

Name: _____

(4 points)

Chemistry 114 Second Hour Exam

Remember- Show all work for partial credit

1. (12 points) Tell my why:

HF has a higher boiling point than HCl.

HF will form intermolecular hydrogen bonds, HCl won't; this will give HF stronger intermolecular interactions and give it a higher boiling point.

I₂ has a lower vapor pressure than Cl₂ at room temperature.

I₂ is larger than Cl₂, this will make its London force larger to give it stronger intermolecular interactions and make it harder to go into the vapor phase, thus lowering its vapor pressure.

NaCl has a lower melting point than MgS.

Both are ionic and the ions are the same size, but MgS had +2 and -2 ions, making its lattice energy stronger so it will have stronger interaction in the solid and a higher melting point.

H₂S is a gas and H₂O is a liquid at room temperature.

H₂O can form intermolecular Hydrogen bonds, H₂S can't. This gives H₂O stronger intermolecular interactions that will hold the liquid together at room temperature. H₂S lacks these interactions so it can go into the gas phase at RT.

2. (12 points) What type of solid (Pick letter from right hand column) will each of the following substances form?

| <u>Substance</u> | <u>Pick (A - F)</u> | <u>Solid</u> |
|-------------------|---------------------|----------------------|
| C (diamond) | ___F___ | A. Ionic |
| CO ₂ | ___C___ | B. Molecular Network |
| I ₂ | ___C___ | C. Molecular |
| Mg | ___D___ | D. Atomic - Metallic |
| CaCO ₃ | ___A___ | E. Atomic - Network |
| H ₂ O | ___C___ | F. Atomic - Group 8a |
| Ne | ___F___ | |
| SiO ₂ | ___B___ | |

3. (12 points) The vapor pressure of water at 25°C is 23.8 torr, and the heat of vaporization of water is 43.9 kJ/mol. Calculate the vapor pressure of water at 50.°C.

$$\ln\left(\frac{P_1}{P_2}\right) = \frac{\Delta H_{vap}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{23.8}{X}\right) = \frac{43900}{83145} \left(\frac{1}{50 + 273} - \frac{1}{25 + 273}\right)$$

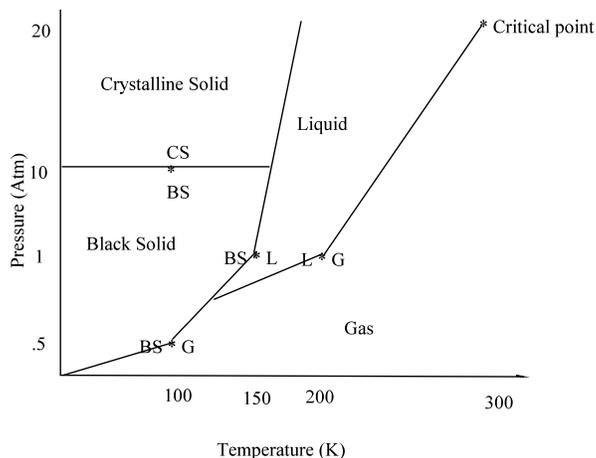
$$\ln\left(\frac{23.8}{X}\right) = 5.28 \times 10^3 (3.095 \times 10^{-3} - 3.356 \times 10^{-3})$$

$$\ln\left(\frac{23.8}{X}\right) = -1.371$$

$$\frac{23.8}{X} = e^{-1.371} = .2538$$

$$X = \frac{23.8}{.2538} = 93.8 \text{ torr (123 atm)}$$

4. (12 points) Make a phase diagram that is consistent with the following data:
- At 1 atm this material is a black amorphous solid at temperatures less than 150K.
 - Its normal melting point is 150K.
 - Its normal boiling point is 200K.
 - It has a critical point at 300K and 20 Atm of pressure.
 - It can sublime at 100K and .5 Atm of pressure.
 - At 100K it undergoes a transition from a black amorphous solid to a clear crystalline solid at 10 Atm of pressure.



Note: Once you plot the points there are many different ways you can make the lines to connect the points, so one graph may not look like another. I was checking to see if the points were properly located and the lines and phases were consistent.

5. (12 points) The liquid in a automobile battery is 3.75M sulfuric acid and it has a density of 1.23 g/ml

How much does 1 liter of this solution weigh?

Density = g/volume; Density \times Volume = Grams; $1.23\text{g/ml} \times 1000\text{ ml} = 1230\text{ g}$

How many moles of H_2SO_4 are in 1 liter of this solution?

3.75 M means that 1 liter contains **3.75 mol** !

How many grams of H_2SO_4 and H_2O are in 1 liter of this solution?

g $\text{H}_2\text{SO}_4 = 3.75\text{ mol} \times 98.07\text{ g/mol} = 368\text{ g}$

Since the total mass of 1 liter is 1230 g, the mass of **water** must be $1230 - 368 = 862\text{ g}$

What is the mass % of H_2SO_4 in this solution?

Using above numbers $368/1230 \times 100\% = 29.9\% \text{ H}_2\text{SO}_4$

What is the Mole fraction of H_2SO_4 in this solution?

Moles $\text{H}_2\text{SO}_4 = 3.75$, moles $\text{H}_2\text{O} = 862\text{ g} \times (1\text{mole}/18\text{g}) = 47.9\text{ mol}$

Mole fraction $\text{H}_2\text{SO}_4 = 3.75/(3.75+47.9) = .0726$

What is the molality of H_2SO_4 in this solution?

$m = \text{moles/kg solvent} = 3.75/.862 = 4.35\text{m}$

6. A (8 points) At room temperature diethyl ether has a vapor pressure of 0.70 atm while acetone has a vapor pressure of .31 atm. If I mix .5 moles of ether with .75 moles of acetone, what is the vapor pressure of the resulting solution?

$$\begin{aligned} \text{VP}_{\text{solution}} &= X_1 \text{VP}_1^0 + X_2 \text{VP}_2^0 \\ &= .5/ (.5+.75) \times .7 + .75/ (.5+.75) \times .31 \\ &= .4(.7) + .6(.31) \\ &= .47\text{ atm} \end{aligned}$$

6.B (4 points) If the above solution has a higher vapor pressure than you calculated, would the solution have gotten hotter or colder when you mixed it?

Higher vapor pressure means a positive deviation from Raoult's Law. Positive deviations from Raoult's Law come from solutions that have a negative $\Delta H_{\text{solution}}$. A negative $\Delta H_{\text{solution}}$ means that the solution got **colder** as it was mixed.

7. (12 points) Carbon tetrachloride has a freezing point of -23°C and a K_f of $5.03^{\circ}\text{C}\cdot\text{kg}/\text{mol}$. If a carbon tetrachloride solution has a freezing point of -30°C , what is the molality of this solution?

$$\Delta T = -23 - (-30) = +7$$

$\Delta T = imK_f$; $i=1$ for this nonionic compound so:

$$7 = x(5.03)$$

$$X = 7/5.03 = \mathbf{1.39\ m}$$

7. (12 points) Define the following terms

van't Hoff factor :

A number that tells how many particles are formed when an ionic compound is dissolved in solution.

heat of solution:

The heat energy that is gained or lost when two compounds are mixed to form a solution.

Henry's Law:

$C=kP$; C = concentration of a gas dissolved in a liquid, P the pressure of the gas over the liquid, k is a constant that is different for every liquid and gas pair.

Semipermeable:

A barrier that will let some molecules pass while it prevents the passage of other molecules.

Tyndall effect

Light that can be seen scattering off of a colloid because it is not truly in solution.

Osmosis

The movement of a molecule across a semipermeable membrane from an area of high concentration to an area of lower concentration