When you add energy to a substance through heating, does the substance’s temperature always go up? When you remove energy from a substance through cooling, does the substance’s temperature always go down? In this lab you’ll investigate these important questions with a very common substance—water.

**OBJECTIVES**
- **Measure** and record time and temperature accurately.
- **Graph** the temperature change of water as it changes state.
- **Analyze** and interpret graphs of phase changes.

**MATERIALS**
- beaker, 250 or 400 mL
- coffee can, large
- gloves, heat-resistant
- 100 mL grad. cylinder
- graph paper
- hot plate
- ice, crushed
- rock salt
- stopwatch
- thermometer
- water
- wire-loop stirring device

**PROCEDURE**
1. Fill the beaker about with approximately 100 mL of water.
2. Turn on the hot plate, and put the beaker on the burner. Put the thermometer in the beaker. **Caution:** Be careful near the heat. Use heat resistant gloves to handle the beaker while heating.
3. Record the temperature of the water every 30 seconds in Table 1-Heating the Water. Continue until about 25 mL of water boils away. Then turn off the hot plate.
4. Put a star in the box of the first temperature reading at which the water is steadily boiling.
5. While the beaker is cooling, make a graph of temperature (y-axis) versus time (x-axis). Draw an arrow pointing to the first temperature at which the water was steadily boiling.
6. After you finish the graph, use heat-resistant gloves to pick up the beaker. Pour the warm water out, and rinse the warm beaker with cool water. **Caution:** Even after cooling, the beaker is still too warm to handle without gloves.
7. Put approximately 20 mL of water in the graduated cylinder.
8. Put the graduated cylinder in the coffee can, and fill in around the graduated cylinder with crushed ice. Pour rock salt on the ice around the graduated cylinder. Place the thermometer and the wire-loop stirring device in the graduated cylinder.
9. As the ice melts and mixes with the rock salt, the level of ice will decrease. Add as needed.
10. Record the temperature of the water in the graduated cylinder every 30 seconds in Table 2-Cooling the Water. Stir the water with the stirring device. **Caution:** Do not stir with the thermometer!!!!!
11. **Once the water begins to freeze, stop stirring. Do not try to pull the thermometer out of the solid ice in the cylinder.**
12. Put a star in the box of the temperature when you first notice ice crystals forming in the water. Continue taking readings until the water in the graduated cylinder is completely frozen.
13. Make a graph of temperature (y-axis) versus time (x-axis). Draw an arrow to the temperature reading at which the first ice crystals form in the water in the graduated cylinder.
A Hot and Cool Lab

When you add energy to a substance through heating, does the substance’s temperature always go up? When you remove energy from a substance through cooling, does the substance’s temperature always go down? In this lab you’ll investigate these important questions with a very common substance—water.

OBJECTIVES
- **Measure** and record time and temperature accurately.
- **Graph** the temperature change of water as it changes state.
- **Analyze** and interpret graphs of phase changes.

MATERIALS
- beaker, 250 or 400 mL
- coffee can, large
- gloves, heat-resistant
- 100 mL grad. cylinder
- graph paper
- hot plate
- ice, crushed
- rock salt
- stopwatch
- thermometer
- water
- wire-loop stirring device

PROCEDURE
1. Fill the beaker about with approximately 100 mL of water.
2. Turn on the hot plate, and put the beaker on the burner. Put the thermometer in the beaker.
   **Caution:** Be careful near the heat. Use heat resistant gloves to handle the beaker while heating.
3. Record the temperature of the water every 30 seconds in Table 1-Heating the Water. Continue until about 25 mL of water boils away. Then turn off the hot plate.
4. Put a star in the box of the first temperature reading at which the water is steadily boiling.
5. While the beaker is cooling, make a graph of temperature (y-axis) versus time (x-axis). Draw an arrow pointing to the first temperature at which the water was steadily boiling.
6. After you finish the graph, use heat-resistant gloves to pick up the beaker. Pour the warm water out, and rinse the warm beaker with cool water.
   **Caution:** Even after cooling, the beaker is still too warm to handle without gloves.
7. Measure approximately 20 mL of water into the Test Tube.
8. Put the test tube in the coffee can, and fill in around the test tube with crushed ice. Pour rock salt on the ice around the test tube. Place the thermometer and the wire-loop stirring device in the test tube.
9. As the ice melts and mixes with the rock salt, the level of ice will decrease. Add as needed.
10. Record the temperature of the water in the test tube every 30 seconds in Table 2-Cooling the Water. Stir the water with the stirring device.
   **Caution:** Do not stir with the thermometer!!!!
11. **Once the water begins to freeze, stop stirring. Do not try to pull the thermometer out of the solid ice in the tube.**
12. Put a star in the box of the temperature when you first notice ice crystals forming in the water. Continue taking readings until the water in the test tube is completely frozen.
13. Make a graph of temperature (y-axis) versus time (x-axis). Draw an arrow to the temperature reading at which the first ice crystals form in the water in the test tube.
A Hot and Cool Lab

ANALYZE THE RESULTS (Answer the following in complete sentences.)

1. **Describe** the state change when heating water. Is this endothermic or exothermic?

2. Explain how and where evaporation and boiling are present when water is heated. (Use page 40 in your book to help you.)

3. **Describe** the state change when cooling water. Is this endothermic or exothermic?

4. When water reaches the boiling point, what happens to the temperature as you continue to add energy by heating? (Look at the graph on page 43 of your book for help)

5. When water reaches the freezing (melting) point, what happens to the temperature as you continue to remove energy by cooling? (Look at the graph on page 43 of your book for help)

6. Look at your 2 graphs. How did temperature change in the endothermic process? How did temperature change in the exothermic process?
Create graphs of {**Temperature versus Time**} for both HEATING and COOLING. Label the states of matter (solid, liquid, gas) and changes of state (boiling, freezing). Do not forget **title** and axis **labels** for your graphs. You chose the **TIMES** to record, so this is the independent variable and should be plotted on the x-axis. The **TEMPERATURE** was what changed for each time you recorded, so this is the dependent variable and should be plotted on the y-axis.

1) HEATING

2) COOLING