ScienceCube

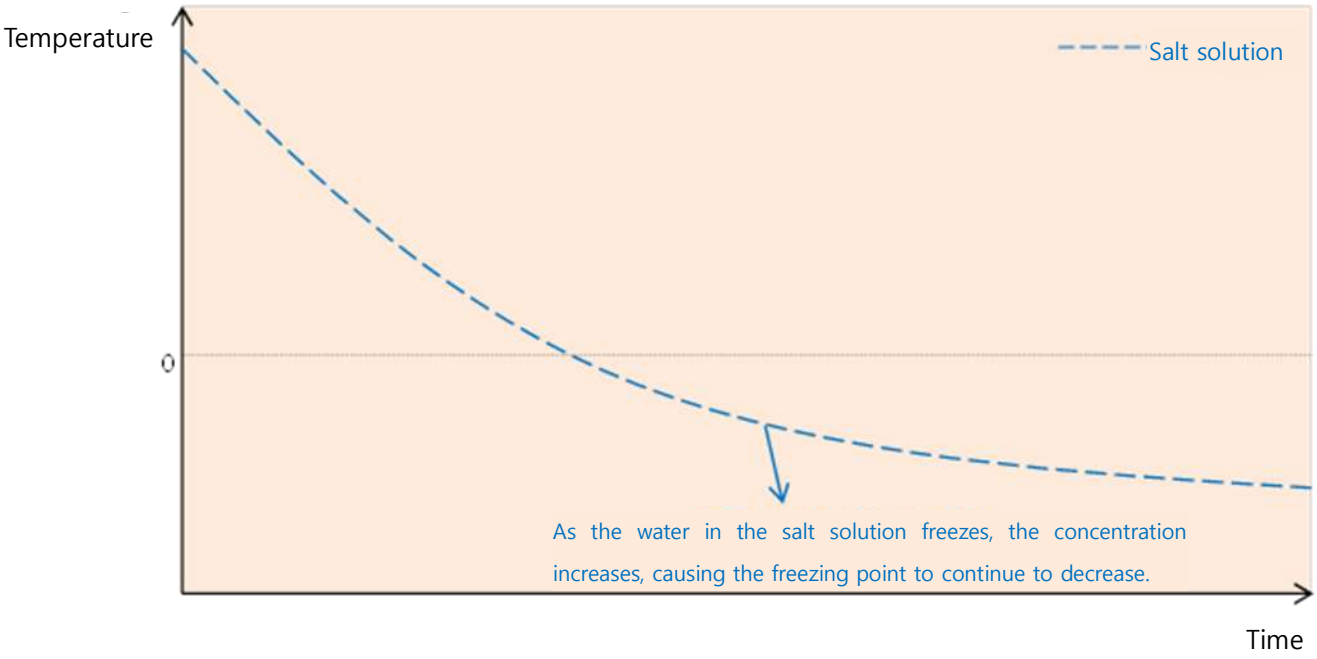
# Supercooling Phenomenon

1. **Observing and explaining the freezing point depression phenomenon in mixtures.**
2. **Observing the supercooling phenomenon in pure substances and explaining the cause.**

