Name: _____

GENERAL CHEMISTRY
CHEM. 111 SEC. 001

EXAM II

Spring, 2003

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Answer all the questions. DO NOT write on this examination paper; use the blank sheets at the back of the exam for your answers. Credit will not be given for numerical questions unless all relevant calculations are shown. Please give answers to numerical questions to 3 significant figures.

1. a) 21.76g of Iron(III) Chloride are dissolved in water to produce 350mL of solution. Calculate

   i) The molarity of the solution.
   ii) The molarity of the Iron ions in the solution.
   iii) The molarity of the Chloride ions in the solution.

10 points

b) 15.45g of sodium carbonate are dissolved in water to produce 155mL of solution. If the density of the solution is 1.057g.mL^{-1} calculate the Wt. % of sodium carbonate in the solution.

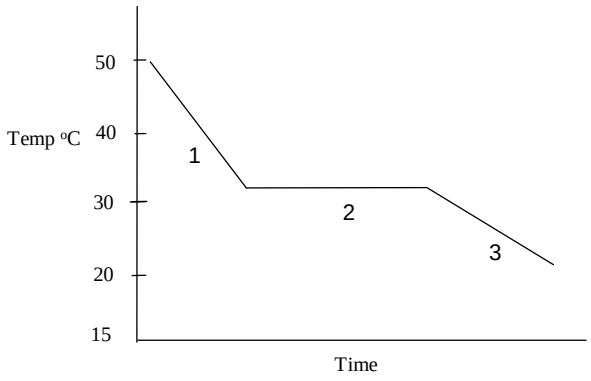
10 points

c) 107.1g of potassium iodide are dissolved in water to produce 460mL of solution. If the density of the solution is 1.117g.mL^{-1} Calculate

   i) The molality of the solution.
   ii) The molality of the Potassium ions in the solution.
   iii) The molality of the Iodide ions in the solution
   iv) The mole fraction of all species present in the solution.

15 points

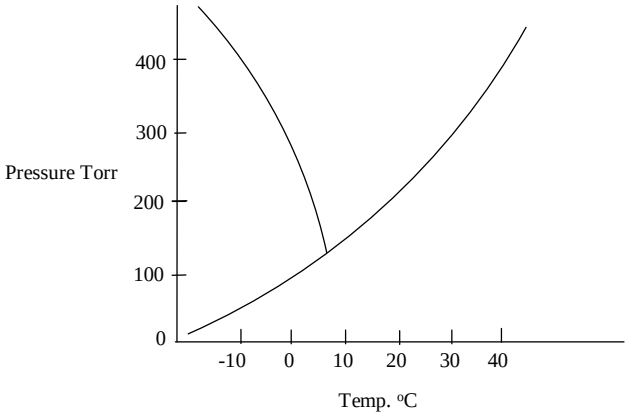
2. a) The following is a cooling curve for a compound:



i) In which region(s) of the curve is the kinetic energy changing. Explain your answer.
ii) In which region(s) of the curve is the potential energy changing. Explain your answer.
iii) At what temperature will the compound melt?

10 points

b) The following is a phase diagram for a compound:



i) What pressure at 20°C does the compound exist in a liquid-gas equilibrium?
ii) At what temperature does the compound boil at 300 Torr pressure?
iii) If the compound existed on another planet in the atmosphere as a gas at 100 Torr pressure at what temperature would it begin to 'snow' this compound?
iv) What is the triple point temperature and pressure for this compound and what occurs at this point?

10 points

3. a) At 25^{o}C the partial pressure of carbon dioxide in a can of soda is 5 atmospheres. If the Henry's Law constant for carbon dioxide in soda is 3.3×10^{-2} mole.L^{-1}.ats^{-1}. Calculate the solubility of carbon dioxide in the soda.

10 points

b) Calculate the vapor pressure of a solution of 50.0g of glycerol ($C_3H_8O_3$) in 600g of water at 25^{o}C. Given the vapor pressure of water at 25^{o}C is 23.76 Torr and assume glycerol has negligible vapor pressure.

10 points

4. a) Explain or define the following:

i) Unit Cell
ii) LeChâtelier's Principle
iii) Lattice Site
iv) Allotrope
v) Ideal Solution
vi) Saturated Solution
vii) Ion-Dipole Interaction
viii) Molecular Solid

8 points

b) A material is more soluble in hot solution than cold solution. Is the enthalpy of solution exothermic or endothermic? Give an explanation of your answer for credit.

2 points

5. a) The following is a list of compounds and their melting points. Assuming that the major force of interactions is hydrogen bonding, what can you say about the relative strengths of hydrogen bonding in the compounds?

Compound	**Melting Point ^{o}C**
H_2O	0
NH_3	-77.7
HF	-83.1
CH_3OH	-93.9

5 points

b) Gasoline can be considered primarily to consist of the compound octane (C_8H_{18}). Gasoline is <u>not</u> soluble in water. Explain.

5 points

c) 50.0g of ice at 0^{o}C is converted to water at 30^{o}C. Calculate the heat energy in kJ to do this. Given that the heat of fusion of ice is 6.02kJ.mole^{-1} and the heat capacity of liquid water is 4.21J.g^{-1}.^{o}C^{-1}.

5 points

USEFUL RELATIONSHIPS

Henry's Law

$$C = k.P$$

C = concentration
k = Henry's Law constant
P = Partial pressure of the gas

Raoult's Law

$$P_{soln} = \chi_{solv.} \text{ x } P^{o}_{solv.}$$

P_{soln} = Vapor pressure of solution
$\chi_{solv.}$ = Mole fraction of solvent
$P^{o}_{solv.}$ = Vapor pressure of pure solvent

ANSWERS

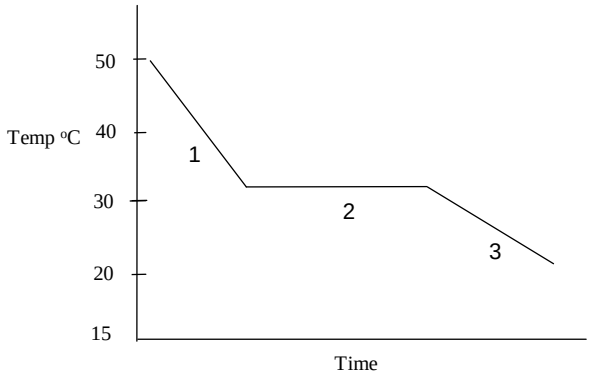
1. a)
   i) 0.382 M
   ii) $[Fe^{3+}] = 0.382$ M
   iii) $[Cl^{-}] = 1.15$ M

   b) Wt % sodium carbonate = 9.43 wt %

   c)
   i) 1.59 m
   ii) $[k^{+}] = 1.59$ m
   iii) $[I^{-}] = 1.59$ m

   iv) $\chi_{I^-} = 2.70 \times 10^{-2}$
   $\chi_{k^+} = 2.70 \times 10^{-2}$
   $\chi_{H_2O} = 0.946$

2. a)



   i) In regions (1) and (3) the Kinetic Energy is changing. The temperature is dropping, therefore the average Kinetic Energy of the molecules/atoms is decreasing.

   ii) In region (2) the potential energy is changing. There is no change in Temperature, therefore, the average Kinetic Energy of the molecules/atoms is not changing. However, the atoms or molecules are becoming closer together in going from a liquid $\rightarrow$ solid and therefore the potential energy is changing.

   iii) ~ 32°C

   b) i) ~ 200 Torr
   ii) ~ 33°C
   iii) ~ 0°C
   iv) ~ 7°C and ~140 Torr. The compound is in a solid/liquid/gas equilibrium.

3. a) 0.105 moles.L^{-1}

   b) P_{soln} = 23.4 Torr

4. a)

   i) This is the smallest repetitive structure that makes up the crystal structure of the material.

   ii) When a constraint (stress) is placed on a system in dynamic equilibrium the equilibrium will move in a direction to oppose that constraint (stress).

   iii) This is the location in the crystal lattice where the atoms, molecules or ions are found.

   iv) This is a material that has two or more different crystal structures.

   v) This is a solution where $\Delta H_{soln} = 0$ and where the strength of the intermolecular forces between solute/solvent , solvent/solvent and solute/solute molecules are approximately the same.

   vi) This is a solution in which the maximum amount possible of solute has been dissolved.

   vii) These are interactions between an ion and a molecule that has a dipole.

   viii) This is a compound in which the lattice sites are occupied by molecules.

   b) Endothermic. This arises from LeChâtelier's Principle. The material is dissolving to try and oppose the increase in temperature (constraint/stress on the system) by cooling the system down. The reaction must therefore be endothermic.

5. a) H_2O, NH_3 and HF have all about the same molecular weight. As a consequence molecule weight is not a factor here. If the strength of the hydrogen bonding was the same on each, they would have similar melting points. NH_3 can form multiple hydrogen bonds, but has approximately the same melting point as HF which can form only single hydrogen bonds. Therefore, its hydrogen bonds must be weaker than HF. H_2O has the highest melting point but it can form multiple hydrogen bonds. However, its melting point is so much higher that the strength of its hydrogen bonds must be larger than HF. CH_3OH has by far the highest molecular weight but the lowest melting point. It must therefore have the weakest hydrogen bonds. $H_2O > HF > NH_3 > CH_3OH$

   b) Octane has only London Dispersion forces and water has hydrogen bonding. These forces are very different in strength and therefore the molecules will not interact very well with each other. Octane is immiscible with water.

   c) 23.0kJ