ScienceCube

Separation of Mixtures

1. **Explain how to separate a mixture of water and ethanol using the difference in their boiling points.**
2. **Explain the scientific principles behind the separation apparatus for mixtures.**

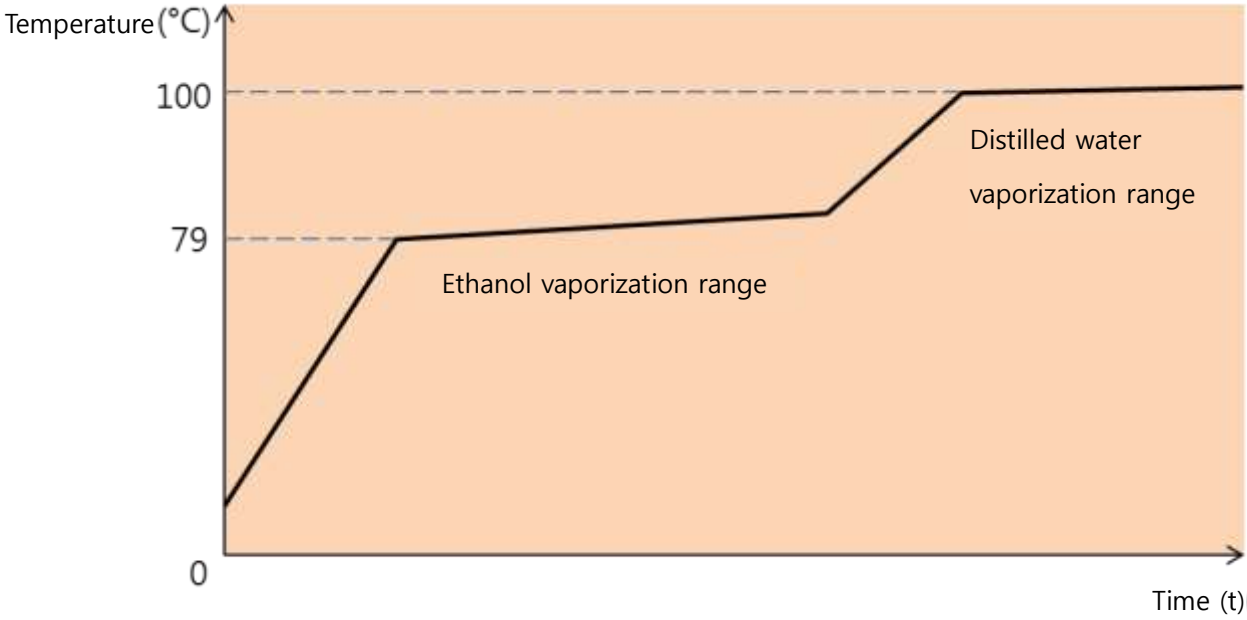
Fundamental Concept

1. Distillation and Fractional Distillation

	Distillation	Fractional Distillation
Definition	A method to obtain pure liquid by heating a solution with solid impurities, condensing the vapor that comes out.	A method to separate a mixture of miscible liquids by heating and condensing the vapor based on their different boiling points.
Example	Making clear rice wine from turbid rice wine. Making drinking water from seawater.	Separating water and ethanol, water and methanol, water and acetone. Separating crude oil.

2. Separation of Water and Ethanol Mixture

When a liquid mixture of water and ethanol is placed in a fractional distillation apparatus and heated, ethanol (boiling point: 79°C) with the lower boiling point will separate out first, followed by water (boiling point: 100°C).



