Intermolecular Attraction and Evaporative Cooling

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

Introduction:

Cooling occurs occurs when a liquid evaporates from a surface. Sweating in humans takes advantage of this process of evaporative cooling to keep body temperature from rising during physical activity. Evaporation is an endothermic process that results in a temperature decrease:

Liquid + energy → Vapor

The magnitude of a temperature decrease is, like melting point and boiling point, 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.

Question:

Which liquid (water, ethanol or acetone) has the strongest intermolecular forces of attraction? Which of the three has the weakest intermolecular forces of attraction?

Procedure:

Part 1 – Evaporative Cooling Measurements

1. Make sure that you have the "Vernier Graphical Analysis" app installed on the Chromebook on which your group will be doing data collection. You can install it from the Chrome WebStore. Once installed, launch the app.

2. Plug the Temperature Probe into the Go!Link and plug that into the USB port on a Chromebook. Graphical Analysis should auto-recognize the temperature probe.

3. Set the mode for data collection (lower left hand corner).

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

4. 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.
5. 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.
6. Put the papered end of the thermometer into the test tube containing the water.
7. Use the "Boxes" icon in the upper right corner to select "Graph and Table". Name this data set "Water".
8. Click the "COLLECT" button at the top of the screen 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. Data collection will stop after 3 minutes.
9. Remove the paper and rubber band, and clean and dry the end of the thermometer.
10. Repeat steps 4 through 9 for ethanol. Name the data set "Ethanol".
11. Repeat steps 4 through 9 for acetone. Name the data set "Acetone".

RESULTS

Prepare your graph for publishing

1. Click on the “Temperature (°C)” label on the “Y” axis. Select all three data sets to be viewed on the graph.
2. Use the graph icon in the bottom left corner and select “Edit Graph Options”
    a. Give your graph an appropriate title
3. Use the graph icon in the bottom left corner and select “Add Annotation”
    a. Add labels for Water, Ethanol and Acetone, and drag each to the line on the graph that represents that substance.
4. Using the “Boxes” icon in the upper right, select “1 Graph” so that we don’t see the data table when we export the graph image
5. Select the “Paper” icon in the upper-left corner and choose “Export” → “Graph Image”
    a. Save a copy of the graph in .png format on your Google Drive. Make note of where you save it.
    b. Share this image with the other members of your group so that they can include it as well.