Chem 1515.001 - 006
Problem Set #2
Spring 2002

Name_____

TA's Name _____

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ALL work must be shown to receive full credit. **Due in lecture, at 8:30 a.m. on Friday, February 1, 2002.**

PS2.1. Using the PLE4 (http://intro.chem.okstate.edu/PLE412502/PLMPhase.html) discussed in class as a source, describe, in terms of a particulate level view, what happens as heat is added to a sample of a pure substance initially in the solid phase until the sample is completely vaporized.

PS2.2. In the boxes below diagram the specified system as viewed at the atomic level in the space provided. Be sure to clearly label each of the substances in your diagram.

A sample CO_2 at 25 ˚C	A sample of potassium at 25 ˚C	A mixture of oxygen and helium at 25 ˚C

PS2.3. Using a substance of your choice, write a chemical equation describing the condensation process and a chemical equation describing the freezing process. For each process discuss the change in enthalpy and entropy that occurs. For each process describe the conditions (in terms of temperature) that favor a spontaneous change, and the conditions that do not favor a spontaneous change.

PS2.4 a. How much heat is required to convert 75.0 g of $H_2O_{(s)}$ at -12.0 °C to $H_2O_{(l)}$ at 75.0 °C?

b) How much heat is produced when 75.0 g of $H_2O_{(g)}$ at 115 °C is converted to $H_2O_{(l)}$ at 75.0 °C?

PS2.5. Ethyl alcohol melts at -114.5 °C and boils at 78.4 °C. The enthalpy of vaporization for ethyl alcohol at 78.4 °C is 38.56 kJ mol^{-1} and the enthalpy of fusion is 4.60 kJ mol^{-1}. If the specific heat of ethyl alcohol vapor is taken to be 1.43 J g^{-1} $°C^{-1}$, and that for the liquid 2.46 J g^{-1} $°C^{-1}$, how much heat is required to convert 10.0 g of ethyl alcohol at -100 °C to the vapor phase at 100 °C?

PS2.6a. Define the term equilibrium vapor pressure.

b) Use a vapor-pressure table (check the Database link on the class web site) to look up the equilibrium vapor pressure of a sample of water at 85 °C and at 70 °C.

c) Consider two closed containers each partially filled with liquid water one at 85 °C and the other at 70 °C. Can the pressure of water vapor in the gas phase in either container ever exceed the equilibrium vapor pressure at the particular temperature? Explain why or why not.

PS2.7. A sample of water in the vapor phase (no liquid present) in a flask of constant volume exerts a pressure of 440 mm Hg at 100 °C. The flask is slowly cooled.

a) Assuming no condensation, use the Ideal Gas Law to calculate the pressure of the vapor at 85 °C; at 70 °C.

b) Will condensation occur at 85 °C; 70 °C? Explain.

c) On the basis of your answers in a) and b), predict the pressure exerted by the water vapor at 85 °C; at 70 °C.

PS2.8. Consider the following data for the dichloromethane (CH_2Cl_2)

Temperature (˚C)	Vapor pressure (mm Hg)
-10.0	79.5
0	134.3
10.0	212.8
20.0	330.1
30.0	494.3
40.0	725.3

a) Use graphing software (Microsoft Excel) to plot ln(vp) vs. T^{-1} (K^{-1}) for dichloromethane and use your graph to determine the slope of the best line through the data. The heat of vaporization of a liquid can be obtained from such a plot. The relationship is given as,

$$\text{Slope} = -\frac{\Delta H^{\circ}_{vap}}{8.314 \text{ J mol}^{-1} \text{ K}^{-1}}$$

Calculate the heat of vaporization for dichloromethane. (Your plot must be turned in with the problem set, so be sure to clearly label your graph. Hand draw graphs are NOT acceptable.)

b) Using the graph, determine the temperature of a sample of dichloromethane when the vapor pressure is 462 mmHg.

c) Using the graph, determine the vapor pressure of a sample of dichloromethane at -2.35 ˚C.

PS2.9a. The normal boiling point of acetone, $(CH_3)_2CO$ is 56.2 °C and its $\Delta H°_{vap}$ = 32.0 kJ mol^{-1}. Draw a Lewis structure for acetone and calculate the temperature at which acetone has a vapor pressure of 593. mmHg.

b) Using data in part a of this problem, calculate the vapor pressure of acetone when the temperature is –15.5 °C.

PS2.10. Calculate the ΔH°_{vap} for carbon disulfide if its vapor pressure at –5.1 ˚C is 100 mm Hg and at 45.5 ˚C its vapor pressure is 755 mm Hg..