CHEM 188 – Spring, 2013

Final Exam (Red)

May 14, 2013

Instructions:

Your scantron answer sheet must show your **NAME**, **STUDENT ID NUMBER**, and **LAB SECTION**. (Begin these entries at the LEFT end of the space provided.)

In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. USE A SOFT (No. 2) PENCIL.

Note that a **periodic table** of the elements is attached at the end of the exam.

You are allowed to use a one page (8½"x11") study guide that you have prepared.

Useful information:

Gas constant	**R = 0.0821 L□atm/K□mol = 8.314 J/K□mol**
Avogadro's constant	**N_{Avo} = 6.02 □ 10^{23} $mol^{□1}$**
Speed of light	**c = 3.00 □ 10^{8} $m·s^{□1}$**
Boltzmann's constant	**k = 1.38 □ $10^{□23}$ J□$K^{□1}$**
Planck's constant	**h = 6.63 □ $10^{□34}$ J□s**

1 atm = 760 mmHg = 760 torr

1 L□atm = 101.3 J

1 kg = 6.02 □ 10^{26} amu

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1. Consider the hypothetical reaction A + 2B □ products. Use the following data to determine the **rate constant, k,** for the reaction.

Expt. #	$[A]_0$	$[B]_0$	Initial rate
1	0.20	0.20	4.38M/min
2	0.20	0.40	4.38 M/min
3	0.40	0.20	8.76 M/min

A. 3.8 min^{-1} B. 7.3 min^{-1} C. 11 min^{-1} D. 22 min^{-1} E. 26 min^{-1}

2. At 25°C, the second-order reaction

$$NOCl(g) \square NO(g) + ½\ Cl_2(g)$$

is 50% complete after 52 hours when the initial concentration of NOCl is 0.50 mol/L. How long will it take for the reaction to be 75% complete?

A. 26 hr B. 39 hr C. 52 hr D. 78 hr E. 156 hr

3. Given that E_a for a certain biological reaction is 75 kJ/mol, and that the rate constant, k, is 2.5 x 10^{-2} s^{-1} at 15°C, **what is the rate constant at 37°C?**

A. 1.1 s^{-1} B. 2.3 x 10^{-1} s^{-1} C. 1.0 x 10^{-1} s^{-1}

D. 5.1x 10^{-2} s^{-1} E. 6.0 x 10^{-3} s^{-1}

4. A particular catalyst increases the rate of a certain reaction by a factor 5.00 x 10^3 at 25°C. By how much (kJ/mol) must this catalyst have lowered the activation energy for this reaction? (Assume the frequency factor remains the same.)

A. 17.1 kJ/mol B. 21.1 kJ/mol C. 25.1 kJ/mol

D. 29.1 kJ/mol E. 33.1 kJ/mol

5. Identify the **catalyst(s)** in the following reaction mechanism:

(1) A + B → AB
(2) AB + C → D
(3) D → B + E

A. AB B. B C. AB and C D. C E. AB and D

6. Consider the two gaseous equilibria:

$H_2(g) + ½ O_2(g) \rightleftharpoons H_2O(g)$ K_1

$2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g)$ K_2

The values of the equilibrium constants K_1 and K_2 are related by

A. $K_2 = K_1$ B. $K_2 = (K_1)^2$ C. $K_2 = 2K_1$

D. $K_2 = (K_1)^{-1}$ E. $K_2 = (K_1)^{-2}$

7. For the reaction

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $K_c = 50.2$ at 445°C.

If $[H_2] = [I_2] = [HI] = 1.75 \times 10^{-3}$ M at 445°C, which one of the following statements is **true**?

A. The system is at equilibrium; no change will occur.
B. The concentrations of H_2 and I_2 will increase as the system approaches equilibrium.
C. The concentration of HI will rise as the system approaches equilibrium.
D. The concentrations of H_2 and HI will fall as the system approaches equilibrium.
E. The concentrations of HI and I_2 will increase as the system approaches equilibrium.

8. A sample consisting of 0.50 moles of AB(*g*) was placed in a 10.0 L reaction chamber at 500°C. After equilibrium was reached, it was found that 5.0% of the AB had dissociated according to the reaction

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g)$$

Calculate the **equilibrium constant K_C** for this reaction at this temperature.

A. 1.6×10^{-4} B. 6.9×10^{-4} C. 2.3×10^{-3} D. 1.0×10^{-2} E. 7.9×10^{-2}

9. Hydrogen iodide decomposes according to the equation

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad K_C = 0.0156 \text{ @ } 400°C$$

Initially, 0.400 mol HI was injected into an empty 2.0 L reaction vessel at 400°C. Calculate the **concentration of HI** at equilibrium.

A. 0.040M B. 0.080 M C. 0.120 M D. 0.160M E. 0.220 M

10. For the following reaction at equilibrium, which one of the changes below would cause the equilibrium to **shift to the right**?

$$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g) \qquad \Delta H°_{rxn} = +30 \text{ kJ}$$

A. Increase the container volume.
B. Remove some NO.
C. Add more NOBr.
D. Increase the temperature
E. All of the above.

11. Which of the following statements is(are) **true** for a 0.10 M solution of a weak acid, HA?

1. The pH > 1.00
2. The pH = 1.00
3. $[H^-] < [HA]$
4. $[H^-] > [A^-]$

A. 2 only B. 3 only C. 1 & 3 D. 2 & 4 E. none of the above

12. The K_a for nitrous acid, HNO_2, is 4.5×10^{-4}. Calculate the **pH** of a 2.5×10^{-5} M HNO_2 solution.

A. 3.82 B. 3.97 C. 4.34 D. 4.62 E. 5.01

13. Pyridine (C_5H_5N) has a base ionization constant, $K_b = 1.7 \times 10^{-9}$. Calculate the **pH** of a 5.0×10^{-3} M solution of C_5H_5N.

A. 4.88 B. 6.18 C. 7.81 D. 8.46 E. 9.11

14. Oxalic acid ($C_2H_2O_4$) is a **diprotic acid**. Its two stages of ionization are: