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:

The purpose of this lab is 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:

Part 1 – Evaporative Cooling Measurements with LabQuest

1. Plug the Temperature Probe into Channel 1 of the LabQuest. Turn on the LabQuest (it may take a while to load the system software). It should auto-recognize the temperature probe.

2. The LabQuest is a touch-screen device. Touch the image of a dial in the upper left-hand corner to go to data collection modes.

    a. For"Mode" select "Time Based"
    b. "2" samples per second, 0.5 s/sample
    c. Duration: 180 seconds
    d. Click "OK" to go back to data collection screen.

3. 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.
4. Obtain a strip of paper and a rubber band from the side counter. Wrap the paper around the metal shaft of the thermometer. 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.
5. Put the papered end of the thermometer into the test tube containing the water.
6. Click the green "start" arrow in the lower left-hand corner to begin data collection. It may take several seconds for the Temperature Probe to equilibrate at the temperature of the solution. After three or four readings at the same temperature have been obtained, remove the thermometer from the liquid and hold it horizontally, and do not move it any further.. As the reaction proceeds, you may find it more interesting to observe the graphing. You can switch back-and-forth between the graph, temperature, and data table using the left-most icon on the upper right-hand corner.
7. Data collection will stop after 3 minutes. To record the initial (t_1) and final (t_2) values, examine the data points along the curve on the displayed graph. As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed
8. Remove the paper and rubber band, and clean and dry the end of the thermometer.
9. Press the "file cabinet" icon on the LabQuest and select "Run 2" (Your Run1 data will be preserved in case you need to refer to it later). Repeat Steps 4 - 8, using ethanol.
10. Press the "file cabinet" icon and select "Run 3" (Your Run 1 and Run 2 data will be preserved in case you need to refer to it later). Repeat Steps 4 - 8, using acetone.
11. View all three graphs at the same time using the "Run" menu. Choose to view all of them.

Part 2 – The Penny Challenge

Another, albeit cruder method for measuring intermolecular forces of attraction, is by seeing how many drops of each liquid can sit on top of a penny.

12. Obtain a penny from the side counter, and place it flat on your lab table.
13. Using an eyedropper from your lab drawer, count how many drops of water you can drop onto the penny before the water runs off onto the table.
14. Using the same dropper, repeat the procedure with the other two liquids.
15. Empty the test tubes into the sink. Wash them thoroughly with tap water. Return the glassware to your lab drawer, and the LabQuest to the instructor.

RESULTS

1. **Data**

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

	Drops on a Penny
Water	
Ethanol	
Acetone	

Observations

Record your observations of the three graphs produced from the water, ethanol and acetone. Which liquid appeared to experience the greatest cooling? Which appeared to experience the least cooling?

Calculations:

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.

	Δt = Lowest Temp – InitialTemp
Water	
Ethanol	
Acetone	