## Fundamental Concept

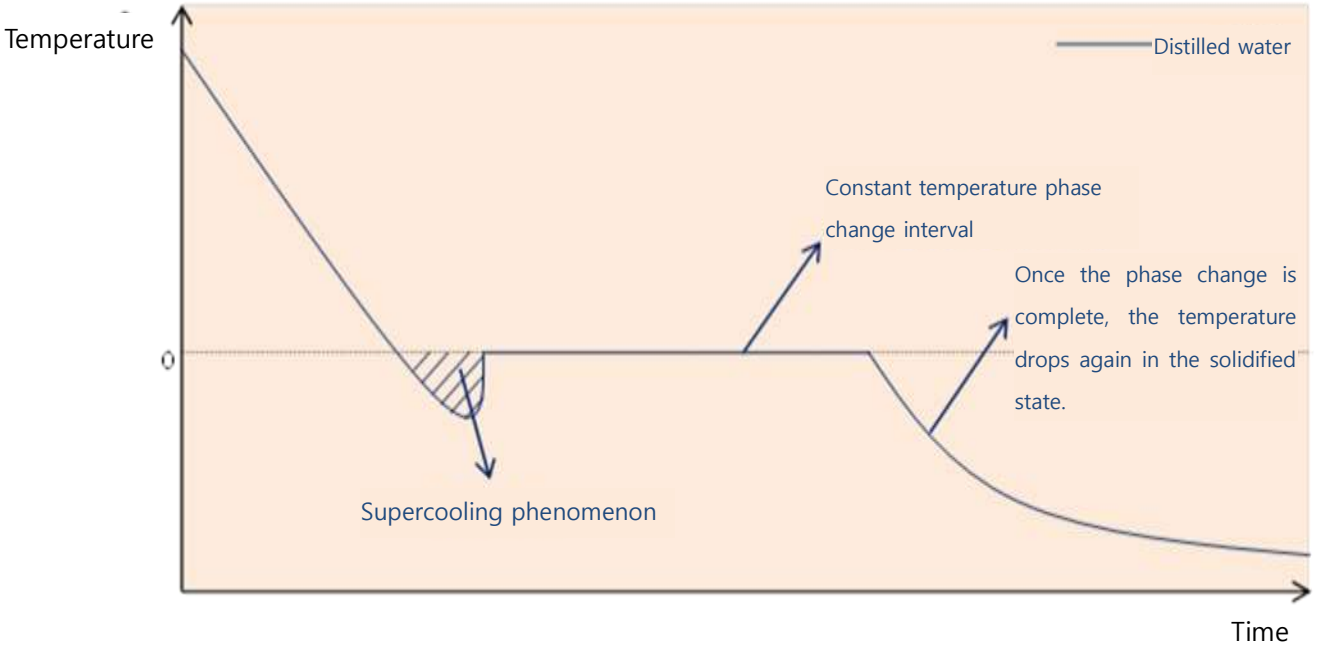
### 1. Freezing Point Depression

When salt is added to distilled water, the freezing point becomes lower than that of distilled water. This is because the salt particles interfere with the freezing of the water, requiring a lower temperature for the water to freeze. Additionally, as saltwater freezes, only the water freezes, increasing the concentration of the salt solution, further lowering the freezing temperature as the salt particles hinder the solidification of the water.




## 2. Supercooling Phenomenon

Pure substances may not freeze even when the temperature drops below the freezing point. This phenomenon is known as supercooling. Supercooling occurs when a liquid is cooled below the phase transition temperature in an equilibrium state without undergoing a phase transition. For example, ordinary water freezes at 0°C under 1 atm, but pure water without nucleating substances can be cooled down to -42°C without freezing. To freeze supercooled water, other ions or dust particles need to be introduced or the water needs to be agitated..



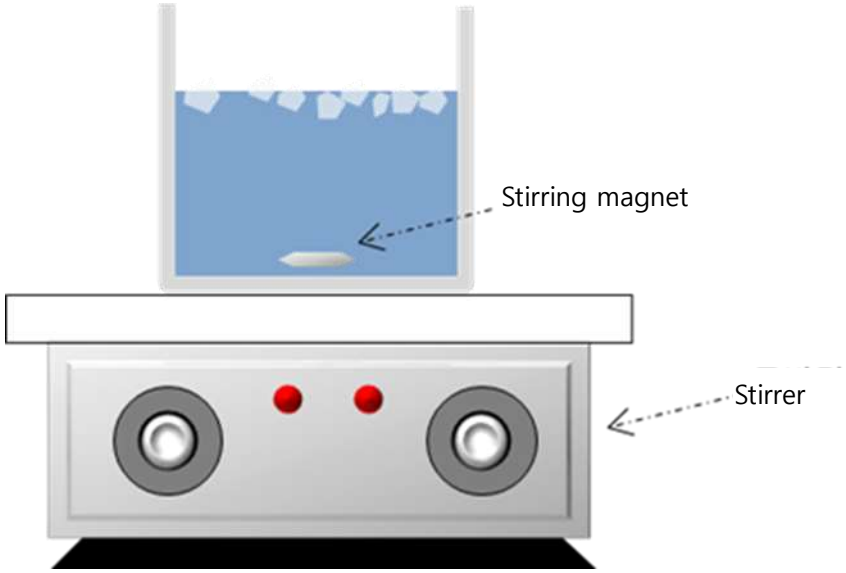
# Experiment

## Materials Needed

Interface, Science# Program, 2 temperature sensors, Styrofoam cup, Ø26 test tubes (2), test tube stoppers (2), salt, stirrer, stirring magnet, distilled water, ice (10 pieces), water, electronic scale

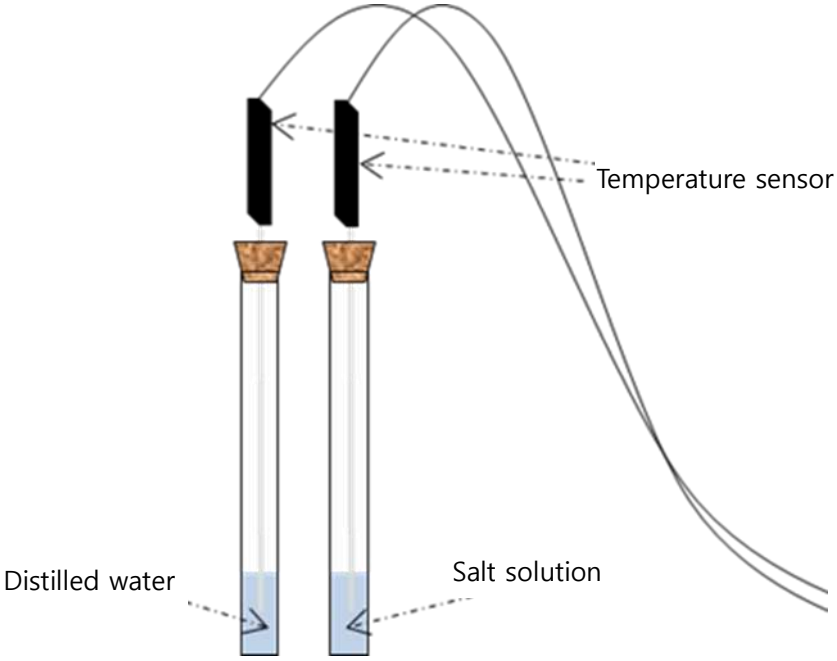
## Preparation of Experimental Apparatus

1. Add 200 mL of water, 15 g of salt, ice, and a stirring magnet to the Styrofoam cup..
2. Use a glass rod to dissolve the salt in the water and continuously stir it with the stirrer..

