Name: Tom Ralph

Class: Physics II AP

Period: 2

Group #: 6

Lab #: 6

<u>Vapor Pressure and Heat of Vaporization Lab</u>

When a liquid is placed in a container, and the container is sealed tightly, a portion of the liquid will evaporate. The newly formed gas molecules exert pressure in the container, while some of the gas condenses back into the liquid state. If the temperature inside the container is held constant, then at some point equilibrium will be reached. At equilibrium, the rate of condensation is equal to the rate of evaporation. The pressure at equilibrium is called vapor pressure, and will remain constant as long as the temperature in the container does not change. In mathematical terms, the relationship between the vapor pressure of a liquid and temperature is described in the Clausius-Clayperon equation, C TR H P vap + Δ− = 1 ln where ln P is the natural logarithm of the vapor pressure, ΔHvap is the heat of vaporization, R is the universal gas constant (8.31 J/mol•K), T is the absolute, or Kelvin, temperature, and C is a constant not related to heat capacity. Thus, the Clausius-Clayperon equation not only describes how vapor pressure is affected by temperature, but it relates these factors to the heat of vaporization of a liquid. ΔHvap is the amount of energy required to cause the evaporation of one mole of liquid at constant pressure. In this experiment, you will introduce a specific volume of a volatile liquid into a closed vessel, and measure the pressure in the vessel at several different temperatures. By analyzing your measurements, you will be able to calculate the ΔHvap of the liquid.
In this experiment, you will • Measure the pressure inside a sealed vessel containing a volatile liquid over a range of temperatures. • Determine the relationship between pressure and temperature of the volatile liquid. • Calculate the heat of vaporization of the liquid.

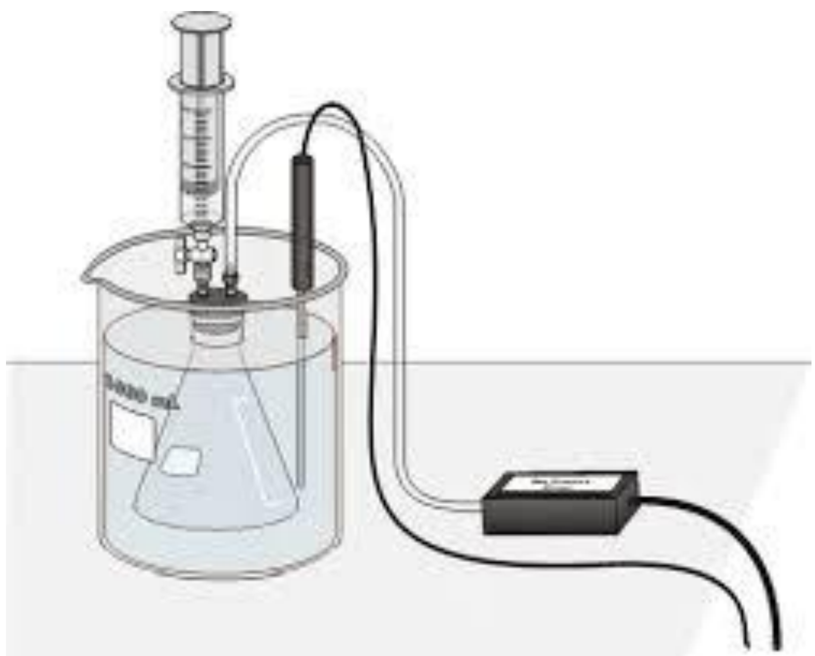
Purpose: To measure the the pressure in a closed container containing a liquid over a range of temperatures, to ultimately determine the relationship between pressure and temperature and to calculate the heat of vaporization of ethanol. To discover the pressure and temperature required to vaporize Ethanol.

Equipment Used: Beaker, Hot Plate, Flask, PASCO Pressure Sensor, PASCO Temperature Sensor, Rubber Stopper, Syringe, 3mL of Ethanol, Erlenmeyer Flask (200mL), small beaker (5mL).

PROCEDURE

1. Place 300 mL of water into the large beaker.

2. The beaker should be deep enough to completely cover the gas level in the Erlenmeyer flask, the flask basically needs to fit in the beaker. (See Image)
3. Add 125mL of water into the Erlenmeyer flask.
3. Connect a *Gas Pressure* Sensor to to the computer and Connect a *Temperature* Probe/sensor to the computer. Both sensors should be ready to collect data. (See board on how to access program)
5. Start the program on your computer.
6. Use the clear tubing to connect the white rubber stopper to the Gas Pressure Sensor. (About one-half turn of the fittings will secure the tubing tightly.) Twist the white stopper snugly into the neck of the Erlenmeyer flask to avoid losing any of the gas that will be produced as the liquid evaporates. Important: <u>Open the valve on the white stopper.</u>



7. Your first measurement will be of the **pressure** (initial) in the **Erlenmeyer flask** at room **temperature.** Place the Temperature Probe near the flask. When the pressure and temperature readings stabilize, record these values in the first column (Initial) of your data table.
8. A. Place the Temperature sensor in the room temperature water (beaker). B. Place the Erlenmeyer flask in the beaker filled with room temperature water. Hold the flask down into the water bath to the bottom of the white stopper to release any air. C. After 30 seconds, close the valve on the white stopper and let go of flask so that it floats.
9. Place beaker with the Erlenmeyer Flask onto the hot plate.
9. Obtain a small amount of Ethanol (given). Draw 3 mL of Ethanol using the syringe. Thread the syringe onto the valve on the white stopper. (See Image)
10. Add Ethanol to the flask.
a. Open the valve below the syringe containing the 3 mL of Ethanol.
b. Push down on the plunger of the syringe to inject the Ethanol.
c. Quickly pull the plunger back to the 3-mL mark on the syringe and close the valve below the syringe.
d. Carefully remove the syringe from the stopper so that the stopper is not moved.