<Heating Curve of Water and Ethanol Mixture>

Experiment

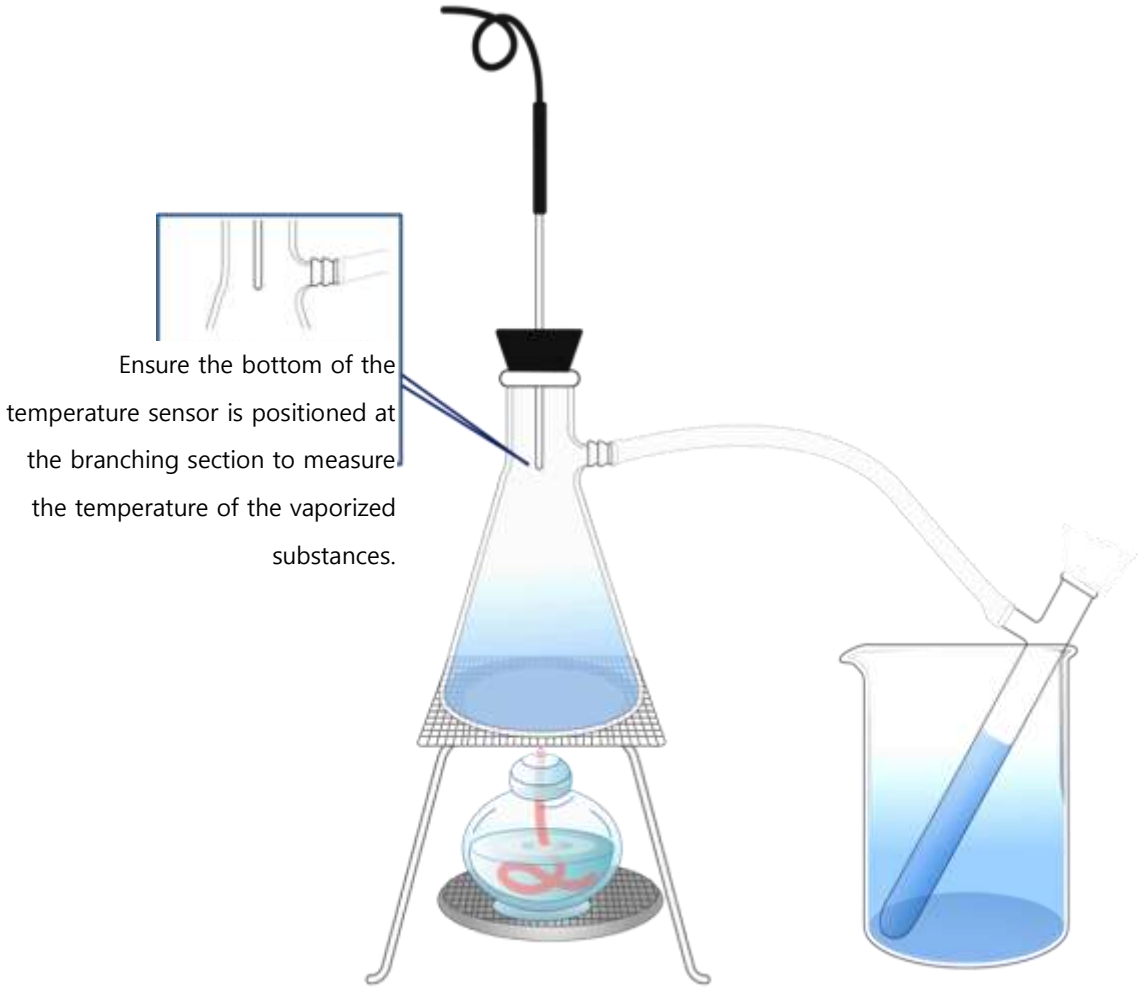
Materials Needed

Interface, Science# program, Temperature sensor, Alcohol lamp, 250mL Erlenmeyer flask with side arm, Side-arm test tube, Rubber tube, Tripod, 500mL beaker, 100mL beakers (2), Boiling chips, Distilled water (50mL), Ethanol (50mL), Test tube stopper, Igniter, Heat-resistant gloves

Preparation of the Apparatus

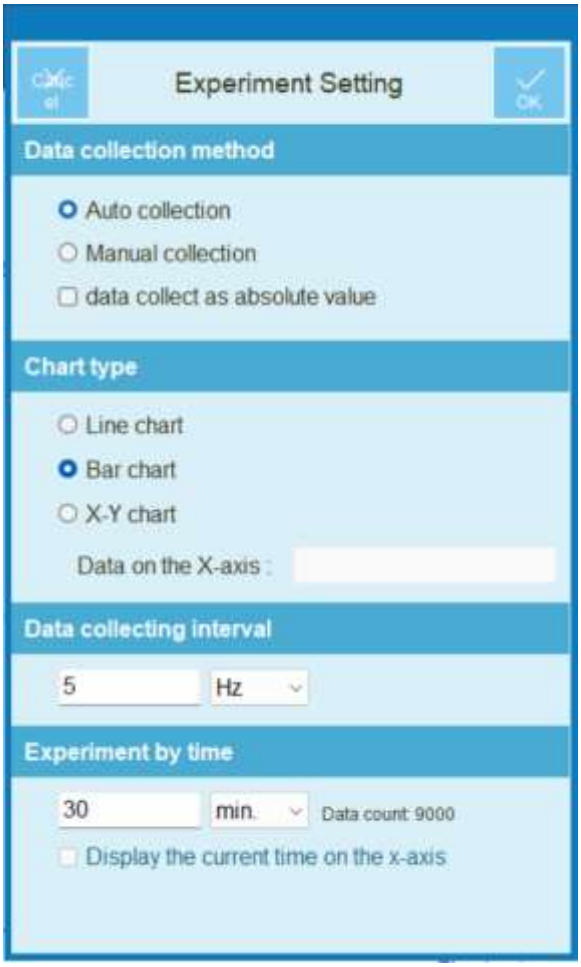
1. Mix 50mL of distilled water and 50mL of ethanol in an Erlenmeyer flask with a side arm.
2. Add some boiling chips.
3. Make a hole in the test tube stopper and insert the temperature sensor.
4. Seal the mouth of the flask with the test tube stopper.
5. Adjust the height of the temperature sensor so that the end is in the side arm of the flask to measure the temperature of the vapor.

