CHEMISTRY 16
EXAM II

Dr. M. Richards-Babb July 16, 1998

An optical scoring machine will grade this examination. The machine is not programmed to accept the correct one of two sensed answers and will not sense answers which are lightly marked. Mark your answer sheet carefully with a No. 2 soft lead pencil and erase any undesired marks COMPLETELY. Avoid making any extraneous marks on the answer sheet other than the information requested below.

On the answer sheet:

1. Print your name in the space for NAME (last name first, circle your last name).

2. In the space marked SUBJECT print your student number.

3. In the space marked HOUR print Summer II `98.

Check to see that you have 20 examination questions, periodic table and scratch paper when the exam begins.

HAND IN ONLY THE ANSWER SHEET.

Useful Equations and Constants:

1atm=760 torr=760 mm Hg
R=0.08206 L-atm/mol-K=8.314 J/mol-K
$K_W=1.0\times10^{-14}$ at 25°C
$x = [-b \pm (b^2 - 4ac)^{1/2}] / 2a$

$\ln[A] = \ln[A]_0 + -kt$ OR $\log[A] = \log[A]_0 + -kt/2.303$
$[A]/[A]_0 = \exp(-kt)$
$[A] = [A]_0 + -kt$
$1/[A] = 1/[A]_0 + kt$

$k=Ae^{(-E/RT)}$
$\ln k = \ln A + -(E_A/RT)$
$\ln(k_2/k_1) = -E_A/R[(1/T_2) - (1/T_1)]$

CHEMISTRY 16
HOUR EXAM II

CHOOSE THE ONE BEST ANSWER.

1. The reaction $C_2H_6(g) \rightarrow 2\ CH_3(g)$ is first order in C_2H_6. If $k=5.5\times10^{-4}\ sec^{-1}$, how long will it take for the initial concentration to drop to 15% of its original value?

A. 3.0×10^2 sec
B. 4.9×10^3 sec
C. 1.3×10^3 sec
D. 9.2×10^2 sec
E. 3.4×10^3 sec

2. A plot of $1/[BrO^-]$ vs time is linear for the reaction

$$3\ BrO^-(aq) \rightarrow BrO_3^-(aq) + 2\ Br^-(aq)$$

The order of the reaction with respect to BrO^- is:

A. 0
B. 1
C. 2
D. 3
E. -1

3. The decomposition of ozone in the stratosphere can occur by the following two-step mechanism.

$$Br + O_3 \rightarrow BrO + O_2$$
$$BrO + O \rightarrow Br + O_2$$

Which of the following gives a correct identification of intermediates and catalysts.

	Intermediates	Catalysts
A.	Br and O	BrO
B.	BrO	Br and O_3
C.	BrO and O	BrO and O_2
D.	BrO	Br
E.	O_3 and O	O_2

4. Consider the following reactions at equilibrium. Which of the equilibria will be shifted to the right (toward formation of more products) when the pressure is increased by reducing the volume?

A. $2\ O_3(g) \leftrightarrow 3\ O_2(g)$
B. $2\ H_2O(l) \leftrightarrow 2\ H_2(g) + O_2(g)$
C. $N_2(g) + O_2(g) \leftrightarrow 2\ NO(g)$
D. $8\ S(g) \leftrightarrow S_8(g)$
E. None will be shifted to the right. Pressure has no effect on equilibrium.

5. For the reaction below, the equilibrium constant expression in terms of concentrations K_c is:

$$4\ KO_2(s) + 2\ H_2O(g) \leftrightarrow 4\ KOH(s) + 3\ O_2(g)$$

A. $\{4\times[KOH]\times3\times[O_2]\}/\{4\times[KO_2]\times2\times[H_2O]\}$
B. $[O_2]^3/[H_2O]^2$
C. $\{[KOH]^4+[O_2]^3\}/\{[KO_2]^4+[H_2O]^2\}$
D. $[H_2O]^2/[O_2]^3$
E. $\{3\times[O_2]\}/\{2\times[H_2O]\}$

6. The rate constants for decomposition of acetaldehyde CH_3CHO to CH_4 and CO are given below at two different temperatures. The activation energy E_A is:

$k(M^{-1}sec^{-1})$	T(K)
0.011	703
4.95	865

A. 9.08×10^4 J/mol
B. 1.38×10^3 J/mol
C. 1.91×10^5 J/mol
D. 3.17×10^3 J/mol
E. 1.96×10^{-4} J/mol

7. Consider the reaction below

$$N_2(g) + 3\ Cl_2(g) \leftrightarrow 2\ NCl_3(g) \quad K_c=3.2\times10^{11}$$

At equilibrium it was found that $[N_2]_{eq}=0.0014$ M and $[Cl_2]_{eq}=4.3\times10^{-4}$ M. What is the equilibrium concentration of NCl_3?

A. 0.050 M
B. 0.0013 M
C. 1.7×10^{12} M
D. 5.3 M
E. 0.19 M

8. At 127°C, $K_c=2.6\times10^{-5}$ for the reaction

$$2\,NH_3(g) \leftrightarrow N_2(g) + 3\,H_2(g)$$

The numerical value of K_p at 127°C is:

A. 0.028
B. 4.1×10^{7}
C. 2.4×10^{-8}
D. 8.5×10^{-4}
E. 3.0×10^{-3}

9. At 298 K the equilibrium constant K_c for the reaction below is 0.0900.

$$H_2O(g) + Cl_2O(g) \leftrightarrow 2\,HOCl(g)$$

If the following concentrations of gases are present initially, which one will proceed to form more of the reactants in order to attain equilibrium? (HINT: Calculate Q_c)

A. [HOCl]=0.10 M; [H_2O]=0.20 M; [Cl_2O]=2.0 M
B. [HOCl]=0.10 M; [H_2O]=0.10 M; [Cl_2O]=0.10 M
C. [HOCl]=0.75 M; [H_2O]=25 M; [Cl_2O]=0.25 M
D. [HOCl]=2.0 M; [H_2O]=0.20 M; [Cl_2O]=4.0 M
E. Both B and D.