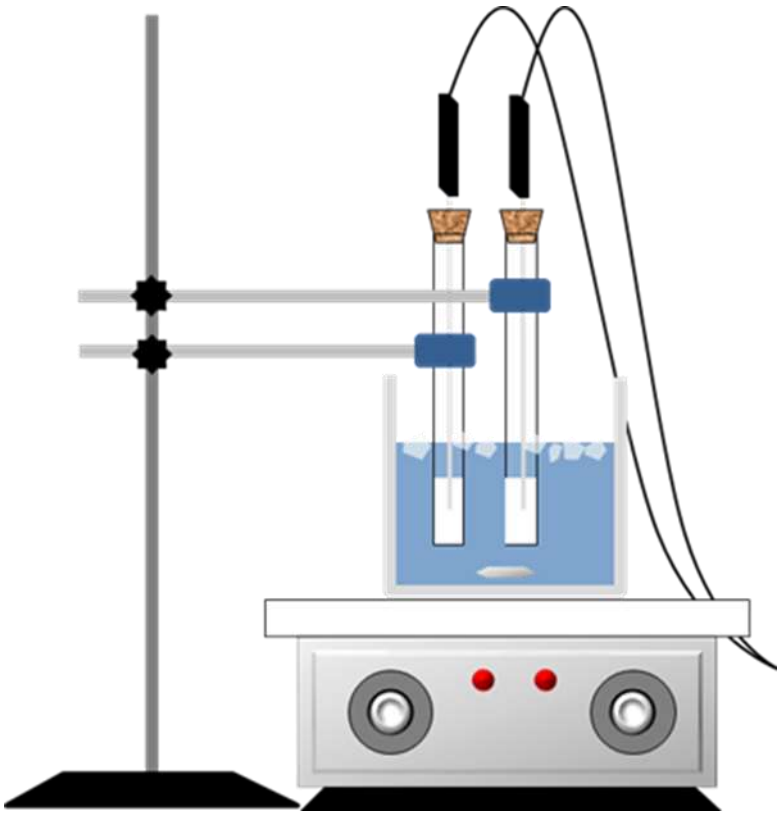



3. Add 5 mL of distilled water to each of the two test tubes.
4. Add 2 g of salt to only one test tube and shake to mix.
5. Use test tube stoppers to fix the temperature sensors at the mid-height of the liquid.

   Tip) Ensure the temperature sensors do not touch the test tube to avoid measuring the temperature of the test tube instead of the liquid.




6. Use clamps to secure the test tubes inside the Styrofoam cup. Adjust the height of the test tubes so that the stirring magnet does not hit the test tubes.

