

NAME: \_\_\_\_\_

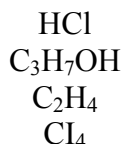
**GENERAL CHEMISTRY  
CHEM. 111 SEC. 001  
FINAL EXAM**

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**Spring 2006**

Answer all the questions. **DO NOT** write on this examination paper; use the blank sheets at the end of your exam for your answers. Credit will not be given for numerical questions unless all relevant calculations are shown. For questions requiring a graph, you may use either a graphing calculator or the graph paper provided in either case, make sure you list your x and y values. Please indicate if you use a graphing calculator and give all numerical calculations to three (3) significant figures.

1. a) For the following compounds:



- i) Indicate if they are polar or non-polar. 2 points
- ii) Explain your reasons for your assignment in (i) above. 4 points

b) For the following compounds explain the trend in boiling points.

<u>Compound</u>	<u>Boiling Point (k)</u>
F <sub>2</sub>	85.0
Cl <sub>2</sub>	239
Br <sub>2</sub>	332
I <sub>2</sub>	458

3 points

c) The following compounds all have similar molecular weights. Explain the trend in boiling points.

<u>Compound</u>	<u>Boiling Point (k)</u>
CH <sub>3</sub> – CH <sub>2</sub> – CH <sub>3</sub>	231
CH <sub>3</sub> Cl	249
CH <sub>3</sub> CN	355

3 points

d) The following are types of forces of intermolecular interaction. Explain the origin of the intermolecular forces.

- i) London Dispersion Forces
- ii) Dipole-Dipole Interaction

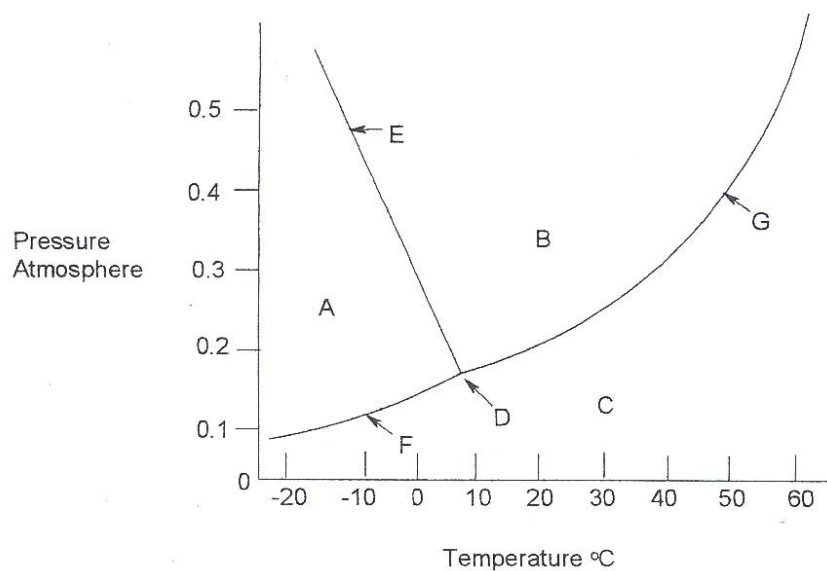
5 points

2. a)

- i) If the molecules in two compounds have the same average kinetic energy, what can we say about their temperature?
- ii) At atmosphere pressure a compound boils at  $120^{\circ}\text{C}$ . At 0.5 atmosphere pressure, will it boil at a higher or lower temperature? Explain

4 points

b) The following is a phase diagram for a compound B.



i) What phases exist at AB & C?

3 points

ii) What phases exist at DEF & G in equilibrium?

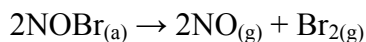
4 points

iii) At  $0^{\circ}\text{C}$  if I increase the pressure from 0 to 0.5 atmospheres, what phase changes will occur?

3 points

- iv) At 0.3 atmospheres, at what temperature will the compound freeze and at what temperature will it boil? 2 points

3. 40.12 g of magnesium chloride are dissolved in water to produce 150mLs of solution. The density of the solution is  $1.101\text{g.mL}^{-1}$ .
- a) Calculate the formal molar concentration of magnesium chloride. 5 points
  - b) Calculate the species or equilibrium molar concentrations. 2 points
  - c) Calculate the molal concentration of magnesium chloride 5 points
  - d) Calculate the species or equilibrium molal concentrations. 2 points
  - e) Calculate the Wt% concentrations of magnesium chloride. 3 points
  - f) Calculate the mole fraction of each component in the solution. 5 points
4. a) 19.1g of potassium sulfate are dissolved in water to produce 200mLs of solution density  $1.056\text{g.mL}^{-1}$ . At what temperature will this solution freeze if pure water freezes at  $0^{\circ}\text{C}$  and the freezing point depression constant for water is  $1.86^{\circ}\text{C.kg.mole}^{-1}$ . 4 points
- b) Barium fluoride is a slightly soluble material. Calculate the equilibrium solubility of barium ions and fluoride ions in pure water. 5 points
5. The kinetics of the following reaction was studied experimentally with the following results:



<u>Time(s)</u>	<u>[NOBr] moles.L<sup>-1</sup></u>
0.00	0.0100
2.00	0.0071
4.00	0.0055
6.00	0.0045
8.00	0.0038
10.00	0.0033

