Intermolecular Attraction and Evaporative Cooling

Reminder – Goggles must be worn at all times in the lab!

Introduction:

In this experiment, a thermometer is placed in various liquids. Evaporation occurs when the thermometer is removed from the liquid's container. This evaporation is an endothermic process that results in a temperature decrease:

Liquid + energy → Vapor

The magnitude of a temperature decrease is, like viscosity and boiling temperature, related to the strength of intermolecular forces of attraction. The larger the forces of attraction, the less readily the molecules evaporate, and the less cooling that takes place. 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.

Purpose:

To identify degrees of molecular attraction between various molecules based on the magnitude of evaporative cooling, and to relate those degrees of attraction to molecular structure.

Procedure:

1. Obtain 2 mL samples of ethanol and acetone from your instructor, placing them in separate, labeled, medium-sized test tubes. Obtain a 2 mL sample of distilled water from the lab water bottles, and put that in a third labeled test tube.
2. Carefully clean and dry the thermometer from your lab drawer. Obrain a strip of paper and a rubber band from the side counter. Wrap the paper around the "bulb" end of the thermometer – the end containing the red alcohol. Secure the paper with a rubber band. The end of the thermomter must still be able to fit into the mouth of a medium test tube, so push the rubber band to the upper end of the paper.
3. Put the papered end of the thermometer into the test tube containing the water. Leave it in place for several seconds while recording the temperature (t = 0).
4. Remove the thermometer from the liquid and hold it horizontally, and do not move it any further. Record the temperature reading on the thermometer every 15 seconds for the next three minutes.
5. At the end of the three minutes, remove the paper and rubber band, and clean and dry the end of the thermometer.
6. Attach a new piece of paper and repeat the procedure with ethanol, and then again with acetone.
7. Empty the test tubes into the sink. Wash them thoroughly with tap water. Return all of the equipment to your lab drawer.

RESULTS

Data and Observations:

	Elapsed Time (seconds)												
	0	15	30	45	60	75	90	105	120	135	150	165	180
Water													
Ethanol													
Acetone													

Calculations:

1. Obtain a piece of graph paper, and graph elapsed time (x-axis) vs. temperature (y-axis). Be sure to label both axes, and select an appropriate scale for each. Include all three cooling curves on the SAME graph, and create a key (legend) to tell the difference between the different liquids.
2. Calculate the change in temperature (Δt) for each of the liquids by finding the difference between the lowest temperature and the initial temperature (t=0). The value you obtain for Δt SHOULD be negative.

	Lowest Temp.	***Initial Temp.***	***Lowest – Initial***	***Δt***
Water				
Ethanol				
Acetone				

3. Draw Lewis dot structures for each of the three compounds, water (H_2O), ethanol (C_2H_5OH) and acetone (C_3H_6O).