Chum 152LL: Experiment #1 –Heat of Vaporization of a Liquid
(Temperature Sensor)

Introduction

Vaporization occurs when a liquid substance changes phase to its gaseous state. Since the molecules of the liquid absorb heat, the surroundings of the liquid are cooled down. You may have already observed this cooling effect in everyday life. Here are a couple of examples:

- Rubbing alcohol is often used to "sponge bath" a patient who is suffering from a high fever.
- Outdoor misting systems are used to spray out fine water droplets that evaporate very rapidly to cool down an area quickly and effectively.

According to the kinetic molecular theory, evaporation follows from the distribution of molecular speeds in the liquid. The faster molecules have enough energy to escape the liquid surface tension despite the attractive forces of the other molecules. Since the most energetic molecules have escaped, the average energy of the left over molecules in the liquid is less than before and the liquid is now at a lower temperature.

How fast the vaporization occurs for a liquid is affected by factors such as the strength of the intermolecular interactions, and the surface area available for evaporation.

In this experiment, you will measure the rate of evaporation for three pure liquids — acetone, isopropyl alcohol and water. You will also consult chemical references to obtain data on the liquids' physical properties such as their boiling points and their heats of vaporization. From the data you have gathered, you will be asked to ponder the following questions. Your answers to these questions should enable you to draw conclusions about the relationship between intermolecular forces and boiling points, latent heats of vaporization and rates of evaporative cooling.

Questions to ponder include

1. What liquid is more efficient (acetone, isopropyl alcohol or water) at cooling down an object?
2. Is there a relationship between the rate of evaporation and the cooling effect that a liquid exhibits?
3. Is there a relationship between either the boiling point of these liquids or their heats of vaporization and their rate of evaporation?
4. What types of intermolecular interactions do these molecules have? How similar or different are they?

Equipment:

Vernier computer interface
Computer
3 10-mL graduated cylinders
Temperature sensor
Safety goggles

Chemicals and Consumables:

Acetone, Isopropyl alcohol, Deionized water

Safety Procedures:

1. **Wear safety goggles!**

2. Follow your teacher's directions for the handling and disposal of all chemicals and solutions.

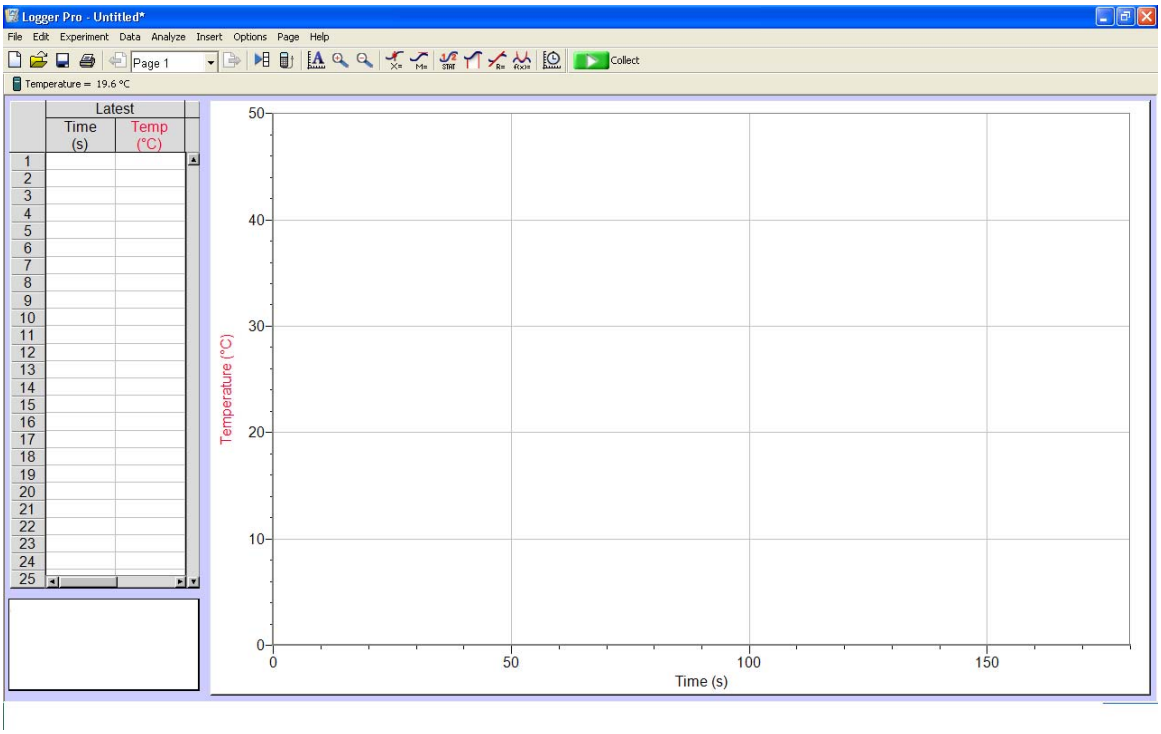
Procedure:

For this activity, the temperature sensor measures the temperature of different liquids during vaporization. The *Logger Pro*™ program records and displays the data.

