

## Technology Idea: Change of State

### Background:

Freezing temperature, the temperature at which a substance turns from liquid to solid, and melting temperature, the temperature at which a substance turns from a solid to a liquid, are characteristic physical properties.

For this activity, a temperature sensor is used to track the temperature of ice water. By examining graphs of the data, the freezing and melting temperatures of water will be determined and compared.

### Question:

At what temperature does water change its phase?

### Materials:

- temperature sensor
- USB link
- base and support rod
- beaker, 400 mL
- beaker, 50 mL
- buret clamp
- graduated cylinder, 10 mL
- stirring rod
- test tube
- watch or clock
- apron and safety goggles
- computer and data collection software (such as DataStudio)

### Procedure:

#### Step 1:

Connect the temperature sensor to your computer.

## Step 2:

Configure the data collection software to collect temperature data over time. Configure the software so that the temperature sensor collects data more slowly, about one reading every 20 or 30 seconds (this can be done in DataStudio by clicking the "setup" button).

## Step 3:

Perform the following:

- Put about 100 mL of water and 5 to 6 ice cubes into a 400 mL beaker.
- Put 5 mL of water into a test tube and use a buret clamp to fasten the test tube to a support rod. The test tube should be situated above the water bath.
- Place a temperature sensor into the water inside the test tube.

## Step 4:

Perform the following:

- Lower the test tube into the ice-water bath and begin collecting data with the software (click "start"). Collect data for 15 minutes.
- Immediately after lowering the test tube, add about 40 ml of salt to the beaker while stirring with a stirring rod.
- Gently but continuously move the sensor during the first 10 minutes.
- When 10 minutes have gone by, stop moving the sensor and allow it to freeze into the ice. Add more ice cubes to the beaker as the original ice cubes get smaller.
- Stop collecting data with the software (click "stop")
- Keep the test tube submerged in the ice-water bath until step 5.

## Step 5:

Perform the following:

- Get ready for a second run of data recording.
- Begin collecting data with the software. Raise the test tube and fasten it into position above the ice-water bath.
- Do not move the temperature sensor.
- Dispose of the ice water as directed by your teacher.
- Put 250 mL of warm tap water in the beaker. When 12 minutes have passed, lower the test tube and its contents into this warm-water bath.
- Stop recording data after a total of 15 minutes.

**Analyze:**

1. What happened to the water temperature during freezing? During melting?
2. According to your data and graph, what is the freezing temperature of water? (If you are using DataStudio software, click on the "Smart Cursor" button. The cursor becomes a crosshair, which you can drag over the graph in order to more easily determine the coordinates at any particular point.) What seems to be the melting temperature?

**Conclude and Apply:**

3. How does the freezing temperature of water compare to its melting temperature?