11. Gently stir the flask in the beaker for a few seconds, using a motion similar to slowly stirring a cup of coffee or tea, to accelerate the evaporation of the water. <u>Do this motion during every increment of 10 degrees.</u>

12. Monitor and collect temperature and pressure data every 10 degrees.

a. Click to begin data collection.

b. Stir flask in the beaker.

c. Monitor the pressure and temperature readings.

13. Stir the water slowly with the Temperature Probe in the beaker. Monitor the pressure and temperature readings.

14. Repeat Step 11-13 until you have completed 8 total trials. Do not warm the water bath beyond 85°C because the pressure increase may pop the stopper out of the flask.

15. After you have recorded the eighth set of readings, open the valve to release the pressure in the flask. Remove the flask from the water bath and take the stopper off the flask. (Use Gloves)

16. Click to end the data collection. Record the pressure readings, as Ptotal, and the temperature readings in your data table.

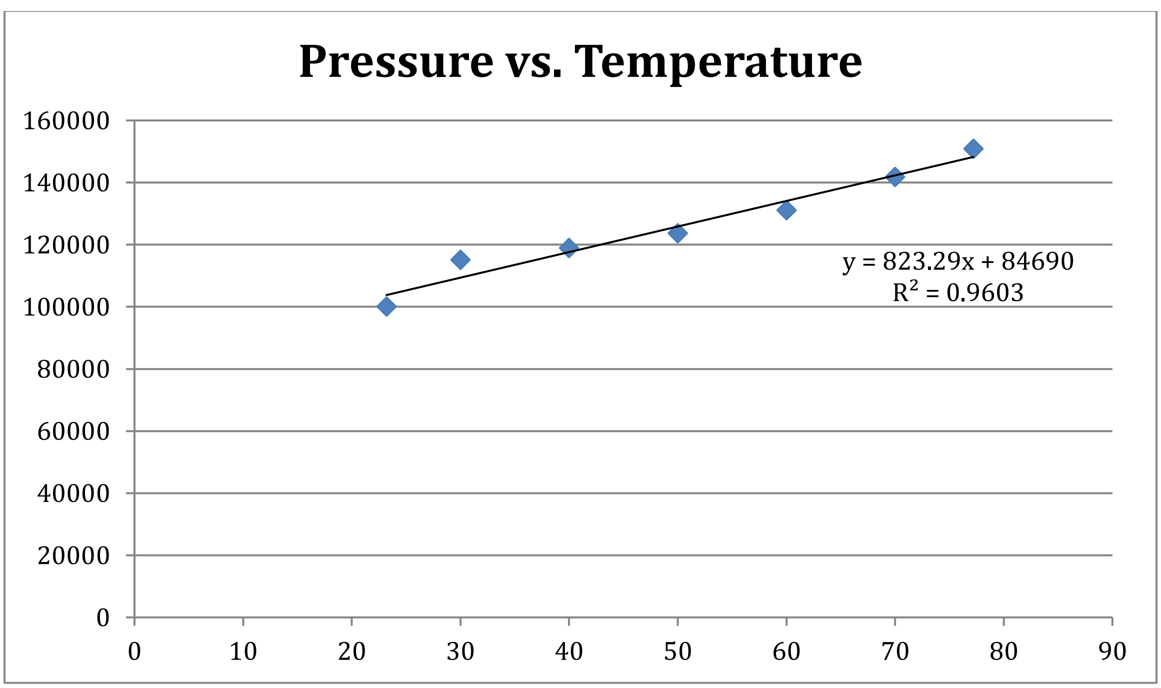
Data:

--Record the pressure at the following temperatures: 20º, 30º, 40º, 50º, 60º,70º, 80º and 85º

-The temperature that you input in the table has to be in Kelvins, so add 273 to the above temperatures.

-Once you input the data into the table, plot Vapor Pressure (y) vs. Absolute Temperature (x).

Temperature (C)	**Vapor Pressure (Pa)**
23.2	**100993**
30	**115081**
40	**118924**
50	**123597**
60	**131073**
70	**141726**
77.2	**150815**



Analysis Questions:

1. Use the data to determine the relationship between temperature and pressure.

    The relationship between pressure and volume is linear

2. Find the Total Pressure by adding all of the pressures together.

    150815 Pa

3. The heat of vaporization represents the amount of thermal energy necessary to convert one mole of the liquid in question into the gaseous state. Find the Heat of Vaporization of Ethanol by using the following equation: ln P = ΔHvap/RT + C. Remember R is the gas constant, which is 8.314 J/mol K and C is a constant of integration, which does not matter. (P is equal to the total pressure you found above and you must take the natural log of it; T is the final temp. in K)

$$150815 = \frac{H_{Vap}}{8.314 * 350}$$

$$H_{Vap} = 4.4 * 10^{8}$$

4. Why do you think you had to quickly pull the plunger back on the syringe to 3 mL after you put in the ethanol?

    To take out 3 ml of gas, keeping the volume in the flask constant

5. What are some sources of error you may have experienced?

    Measurement errors, heat transfer