ScienceCube

Volume Change of Water Due to Heat

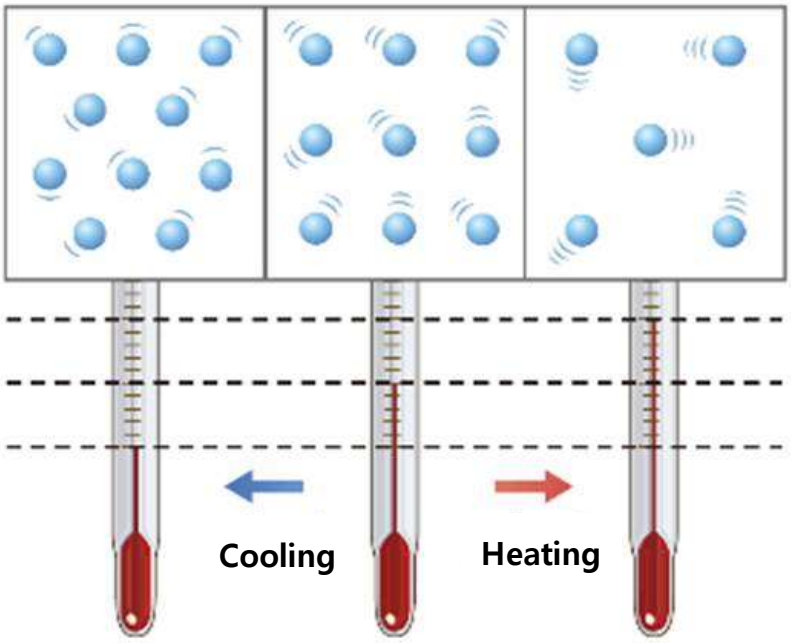
Learning Objectives Observing and Explaining Volume Changes of Water with Temperature During Heating and Cooling

Should I think about it? What happens to the water column in the glass tube when the water-filled test tube is heated?

Learning Content

1. Volume of Liquids According to Temperature

Although the shape of a liquid changes depending on the container, the volume remains almost constant.. Therefore, if a liquid is placed in a standard container, its volume can be measured and compared. However, the volume changes when the liquid is heated. When a glass tube is inserted into a test tube filled with water and the test tube is heated, the height of the water column in the glass tube increases. This is because the volume of the water expands as it is heated. When the test tube is cooled again, the height of the water column decreases.. Thus, while the volume of a liquid remains constant despite changes in shape, it changes with temperature. Thermometers also use this principle, where the volume of the liquid changes according to temperature.



2. Reason for Volume Changes in Liquids

When the temperature of a liquid increases, the movement of the molecules that make up the liquid becomes more active, increasing the gaps between molecules. This is called thermal expansion of the liquid. Liquids expand more than solids because the intermolecular forces in liquids are weaker than in solids. Comparing the degree of thermal expansion among different states of matter, gases expand the most, followed by liquids, and then solids. In solids, the strong intermolecular forces cause molecules to vibrate in place, resulting in minimal expansion when heated. In liquids and gases, molecules move and vibrate, causing greater volume changes than in solids.

3. Temperature Sensor

- Can measure temperatures between -50℃ and 180℃.
- The sensor contains a component whose resistance changes with temperature, allowing it to display measurement values.
- Made of stainless steel.

