ScienceCube

Vapor Pressure

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1. **Explain the vapor pressure of different substances at the same temperature.**
2. **Compare the vapor pressure of a solvent and a solute at the same temperature and explain vapor pressure lowering.**

Fundamental Concept

1. General Properties of Liquids

(1) Compared to gases, liquids have small volume changes with changes in pressure or temperature.

Example) 0℃ water to 100℃ water volume change is 2%.

100℃ water to 100℃ steam volume increases by 1600 times, intermolecular distance increases by 12 times.

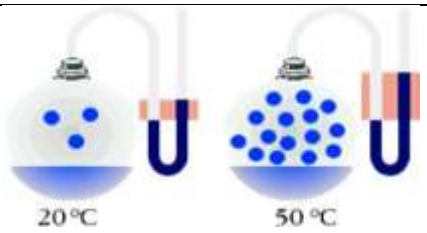
(2) Liquids have shape and fluidity, and their shape changes according to the container.

(3) The aggregation state of molecules is dense, making diffusion slower than in gases.

(4) Molecular motion includes slow translational motion, rotational motion (main motion of liquids), and vibrational motion.

(5) Evaporation and Heat of Evaporation

- Evaporation: The process where molecules on the surface of a liquid escape into the gas phase.
- Heat of Evaporation: The heat required to evaporate 1g of liquid (cal/g).

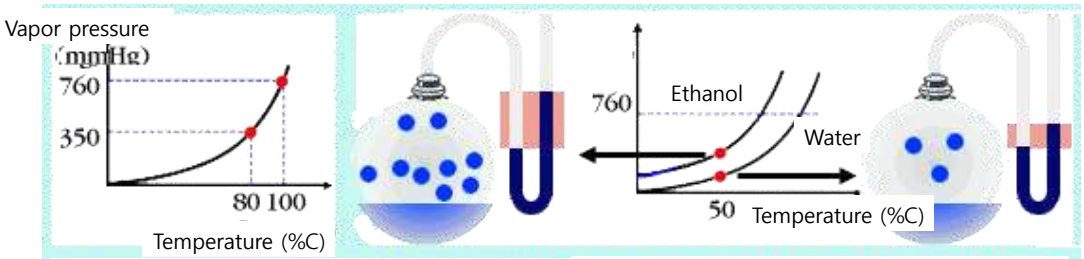
	Increasing the temperature increases molecular motion, allowing more molecules to overcome intermolecular forces, thus increasing vapor pressure.

2. Vapor Pressure and Boiling Point

(1) Vapor Pressure of a Liquid: In a closed container, liquid evaporates until it reaches a point where it no longer evaporates..

- Dynamic Equilibrium: The state where the rate of evaporation equals the rate of condensation, making it appear as if no evaporation is occurring.
- Vapor Pressure: The pressure exerted by the vapor at dynamic equilibrium.

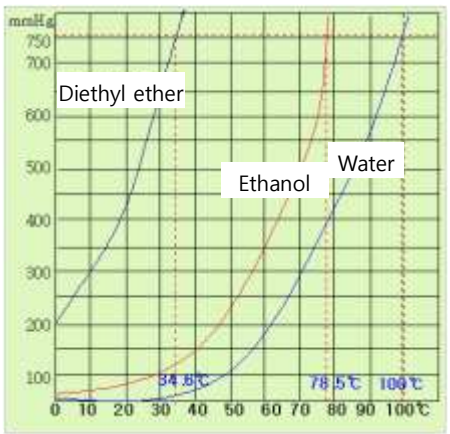
(2) For the same substance, higher temperatures result in higher vapor pressures. Substances with higher volatility have higher vapor pressures at the same temperature..



Changes in vapor pressure with water temperature

Comparison of vapor pressure of ethanol and water at the same temperature

(3) Vapor Pressure Curve: A graph showing the relationship between temperature and vapor pressure.



