Evaporation and Intermolecular Attractions Lab

AP Chemistry

(Adapted from Vernier Chemistry with Computers)

Background:

In this experiment, temperature probes are placed in various liquids. Evaporation occurs when the probe is removed from the liquid’s container. This evaporation is an endothermic process that results in a temperature decrease. The magnitude of a temperature decrease is, like viscosity and boiling temperature, related to the strength of intermolecular forces of attraction. In this experiment, you will study temperature changes caused by the evaporation of several liquids and relate the temperature changes to the strength of intermolecular forces of attraction. You will use the results to predict, and then measure, the temperature change for several other liquids.



Figure 1

MATERIALS

Methanol

Ethanol

1-propanol

1-butanol

Pentane

Hexane

Unknown volatile chemical

LabPro or CBL 2 interface

Computer and USB cable

(2) temperature probes

(7) pieces of filter paper (~2.5 cm x 2.5 cm)

(2) small rubber bands

Masking tape

(2) Tweezers

Pre-lab

Prior to doing the experiment, complete the pre-lab table. The name is given for each compound. Provide the formula, draw a structural formula or Lewis structure, determine the molecular weight, and record the type(s) of intermolecular forces present in a pure sample of each substance..

PROCEDURE

1. Obtain and wear goggles! **CAUTION:** The compounds used in this experiment are flammable and poisonous. Avoid inhaling their vapors. Avoid contacting them with your skin or clothing. Be sure there are no open flames in the lab during this experiment. Notify your teacher immediately if an accident occurs.
2. To prepare the computer for data collection.

* Open the Experiment 9 folder from *Chemistry with Computers*. Then open the experiment file that matches the probes you are using.
* On the Graph window, the vertical axis has temperature scaled from 5 to 30°C. The horizontal axis has time scaled from 0 to 250 seconds.

1. Wrap Probe 1 and Probe 2 with square pieces of filter paper secured by small rubber bands as shown in Figure 1. Roll the filter paper around the probe tip in the shape of a cylinder. Hint: First slip the rubber band up on the probe, wrap the paper around the probe, and then finally slip the rubber band over the wrapped paper. The paper should be even with the probe end.
2. Obtain 2 pieces of masking tape, each about 10-cm long, to be used to tape the probes in position during Step 6.

**Part A:**

1. Insert Probe 1 in the ethanol container and Probe 2 in the 1-propanol container. Make sure the containers do not tip over. Note: Probes 1 and 2 correspond to Temperatures 1 and 2, respectively, on the graph.
2. After the probes have been in the liquids for at least 30 seconds, begin data collection by clicking . Monitor the temperature for 15 seconds to establish the initial temperature of each liquid. Then simultaneously remove the probes from the liquids and tape them so the probe tips extend about 5 cm over the edge of the table top as shown in Figure 1 (above).
3. When both temperatures have reached minimums and have begun to increase, click  to end data collection; if the temperatures are still decreasing when time runs out, you do not need to repeat the trial. Click the Statistics button, , then click  to display a box for both probes. Record the maximum (tmax) and minimum (tmin) values for Temperature 1 and Temperature 2.
4. Roll the rubber band up the probe shaft and dispose of the filter paper in the trash can.
5. Repeat Steps 3-9, testing Probe 1 in the pentane container and Probe 2 in the unknown container. Make sure the containers do not tip over.
6. Based on the t values you have obtained for all four substances, plus information in the   
   Pre-Lab exercise, predict the t values for methanol, butanol, hexane, and water. Record your predicted t.
7. Test your predictions in Step 11 by repeating Steps 3-9 for the remaining chemicals.

Evaporation and Intermolecular Attractions Lab Name(s):

AP Chemistry Pd: 1 2 3 4

**Date:**

**Pre-Lab Table:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Formula** | Structural formula or Lewis structure | **Molecular weight (amu)** | **Type(s) of IMF present in pure sample** |
| Ethanol |  |  |  |  |
| 1-Propanol |  |  |  |  |
| Pentane |  |  |  |  |
| Methanol |  |  |  |  |
| 1-Butanol |  |  |  |  |
| Hexane |  |  |  |  |
| Water |  |  |  |  |

Data & Results Table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Tmax (°C)** | **Tmin (°C)** | ** (T1–T2) (°C)** |  |
| Ethanol |  |  |  |  |
| 1-Propanol |  |  |  |
| Pentane |  |  |  |
| Unknown |  |  |  | **Predicted T (°C)** |
| Methanol |  |  |  |  |
| 1-Butanol |  |  |  |  |
| Hexane |  |  |  |  |
| Water |  |  |  |  |  |

Analysis

1. Briefly explain how you predicted the T for:
   1. Methanol
   2. 1-butanol
   3. Hexane
   4. Water
2. List all the chemicals tested (including the unknown) in order from strongest to weakest overall intermolecular forces of attraction, based on your results. Briefly explain in 2-3 sentences.

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1. Based on your data, what can be determined about the chemical formula, structure, etc, of the unknown? Briefly explain, citing the results of this experiment as evidence.