Experimental Activities

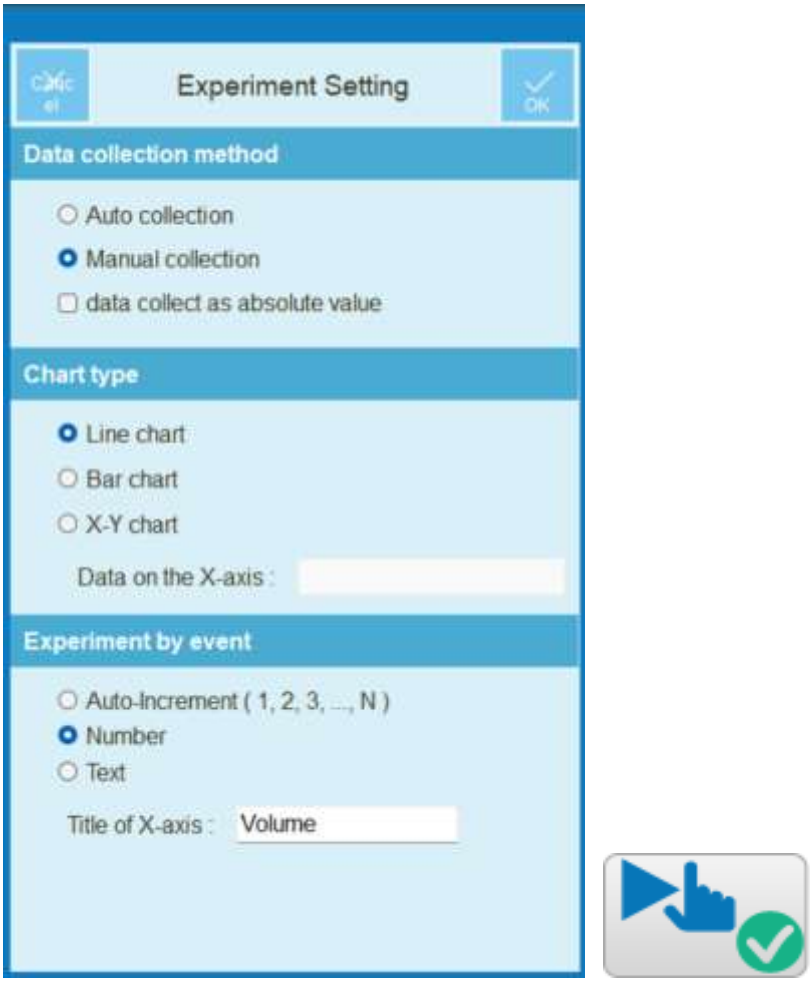
Materials Needed

Interface, Science# program (smart device), Temperature sensor, 1 mL syringe, Test tube, Cork stopper, 250 mL beaker, Alcohol lamp, Stand (including 2 clamp holders), Awl, Coloring agent

Experimental Procedure

Setting Up the Equipment

1. Run the Science# program on the smart device and connect it to the powered interface via Bluetooth or cable.
2. Connect the temperature sensor to the interface.
3. Press the button  in Science# to set up the experimental environment as shown below. (Press the button for automatic setup.)



Experiment

1. Drill a hole in the cork stopper to insert the syringe. Insert the syringe into the stopper up to the 20 mL mark.

2. Pour about 200 mL of water into the beaker and place it on the stand.
3. Adjust the wick length of the alcohol lamp and place it under the stand.
4. Fill the test tube with colored water, leaving about 1 cm at the top, and seal it with

the stopper containing the syringe. (Ensure that the water in the test tube slightly rises into the syringe.)

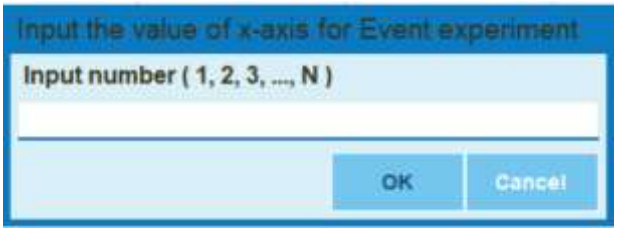
5. Secure the test tube in the clamp holder, submerging it in the water-filled beaker. Ensure the test tube does not touch the bottom of the beaker, leaving a gap of 1-2 cm.

6. Insert the temperature sensor into the syringe and secure it with another clamp holder.

7. Adjust the stopper in the test tube so that the water column in the syringe is at the 20 mL mark.

8. Light the alcohol lamp with a lighter and press the button  to start data collection.

9. Press the button  to record the initial temperature, noting the volume on the X-axis. Example: 20.



10. Observe the water column in the syringe and measure the temperature at each 10 mL increase in volume by pressing the button  and entering the volume on the X-axis. Example: 30, 40, etc.

11. Continue measuring the temperature until the volume reaches 100mL, then press the button  to end the experiment.

Experimental contents

1. Display and compare the changes in volume with temperature using a graph and table.

[Graph]

[Table] Press the table chart button  , then press the Y-axis data button  to add the corresponding values.

2. Explain how the volume of water changes with temperature based on the experiment results.

Experimental results

1. After the experiment, predict how the height of the water in the syringe will change if the test tube is quickly placed in ice water.

2. Explain the principle of a thermometer based on the experiment results.