Chemistry 103 PRACTICE HE 1 Summer 2004

Student Info: name, _____ SID, _____

Lab Instructor: _____

Ground Rules

In solving word problems, you must show sufficient work that the grader may follow your logic, for example, show chemical formulas and the corresponding molar masses you calculate, etc.. Many questions have multiple parts. **Clearly** indicate your answer to each part.

If you cannot complete a part of a problem due to what you see as missing information, describe what is missing and how the problem could be solved using that information and you may receive partial credit depending upon the validity of your arguments.

Finally, this exam is a reflection of *your* understanding of the material. Cheating is a serious offense that bears many penalties, outlined in the student handbook. If you do succeed in cheating, the greatest penalty will be when you are required to apply the material you were to have learned.

Potentially Useful Information for Chem. 103:

$R = 8.314$ J/mol•K

$R = 0.0821$ L•atm/mol•K

$\ln k = \ln A - (E_a/RT)$

$PV = nRT$

$N_O = 6.022 \times 10^{23}$ mole

760 mm Hg = 1 atm

0° C = 273.15 K

$h = 6.626 \times 10^{-34}$ J•s

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$c = 3.00 \times 10^{8}$ m/s

$m_{electron} = 9.109 \times 10^{-31}$ kg

$KE = \frac{1}{2} mv^2$

$K_W = 1.00 \times 10^{-14}$ AT 298K

$\Delta H = \Delta E + \Delta nRT$

$\Delta S = \frac{q}{T}$

$K_A K_B = K_W$

$S = k \ln W$

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G = \Delta G° + RT\ln Q$

$\Delta G° = -RT\ln K$

$\Delta E = q + w$

1 L•atm = 101.27 J

$q = nC_p\Delta T$

$w = - P_{ext}\Delta V$ or F•d

$q = C\Delta T$

$\Delta H = q_P$

Significant Figures figure Significantly in your answer!

1. 1 Use standard thermodynamic data (Appendix D in your text) to calculate the equilibrium constant at 298K for each of the following equilibria:

i) CH_4 (g) + H_2O (l) = CO(g) + $3H_2$ (g)

ii) CO(g) + $3H_2$ (g) = CH_4 (g) + H_2O (l)

iii) Sn(s, white) + 2 H_2O (l) = SnO_2(s) + $2H_2$ (g)

1.2 Estimate the equilibrium constant at 350K for each reaction in 1.1

2 .1 What is meant by the half life of a first order reaction?

2.2 Nitramide, H_2NNO_2, decomposes at 298K in aqueous solution to give N_2O and H_2O.
The nitramide decomposition reaction is catalyzed by bases.

(a) What is the function of a catalyst?

(b) Draw an energy/reaction pathway diagram for both the catalyzed and uncatalyzed reaction. Show clearly the energy difference between reagents and products and the activation energies for both reactions.

(c) Calculate the activation energy for the reaction if its rate constant at 318K is 10.7 times its rate constant at 288K.

3. At 373K K = 1.5 x 10^8 for the following reaction: $CO(g) + Cl_2(g) = COCl_2(g)$

3.1 By making appropriate approximations calculate the partial pressures of CO(g) and $Cl_2(g)$ in equilibrium in a vessel of volume 5.35L at 373K that initially contained $COCl_2(g)$ at a pressure of 0.50 atm.

3.2 The reaction $CO(g) + Cl_2(g) = COCl_2(g)$ is exothermic. To increase the equilibrium concentration of $COCl_2(g)$ you should

A. Decrease the pressure
B. Increase the temperature
C. Remove some CO(g) from the mixture
D. All the above
E. None of the above

4. (This is 14.5.3!) The oxidation of NO by O_2 has the following rate law:

for $2NO(g) + O_2(g) = 2NO_2(g)$ rate = $k[NO]^2[O_2]$

4.1 Express the rate in terms of the rate of loss of NO(g)

4.2 This reaction probably proceeds by a mechanism that involves a fast bimolecular elementary reaction:

$$2NO(g) = N_2O_2(g)$$

(a) Propose a slow second step to complete the mechanism.

(b) Show that your proposed mechanism accounts for the observed products and the rate law for the overall reaction.

5. Question 15.34. Cyanic acid, HCNO, is a weak acid. In a 0.20M solution of HCNO the concentration of $H_3O^+$is found (incidentally, how is it found?) to be 6.5 x 10^{-3} M. Calculate Ka for HCNO.