Name: _____

GENERAL CHEMISTRY
CHEM. 111 SEC. 001

EXAM III

2nd Summer Session, 2003

These files are in Adobe Acrobat format, if you are using Netscape Navigator or Internet Explorer and have Adobe Acrobat Reader installed (if you do not; Acrobat Reader can be downloaded for free from Adobe); these files should open directly in your browser.

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 all numerical questions to 3 significant figures.

1. a) An aqueous solution that is 0.1M in Calcium Chloride is prepared. Calculate the osmotic pressure that this solution would exert at 25°C.

10 points

b) 4.963g of an unknown substance is dissolved in water to produce 100 mL of solution. (The solution density is 1.00g.mL^{-1}). If the resultant solution freezes at –0.51°C calculate the molecular weight of the compound. Given k_f for water is 1.86°C m^{-1}.

10 points

c) The actual molecular weight of the material is 362g.mole^{-1} . What can you say about its behavior in solution?

5 points

2. a)

1. Explain what a catalyst is and how it functions?
2. Explain what an inhibitor is and how it functions?
3. What is meant by Activation Energy?
4. What is meant by Transition State Complex?

8 points

b) The following experimental data was obtained for the reaction:

$$2N_2O_{(g)} \rightarrow 2N_{2(g)} + O_{2(g)}$$

Experiment	Temperature K	k (L.mole^{-1}.s)
1	1125	11.59
2	1053	1.67
3	1001	0.380
4	838	0.0011

Calculate the activation energy for the reaction. **(*Graph paper is provided at the end of the exam.*)**

10 points

3. a) For the reaction:

$$Br_{2\,(g)} + 2\,NO_{(g)} \rightarrow 2\,BrNO_{(g)}$$

the mechanism is:

$$Br_{2\,(g)} + NO_{(g)} \rightarrow BrNO_{(g)} \text{ Slow Step}$$
$$Br_2NO_{(g)} + NO_{(g)} \rightarrow 2BrNO_{(g)}$$

write the rate expression for the reaction.

5 points

b) The following data were collected for the reaction:

$$2N_2O_{5(g)} \rightarrow 2N_2O_{4(g)} + O_{2(g)}$$

$[N_2O_5]$ mole.L^{-1}	**t (min)**
2.08	3.07
1.67	8.77
1.36	14.45
0.72	31.28

i) Calculate the average rate of reaction between 3.07 and 8.77 min.

5 points

ii) Calculate the rate of the reaction after exactly 6.0 min.
(***Graph paper is provided at the end of the exam paper***.)

10 points

iii) If the reaction is first order, calculate the rate constant.

5 points

4. a) Define pH.

5 points

b) For the following reaction using BrΦnsted Lowery acid base theory, indicate:

i) The acid
ii) The base
iii) The conjugate acid
iv) The conjugate base

$$CH_3NH_2 + H_2O \leftrightarrow CH_3NH_3^+ + OH^-$$

5 points

c) Draw the pH scale.

2 points

d) If a solution has a pH = 3.3:

i) Is it acidic or basic?
ii) What is the pOH?
iii) What is the hydronium ion concentration?
iv) What is the hydroxide ion concentration?

10 points

e) 0.123g of potassium hydroxide are dissolved in water to form 150mLs of solution. What is the pH of the solution?

10 points

Useful Information

Osmolic Pressure

$$\Pi = MRT$$

Π = Pressure
M = Molarity
R = 0.08206 L .atm. $K.^{-1}$ $mole^{-1}$
T = Temperature K

Freezing Point Depression

$$\Delta T = k_f m$$

Activation Energy

$$k = Ae^{-\frac{Ea}{RT}} \text{ or } \log k = \log A - \frac{Ea}{2.303RT}$$

pH

$$14 = pOH + pH$$

ANSWERS

1. a) 7.34ats.
   b) 181.1g.mole^{-1}
   c) The material dissociates in solution in either of the following ways.
   $A \rightarrow 2B$
   $A \rightarrow B + C$

2. a)
   i) A catalyst is any material that increases the rate of a reaction without being used up in the reaction. Catalysts work by decreasing the activation energy of a reaction.

   ii) An inhibitor is any material that slows down the rate of a reaction without being used up in the reaction. Inhibitors work by increasing the activation energy of a reaction.

   iii) Activation energy is the energy barrier that reactants must overcome in order to become products.

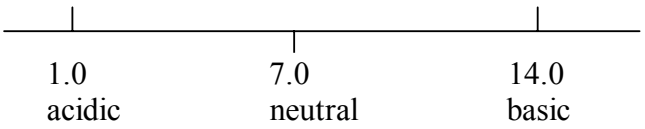
   iv) This is an intermediate 'complex' that represents the transition complex that is formed as reactants go to products. It is the molecular form that represents the species that exists at the 'top' of the activation energy.

   b) 251.5kJ.

3. a) Rate = k $[Br_2]$ [NO]
   b) i) 7.19×10^{-2} moles.L^{-1}.min^{-1}
   ii) 6.62×10^{-2} moles. L^{-1}.min^{-1}
   iii) 3.52×10^{-2} min^{-1}

4. a) pH = -log $[H_3O^+]$
   b)
   i) H_2O
   ii) CH_3NH_2
   iii) $CH_3NH_3^+$
   iv) OH^-

   c)



   d) i) Acidic
   ii) 10.7
   iii) 5.01×10^{-4}
   iv) 1.99×10^{-11}

   e) pH = 12.2