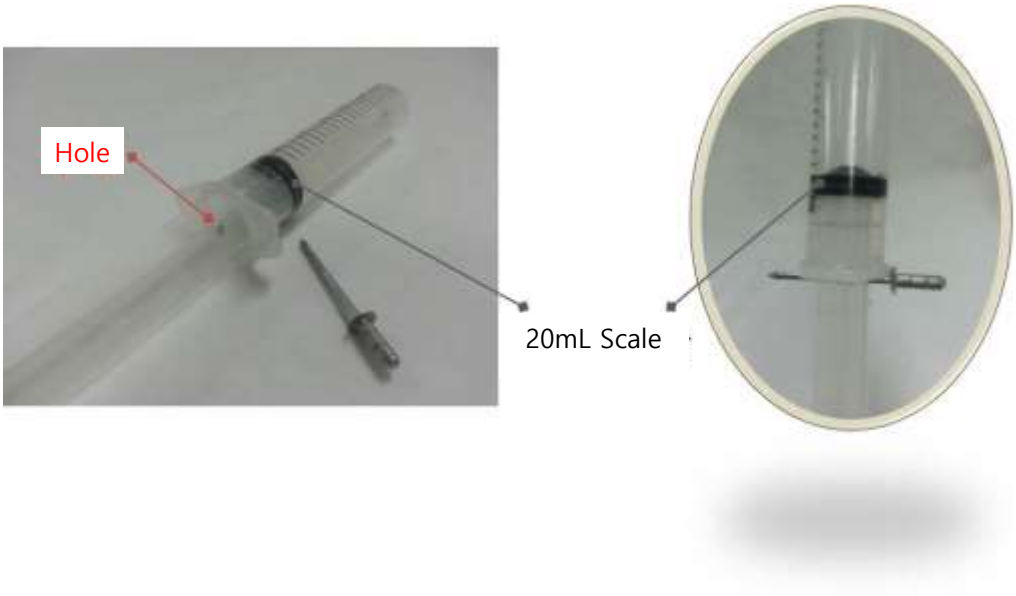
Experiment

Materials Needed

Interface, Science# Program, Two Gas Pressure Sensors (A), Two 20 mL Syringes, Styrofoam Box, Large Paper Cup, 1.5L PET Bottle, Sugar, Glass Rod, Distilled Water, Ethanol, Two Nails (3-4 cm long), Three Beakers, Permanent Marker

Preparation of Experimental Setup

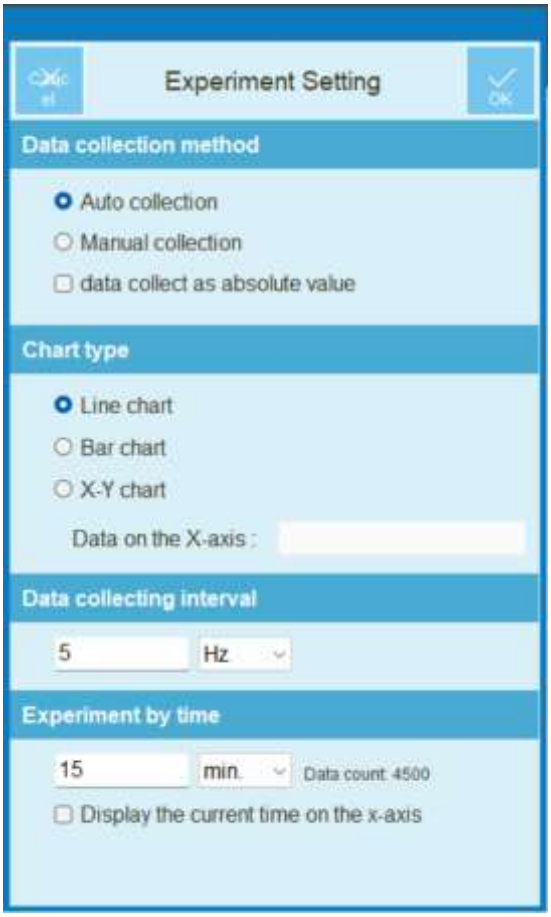
1. Pull the pistons of two syringes to the 20 mL mark and use a heated awl to make holes that fit the nails at the 20 mL mark to fix the pistons in place.



2. Pour distilled water, ethanol, and sugar water into separate beakers and let them sit until they reach room temperature.
3. Add 5 mL of distilled water to one syringe and 5 mL of ethanol to the other syringe, ensuring no air enters the syringes.
4. Label the syringes with distilled water and ethanol using a permanent marker.
5. Attach a gas pressure sensor to each syringe.
6. Cut off the top of a PET bottle, fill it with hot water (60-70℃), and place it in a Styrofoam box to minimize temperature changes..

Interface Setup

1. Launch the Science# program and connect the interface.
2. Connect the cables of the two gas pressure sensors to the interface channels..
3. Press to set up the experimental environment as shown below, or use the automatic setting option. .



4. Pull the piston of the syringe containing water to the 20 mL mark and fix the position with a nail.
5. Quickly press the zero button on the corresponding gas pressure sensor to calibrate.
6. Fix the syringe containing ethanol in the same way as in step 4. Keep the syringe upside down to prevent liquid from entering the gas pressure sensor..

Data Collection

1. Press to start data collection.
2. Place both syringes in hot water.

3. Once the gas pressure data stabilizes, press the stop button to end the experiment.
4. Conduct a similar experiment to compare the vapor pressure of sugar water and distilled water..

Data Analysis

Recording Data

1. Compare the pressure changes of syringes containing distilled water and ethanol in hot water, plot the pressure changes on a graph, and record the vapor pressure of each substance.

2. Conduct the experiment with sugar water and distilled water and compare the pressure changes in the syringes on a graph, recording the vapor pressure of each substance..

Data Application

1. Compare the vapor pressure of distilled water and ethanol using inequality signs, and explain the reason for the observed results..

Distilled Water [ ] Ethanol

2. Compare the vapor pressure of distilled water and sugar water using inequality signs, and explain the reason for the observed results.

Distilled Water [ ] Sugar Water

3. How does vapor pressure change with temperature? Indicate the correct answer.

Increase [ ] Decrease [ ]

4. How does vapor pressure change with the concentration of the solution? Indicate in the appropriate place.

Increase [ ] Decrease [ ]

Extension Activity

1. Why is it necessary to increase and fix the volume of the syringe to 20 mL after injecting the liquid when measuring vapor pressure?