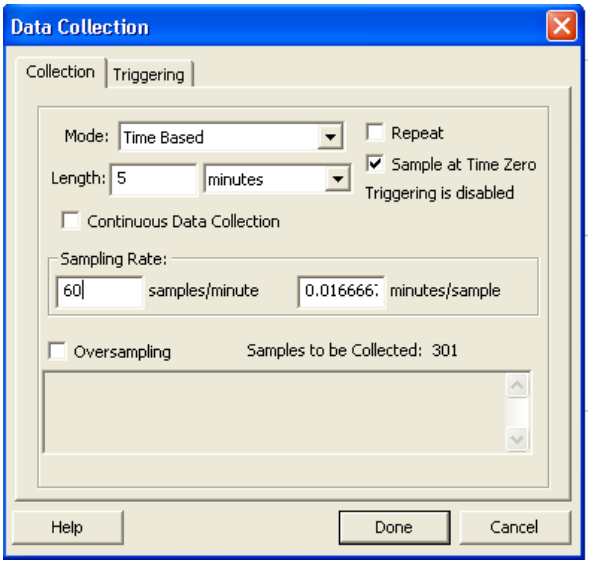
1. Obtain and wear goggles. It is best to conduct this experiment in a well-ventilated room.

2. Connect a Temperature Probe to Channel 1 of the Vernier computer interface. Connect the interface to the computer with the proper cable.

3. Start the *Logger Pro*™ program on your computer. The program should recognize the connected Temperature Probe and display a plot of the Temperature (C) versus Time (sec).



4. You do not need to calibrate the temperature sensor. Reset the length of experiment to 5 minutes at a sampling rate of 60 samples/minute via the Data Collection option under Experiment heading.



4. Put 7 mL of acetone, isopropyl alcohol, and water in to SEPARATE identical 10-mL graduated cylinders.

5. Place the Temperature Sensor into the cylinder with the acetone until the sensor touches the bottom of the cylinder. THE LIQUID AND SENSOR SHOULD BE AT ROOM TEMPERATURE AT THE START OF THE ACTIVITY. When everything is ready, start recording data. Leave the sensor in the liquid for 10 seconds.

6. After 10 seconds, remove the sensor from the liquid. Hold the sensor vertically. The liquid will evaporate and the evaporation will usually take less than 2 minutes.

7. Continue collecting data until the liquid on the sensor appears to be completely evaporated and then stop recording data.

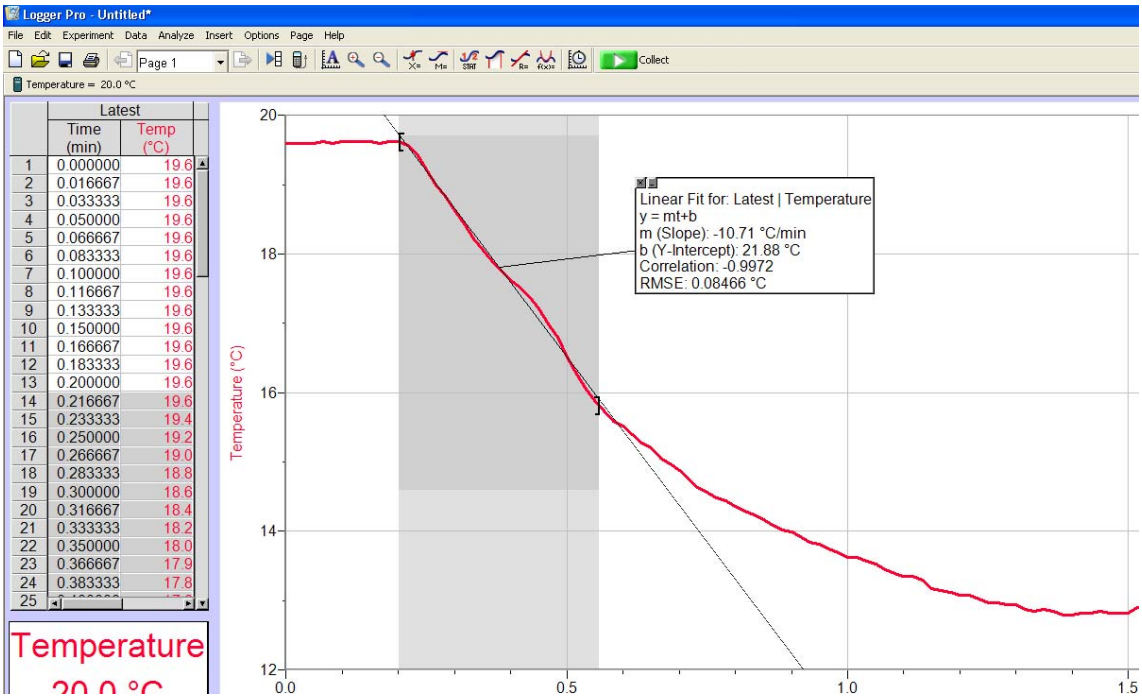
8. Rinse and dry the Temperature Sensor.

9. Repeat steps 5 ~ 9 with isopropyl alcohol and then water.

10. Dispose of the liquids in the graduated cylinders as directed.

11. One way to determine the rate of evaporation is to compare the change in temperature to the amount of time by using the linear regression 

feature in the Graph in *Vernier*. The slope obtained gives the rate of evaporation.



Obtain the rate of evaporation separately for acetone, isopropyl alcohol and water.