10. Calculate the **equilibrium concentration** of reactant B given the table and equation below.

$$2A(g) + 4B(g) \leftrightarrow C(g) + 3D(g)$$

Initial:	0M	1.2M	5.0M	3.5 M
Change:				-0.7 M
At Eq:				2.8 M

A. 0.3 M
B. 1.0 M
C. 2.1 M
D. 0.5 M
E. 1.9 M

11. At a particular temperature, $K_c=2.50$ for the reaction

$$SO_2(g) + NO_2(g) \leftrightarrow SO_3(g) + NO(g)$$

Calculate the concentration of SO_3 at equilibrium, if the **initial concentrations** of SO_2 and NO_2 were 1.0 M. (HINT: Simplify algebra by taking square root of both sides of eqn.)

A. 0.39 M
B. 0.71 M
C. 0.46 M
D. 0.61 M
E. 0.29 M

12. Hydrogen for use in ammonia production is produced by the reaction

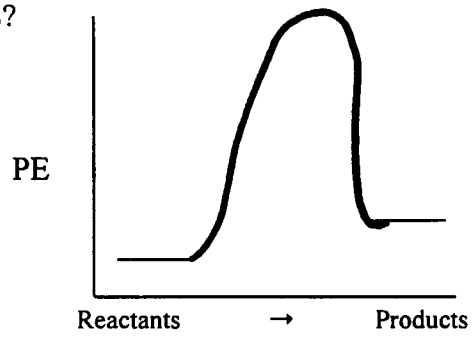
$$CH_4(g) + H_2O(g) \leftrightarrow CO(g) + 3\ H_2(g) \qquad \Delta H = +\ (\text{endothermic})$$

Which of the following stresses when applied to an equilibrium mixture of the gases, will cause $[H_2]$ to decrease?

I. An increase in temperature.
II. Removal of half of the gaseous water.
III. Addition of CO(g) such that its concentration is doubled.
IV. Addition of a catalyst.

A. All will decrease $[H_2]$.
B. I, II and III will decrease $[H_2]$.
C. II and III will decrease $[H_2]$.
D. Only I will decrease $[H_2]$.
E. I and II will decrease $[H_2]$.

13. Consider the reaction profile below and use it to help decide which of the statements below is **TRUE**?



A. The transition state species is an actual product of an elementary reaction.
B. The activation energy measures the difference in potential energy between products and reactants.
C. The activation energy for the forward reaction and the reverse reaction are always the same.
D. The reaction profile given indicates that the net reaction is exothermic.
E. Addition of a catalyst speeds up the reaction by decreasing the activation energy of the reaction.

14. A certain second order reaction has a rate constant $k=3.0\times10^5\ M^{-1}sec^{-1}$. How long will it take for half of the reactant to disappear (ie. what is half-life) if its initial concentration is 5.0×10^{-5} M?

A. 15 sec
B. 0.067 sec
C. 2.3×10^6 sec
D. 30. sec
E. 0.13 sec

15. Which of the following statements about equilibrium is **TRUE**?

A. At equilibrium, the reverse rate is faster than the forward rate.
B. Large values of K_c ($K_c > 10^3$) indicate that mostly products are present at equilibrium.
C. The numerical value of K_c depends on concentration.
D. The numerical value of K_c is independent of temperature.
E. All reactions go 100% to completion independent of the value of K_c.

16. The conjugate base of boric acid H_3BO_3 is _____ while the conjugate acid of HS^- is _____.

A. $H_2BO_3^-$; H_2S
B. OH^-; H_3O^+
C. BO_3^{-3}; H_2S
D. $H_4BO_3^+$; S^{-2}
E. None of the above are correct.

17. Calculate $[OH^-]$ in a solution with $[H_3O]^+ = 3.5\times10^{-3}$ M.

A. 5.0×10^{-3} M
B. 3.5×10^{11} M
C. 8.6×10^{-11} M
D. 3.5×10^{-17} M
E. 2.9×10^{-12} M

18. The pH of 7.5×10^{-4}M HCl is:

A. 7.50
B. 10.88
C. 3.12
D. 2.82
E. 6.15

19. Which one of the following solutions is **basic**?

A. Solution with pH=5.4
B. Solution with pOH=3.7
C. Solution with pOH=7.0
D. Solution with pH=8.5
E. Both B and D are basic.

20. The reactant acting as a Bronsted-Lowry **acid** in reaction I is _____ while the reactant acting as a **Bronsted-Lowry base** in reaction II is _____.

I: $S^{-2}(aq) + H_2O \rightarrow HS^-(aq) + OH^-(aq)$
II: $HS^-(aq) + H_2O \rightarrow S^{-2}(aq) + H_3O^+(aq)$

A. S^{-2}; H_2O
B. H_2O; H_2O
C. S^{-2}; HS^-
D. H_2O; HS^-
E. These reactions are not acid-base reactions.