6. Connect the Erlenmeyer flask and the side-arm test tube using a rubber tube.
7. Fill a 500mL beaker with about 300mL of cold water.
8. Submerge the side-arm test tube in the beaker filled with cold water.
9. Place the Erlenmeyer flask with a side arm on a tripod as shown in the diagram below.



Interface Setting

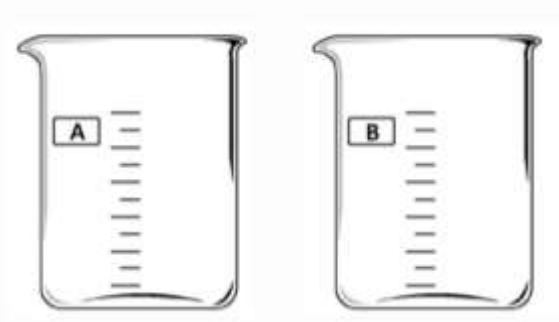
1. Run Science#.
2. Connect the temperature sensor to the interface.
3. Click the button to set up the experiment environment as shown below, or click the button for auto setup.



Automatic Setup

Data Collection

1. Click the button to start collecting data.
2. Use the igniter to light the alcohol lamp and heat the Erlenmeyer flask.
3. Collect the substances that boil out during the first relatively stable temperature phase in 100mL beaker A, and those that boil out during the second stable temperature phase in 100mL beaker B.



4. After all the liquid has boiled away, extinguish the flame and stop collecting data.

Data Analysis

Recording Data

1. Draw the heating curve of the water and ethanol mixture.

2. Explain the boiling point curve of the water and ethanol mixture.

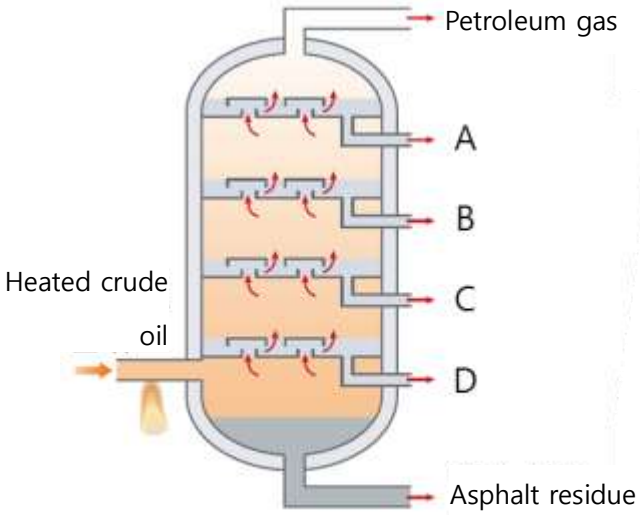
3. Fill in the blanks with the appropriate words.
   A. The substance collected in the side-arm test tube during the first relatively stable temperature phase in the heating curve is ( ), and the substance collected during the second stable temperature phase is ( ).
   B. The number of phases where the temperature remains relatively stable in the heating curve is ( ). This indicates that there are ( ) types of liquids in the mixture.
   C. When heating a mixture of water and ethanol, the substance with the lower boiling point, ( ), will distill out first, followed by the substance with the higher boiling point, ( ).

Application and Extension Activities

1. Explain why the side-arm test tube is submerged in a beaker filled with cold water.

2. Explain the scientific principle that allowed the separation of the water and ethanol mixture.

3. The following diagram represents a distillation column. Answer the questions about it.



(1) What characteristic difference allows the separation of crude oil components?

(2) List substances A~D separated in the distillation column in the order they boil out.

(3) List substances A~D separated in the distillation column in order of their boiling points, from highest to lowest.

(4) Identify the substances corresponding to A~D..


Report
(For Students)
Report
(For Teachers)