NAME

**WORKSHOP 9B: Vapor Pressure** Section

The stronger the intermolecular forces that exist between liquid molecules, the less likely they will escape into the vapor phase. Boiling point (which you explored in Workshop #11) and vapor pressure are both good measures of intermolecular forces. In the following problem set, you will analyze some provided “experimental” data in order to calculate the vapor pressure of a liquid.

Vapor pressure is defined as the pressure of a vapor that is in equilibrium with its liquid. It is controlled by 2 factors:

1. temperature – the higher the temperature, the greater kinetic energy the liquid molecules possess; therefore, they vaporize more readily, hence increasing the vapor pressure.
2. molar heat of vaporization, Hvap – the energy required to change a liquid to a gas at its boiling point. The stronger the intermolecular forces, the harder it is to pull liquid molecules apart, and therefore the higher its Hvap, which decreases its vapor pressure.

The Clausius-Clapeyron Equation relates the three quantities vapor pressure, Hvap, and temperature according to the equation:

*Hvap*

ln VP =  + B

*RT*

Notice this equation fits the slope-intercept form y = mx + b, so if ln VP is plotted against 1/T, a straight line results with -Hvap/R as the slope. You will use this equation and the provided “experimental” data to calculate an unknown liquid’s Hvap and its boiling point at a particular temperature. Consider the following:

|  |  |  |
| --- | --- | --- |
| Temperature, t, | Heights of Manometer | Vapor Pressure |
| (in oC) | Mercury Levels (in mm) | (in mmHg or torr) |

atm + VP open to atm trapped on gas side

1. 1.2 250 228

2. 21.1 265 205

3. 40.0 297 142

4. Boiling Point: 76 oC Barometric Pressure: 752 torr

Now fill in the following table to prepare for the graph:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **t, ºC** | **T, Kelvin** | **1/T, K-1** | **VP, mmHg** | **ln VP** |
| **1.2** |  |  |  |  |
| **21.1** |  |  |  |  |
| **40.0** |  |  |  |  |

Graph ln VP vs. 1/T on Microsoft Office Excel®. According to the Clausius-Clapeyron equation, the slope is equal to -Hvap/R. Using R = 8.314 x 10-3 kJ/mole-K, calculate

Hvap for the liquid:

slope = y/x = (lnVP)/ (1/T) = = -Hvap/R (rearrange to solve for Hvap) SHOW CALCULATION:

Therefore, Hvap = kJ/mole

From the graph, you can also calculate what the liquid’s boiling point should be at the “experimental” barometric pressure. Recall that boiling point is the temperature where the vapor pressure is equal to the atmospheric pressure.

“Experimental” barometric pressure (= the VP needed for boiling)

mmHg

ln (barometric pressure)

1/T at this vapor pressure K-1 (from the graph)

T at this pressure K

t at this pressure oC (= the predicted boiling point) “Experimental” boiling point oC

*Make sure to submit your properly labeled graph when submitting this Workshop!*