions

PS3A: Definitions of Energy

PS3B: Conservation of Energy and Energy Transfer

## Essential Questions:

1. What is an endothermic reaction?
2. What is an exothermic reaction?

## Materials:

* 1 Sci-VoiceTM Talking LabQuest connected to one Vernier temperature probe
* Notched syringe
* Two 250 mL labeled beakers to hold two Styrofoam cups
* One 250 mL rinse beaker containing distilled water to rinse the temperature probe
* Labeled 100 mL beakers with different chemicals (vinegar, 3% hydrogen peroxide solutions), baking soda, and active yeast
* Goggles
* Lab coat or apron
* Device to record data taken during the experiment

Preparation Notes: Depending on the individualized needs of the students, the mass of baking soda can be pre-measured in a labeled container such as a 50 mL beaker or weighed by the student on an accessible balance. Similarly, students can be provided with active yeast either in or out of an individual packet. As this investigation involves measuring temperature changes, it is recommended that dry yeast be added rather than activating it in warm water.

The labeled beakers need to be placed on more than one cafeteria-style tray to organize the workspace. The labels may be braille or large print based on the needs of the student. It is recommended that numbers are used as labels, which students can reference against a braille or large-print legend during the lab activity, which relates numbers and chemicals.

## Lesson Sequence:

1. Before beginning the lesson, it is suggested that a review of previous learning be completed. To give students a deeper grounding in the basics and reinforce basic concepts, review the mechanics of chemical changes, how to write balanced chemical equations, and the law of conservation of energy. Some chemistry vocabulary and concepts that can be introduced and/or reinforced in this lesson are: heat, temperature, endothermic, exothermic, system, surrounding, and open system.
2. Have students place a Styrofoam cup into their 250 mL beaker.
3. Use a notched syringe to measure out 30 mL of vinegar into the Styrofoam cup.
4. Place the temperature probe into the vinegar and record the initial temperature once the reading stabilizes after approximately 30 seconds.
5. Add baking soda into the vinegar
6. Stir with temperature probe to ensure good mixing.
7. Collect data until the temperature readings do not change. (Encourage students to decide the intervals of data they want to take, starting with every 2–5 seconds.)
8. End data collection and record final temperatures.
9. Dispose of reaction products.
10. Rinse the temperature probe in the rinse beaker.
11. Repeat the procedure using 3% hydrogen peroxide and active yeast
12. Once the experiments are complete, facilitate a whole-class discussion with guiding questions where students share their observations and explanations of what they observed.
13. What were the temperature changes for each reaction?
14. In which reaction was there a negative temperature change?
15. What does a negative temperature change mean?;
16. Which chemical reaction is pulling in energy from its surroundings? Explain your reasoning.
17. Which reaction was endothermic? Which was exothermic? Explain your reasoning.
18. Were the rates of the two reactions the same? Explain your thinking.

## Extension Activities:

As an extension, students can repeat this experiment for different masses of baking soda (e.g., 2.5 g, 5.0 g, 15.0 g), calculate the energy change in joules per gram of solid baking soda, and use the calculations to make predictions.