- i) Calculate the average rate of the reaction between 2.00 and 4.00 seconds. 4 points
- ii) Calculate the rate of the reaction after exactly 5.0 seconds. 4 points
- iii) If the reaction is 1<sup>st</sup> order write the rate expression. 1 point
- iv) If the reaction is 1<sup>st</sup> order calculate the rate constant. 4 points
6. a) Calculate the pH and pOH of a 0.05M solution of barium hydroxide. 5 points
- b) Calculate the pH and the pOH of a 0.1M solution of formic acid. 4 points
- c) Would you expect a 0.1M solution of ammonium chloride to be acidic, neutral or basic? Explain your answer. 4 points
- d) For the reaction:
- $$\text{CuO(s)} + \text{H}_2\text{(g)} \rightarrow \text{Cu(s)} + \text{H}_2\text{O(g)}$$
- i) Calculate the Gibbs free energy under standard condition of temperature and pressure. 5 points
- ii) Is the reaction spontaneous or non-spontaneous? Explain. 3 points
- iii) If the reaction was at equilibrium, what would be the value of the Gibbs free energy? 2 points

## USEFUL INFORMATION

$$\Delta T = mK_f$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

## ANSWERS

1. a)
- i) HCl – polar  
C<sub>3</sub>H<sub>7</sub>OH - polar  
C<sub>2</sub>H<sub>4</sub> - non polar  
Cl<sub>4</sub> – non polar
  - ii) HCl – Linear molecule H & Cl have different electronegativities and therefore the molecule is polar.  
  
C<sub>3</sub>H<sub>7</sub>OH – Complex structure (nonsymmetrical) has C-O bond, C & O have difference electronegativities and therefore the molecule is polar.  
  
C<sub>2</sub>H<sub>4</sub> – C and H have approximately the same electronegativity, all bonds are non polar, molecules is non polar.
- b) All the compounds are non-polar. They have just London Dispersion forces as forces of interactions. Boiling points therefore will just depend on molecular weight.
- c) All the compounds have approximately same molecular weight. Therefore boiling points must depend on strength of intermolecular forces. CH<sub>3</sub>-CH<sub>2</sub>-CH<sub>3</sub> has just London Dispersion forces the other two have London Dispersion plus dipole-dipole. Therefore CH<sub>3</sub>-CH<sub>2</sub>-CH<sub>3</sub> has the lowest boiling point. The electro negativity difference between C and Cl is less than between C and N. Therefore C-Cl is a less polar bond than C and N which reflects the order of their boiling points.
- d)
- i) London dispersion forces arise from the induced dipole that arise when two atoms or molecules come close together and their electron clouds become distorted through repulsion.
  - ii) This arises in compounds that have polar bonds and are themselves polar. The negative end of one molecule is attracted to the positive end of another molecule so setting up electrostatic interaction.
2. a)
- i) The temperature is the same.
  - ii) Boiling occurs when the vapor pressure of a liquid becomes equal to the external pressure. The vapor pressure of a liquid will

become equal to a lower external pressure at a lower temperature.  
The liquid will then boil at a lower temperature.

- b)
- i) A – solid, B – liquid, C – gas
  - ii) D – gas, liquid, solid; E – solid, liquid; G – gas, liquid; F – gas, solid
  - iii) Gas – solid/gas (equilibrium) – solid – solid/liquid (equilibrium) – liquid
  - iv) Freeze 0°C, boil ~ 40°C

3. a) 2.81M

b)  $[\text{Mg}^{2+}] = 2.81\text{M}$

$[\text{Cl}^-] = 5.62\text{M}$

c) 3.37m

d)  $[\text{Mg}^{2+}] = 3.37\text{m}$

$[\text{Cl}^-] = 6.74\text{m}$

e) 24.3%

f) Species present  $\text{Mg}^{2+}$ ,  $\text{Cl}^-$  and  $\text{H}_2\text{O}$

$$\chi_{\text{Mg}^{2+}} = 5.13 \times 10^{-2}$$

$$\chi_{\text{Cl}^-} = 0.103$$

$$\chi_{\text{H}_2\text{O}} = 0.846$$

4. a) -1.06°C

b)  $[\text{Ba}^{2+}] = 3.56 \times 10^{-3}\text{M}$

$[\text{F}^-] = 7.11 \times 10^{-3}\text{M}$

5.

i) Rate =  $8.0 \times 10^{-4}$  moles.min<sup>-1</sup>

ii) Plot graph  
Rate =  $5.00 \times 10^{-4}$  moles.min<sup>-1</sup>

iii) Rate = k [NOBr]

6. a) iv)  $k = 0.1 \text{ min}^{-1}$   
pH = 1.0  
pH = 13
- b) pH = 2.38  
pOH = 11.62
- c) Acidic –  $\text{NH}_4^+$  is the conjugate acid of a weak base ( $\text{NH}_3$ ) and is therefore an OK acid.  $\text{Cl}^-$  is the conjugate base of a strong acid and is therefore a very very weak base.
- d)
- i)  $\Delta G^\circ = -98.5 \text{ kJ}$
  - ii) Spontaneous
  - iii)  $\Delta G^\circ = 0$