

Name: \_\_\_\_\_

**GENERAL CHEMISTRY  
CHEM.111. SEC. 003  
EXAM II**

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**Spring, 2004**

Answer all the questions. DO NOT write on this examination paper; use the blank sheets at the end 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) 14.7g of Copper(II) Nitrate are dissolved in water to produce 250mL of solution.
  - i) Calculate the molarity of the solution.
  - ii) Calculate the equilibrium or species molar concentrations.

10 points
  
- b) 31.6g of sodium sulfate are dissolved in 500mL of water. Given the density of water is  $1.000\text{g.mL}^{-1}$ .
  - i) Calculate the molality of the solution.
  - ii) Calculate the equilibrium or species molal concentrations.

10 points
  
2. a) An aqueous solution has a concentration of  $1.0 \times 10^{-3}\text{M}$  in potassium chloride.
  - i) Calculate the concentration of potassium ions in ppt.
  - ii) Calculate the concentration of chloride ions in ppt.

10 points
  
- b) 36.7g of Calcium Nitrate are dissolved in 100g of water. Calculate the mole fraction of all species present in the solution.

10 points
  
3. a) State Le Châtlier's principle.
  - b) Explain what is meant by the term 'Dynamic Equilibrium'.
  - c) When Ammonium Chloride is dissolved in water the reaction is endothermic. If I raise the temperature of the solution, will the solubility of ammonium chloride increase or decrease? Explain your answer. Credit will not be given without an explanation.
  - d) What is meant by the term 'saturated solution'.
  - e) What is meant by the terms 'miscible' and 'immiscible'.

20 points

4. a) The partial pressure of Carbon Dioxide gas inside a can of soda is 4 atmospheres. Calculate the solubility of carbon dioxide in the can of soda. Given Henry's Law constant is  $3.3 \times 10^{-2} \text{ moles.L}^{-1}.\text{atm}^{-1}$ .  
10 points
- b) Calculate the vapor pressure of a solution prepared by dissolving 10.0mL of glycerol ( $\text{C}_3\text{H}_8\text{O}_3$ ) (density  $1.2\text{g.mL}^{-1}$ ) in 500mL of water (density  $1.00\text{g.mL}^{-1}$ ) at  $50^\circ\text{C}$ . Given the vapor pressure of pure water at  $50^\circ\text{C}$  is 92.5 Torr. and that glycerol has negligible vapor pressure.
5. a) 10.0g of a compound are dissolved in 200g of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ). The resulting solution freezes at  $-118.6^\circ\text{C}$ . If pure ethanol freezes at  $-117.3^\circ\text{C}$  and  $k_f$  for ethanol is  $1.99^\circ\text{C.m}^{-1}$ , calculate the molecular weight of the compound.  
10 points
- b) 10.0g of sodium carbonate are dissolved in water to produce 200mL of solution. Calculate the osmotic pressure of the solution at a temperature of  $20^\circ\text{C}$ .  
10 points

## USEFUL INFORMATION

### **Henry's Law**

$$C_{(g)} = k_H P_{(g)}$$

### **Roault's Law**

$$P_{\text{soln}} = X_{\text{soln}} P^{\circ}_{\text{solvent}}$$

### **Depression of Freezing Point**

$$\Delta T = k_f m$$

### **Elevation of Boiling Point**

$$\Delta T = k_b m$$

### **Osmotic Pressure**

$$\Pi = MRT$$

$$R = 0.0821 \text{ atm}\cdot\text{L}\cdot\text{mole}^{-1}\cdot\text{K}^{-1}$$

## ANSWERS

1. a)
  - i) 0.313 M
  - ii)  $[\text{Cu}^{2+}] = 0.313 \text{ M}$   
 $[\text{NO}_3^-] = 0.627 \text{ M}$
- b)
  - i) 0.444 M
  - ii)  $[\text{Na}^+] = 0.888 \text{ m}$   
 $[\text{SO}_4^{2-}] = 0.444 \text{ m}$
2. a)
  - i) 0.0391 ppt
  - ii) 0.0355 ppt
- b)
$$\chi_{\text{H}_2\text{O}} = 0.892$$
$$\chi_{\text{Ca}^{2+}} = 0.036$$
$$\chi_{\text{NO}_3^-} = 0.072$$
3. a) When a constraint/stress is placed on a system in dynamic equilibrium, the system will move in a direction to oppose that constraint/stress.
- b) A dynamic equilibrium is a system that appears not to change on the macro scale but is undergoing constant change on the atomic/molecular scale.
- c) The solubility will increase. When the solution is saturated the system is in a dynamic equilibrium. If I raise the temperature, (i.e., apply a stress), the system will move in a direction to oppose the stress. In this case, it will want to lower the temperature. As the reaction is endothermic it can do this by dissolving more material.
- d) A saturated solution is one in which no more solute will dissolve.
- e) Miscible means that a solute will dissolve in a solvent. Immiscible means that a solute will not dissolve in a solvent.
4. a)  $0.132 \text{ g} \cdot \text{L}^{-1}$
5. b) 11.3 atm