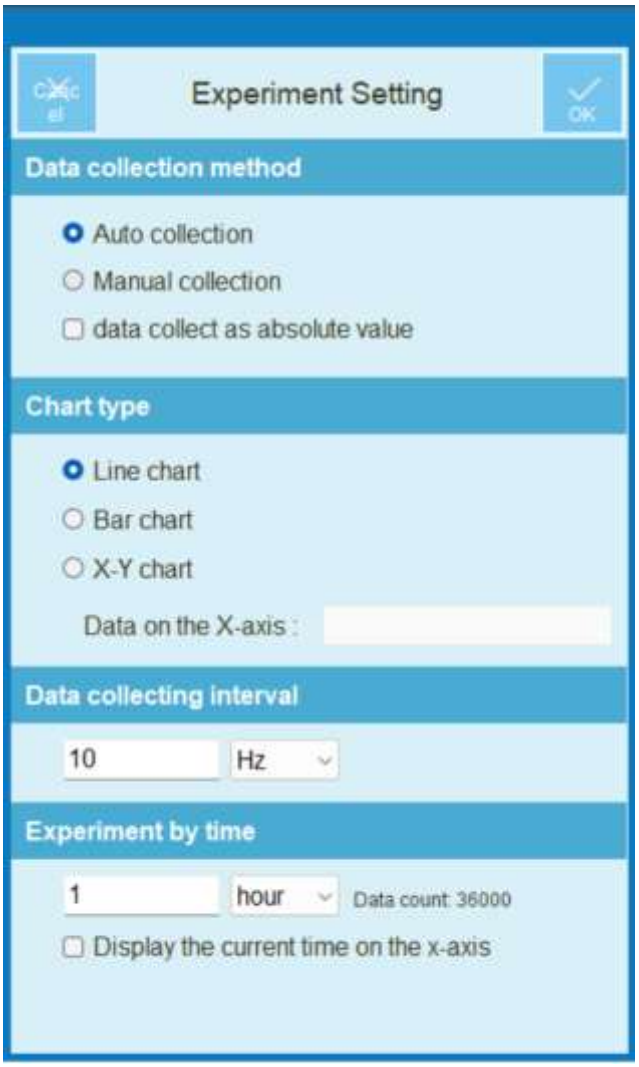


## Interface Setup

1. Run the Science# program.

2. Connect the two temperature sensors to the interface.

3. Click to set up the experimental environment as shown below or click to automatically set up.




Auto Setup

## Data Collection

1. Click to start collecting data.

# Data Analysis

## Recording

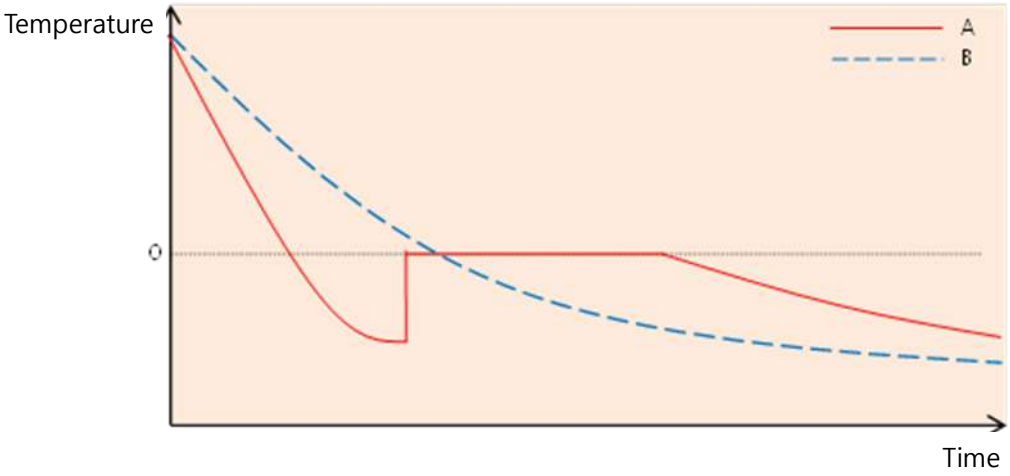
1. Draw a cooling graph of distilled water and saltwater over time and complete the table below.

| Liquid | Distilled Water | Saltwater |
|---|---|---|
| Initial Temperature (°C) | | |
| Lowest Temperature (°C) | | |
| Freezing Point (°C) | | |

2. Divide the cooling curve of distilled water into four sections and describe each section.

## Data Application and Extended Activities

1. The following graph shows the cooling curves of distilled water and saltwater. Identify the liquids corresponding to A and B, and mark the correct statements with O and the incorrect statements with X.




A ( ) , B ( )

① In cold winter, river water freezes, but seawater does not easily freeze. ( )

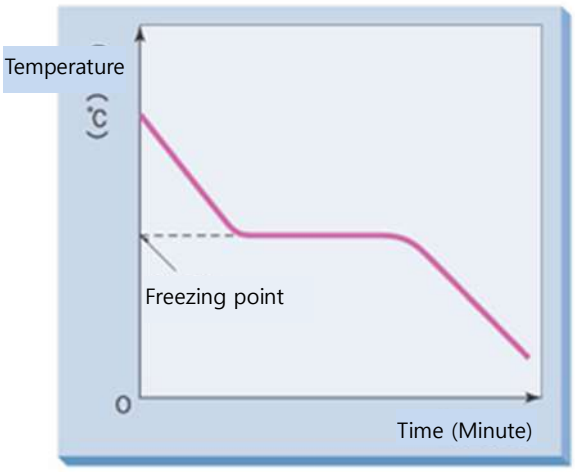
② The reason for spreading calcium chloride on roads when it snows is to raise the freezing point and prevent freezing. ( )

③ The freezing point can be used to easily determine the level of contamination in river water. ( )

④ When sugar water is cooled, it starts freezing at a higher temperature rather than at 0°C. ( )

2. Compare and explain the differences between the cooling curves of distilled water and saltwater..

3. The following graph is a typical cooling curve of a liquid. Explain the differences between this graph and the cooling curve of distilled water obtained from our experiment and the reasons for these differences..




4. Explain why the freezing temperature does not remain constant in the case of mixtures like saltwater..