Name_____ I.D.#_____

CHM 116 March 22, 2006

Test 2B

Place your name on this test booklet and parSCORE Test Form. Fill in the ellipses associated with the I.D. number. Also fill in B under the title TEST FORM.

This exam consists of two parts. Part I consists of 18 multiple choice items which must be answered on the ParSCORE Test Form with a number 2 pencil. Make a heavy black mark filling the rectangle associated with your answer. Part I is worth 108 points. Part II consists of 4 questions which must be answered in detail in this test booklet. The points assigned for each question in Part II are indicated. Total points are 150.

R = 8.314 J/mol K

Some potentially useful equations:

$$t_{1/2} = \frac{0.693}{k}$$

$$\log\frac{[A]_t}{[A]_o} = \frac{-kt}{2.303}$$

$$k = Ae^{\frac{-E_a}{RT}}$$

$$\ln[A]_t = -kt + \ln[A]_o$$

$$\ln k = \frac{-E_a}{RT} + \ln A$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_o}$$

$$\ln\frac{k_1}{k_2} = \frac{-E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$t_{1/2} = \frac{1}{k[A]_o}$$

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

1. Consider the reaction

$$aA + bB \xrightarrow{C} dD + eE \qquad (C = \text{catalyst})$$

The rate law is: Rate = $k[A]^q[B]^r[C]^s$

Which of the following statements is false?

A) The exponents q, r and s are often integers.
B) The exponents q and r are always equal to the coefficients a and b respectively
C) The exponent s must be obtained experimentally
D) The symbol k represents the rate constant
E) The overall reaction order is q + r + s

2. If the rate law for a reaction is

Rate = $k[ClO_3^-][I^-][H^+]^2$

what are the units of k when time is in seconds and the concentration is in moles per liter?

A) $\frac{mol}{Ls}$ B) $\frac{Ls}{mol}$ C) $\frac{mol^2}{L^2 s}$ D) $\frac{L^2}{mol^2 s}$

E) $\frac{L^3}{mol^3 s}$

3. For the reaction that has the rate law, rate = $k[A]^2$

A) a plot of [A] versus time will be a straight line.
B) a plot of log[A] versus time will be a straight line.
C) a plot of [A] versus 1/time will be a straight line.
D) a plot of 1/[A] versus time will be a straight line.

4. A very high activation energy corresponds to

A) a slow reaction.
B) a fast reaction.
C) an endothermic reaction.
D) a non-spontaneous reaction.

5-6. Questions 5 and 6 refer to the following mechanism suggested for the reaction of

$2NO + Br_2 \rightarrow 2NOBr$.

Step 1 $NO + Br_2 \rightarrow NOBr_2$

Step 2 $NOBr_2 + NO \rightarrow 2NOBr$

5. What would be the rate law for the reaction if the first step were slow and the second step a fast non-equilibrium step?

A) rate = $k[NO]^2[Br_2]$

B) rate = $k[NO][Br_2]$

C) rate = $k[NO][Br_2]^2$

D) rate = $k[NO][NOBr_2]$

6. What would be the rate law if the second step were slow and the first step a rapidly established equilibrium?

A) rate = $k[NO]^2[Br_2]$

B) rate = $k[NO][Br_2]$

C) rate = $k[NO][Br_2]^2$

D) rate = $k[NO]$

7. If a reaction is first order with a rate constant of 5.48×10^{-2} min^{-1}, how long will it take for 75% of the initial concentration to disappear?

A) 6.3 min B) 12.6 min C) 25.3 min
D) 36.5 min E) 50.6 min

8. In general, reaction rate increases with an increase in temperature principally because

A) molecular collisions occur more frequently at higher T.
B) the fraction of high-energy molecules increases with increasing T.
C) molecular velocities increase.
D) larger molecules move faster than smaller ones.

9. For the reaction $BaSO_{3(s)} \rightleftarrows BaO_{(s)} + SO_{2(g)}$
the mathematical expression for the equilibrium constant is

A) $K_c = \dfrac{[SO_2][BaO]}{[BaSO_3]}$

B) $K_c = \dfrac{[SO_2]}{[BaSO_3]}$

C) $K_c = \dfrac{[BaO]}{[BaSO_3]}$

D) $K_c = [SO_2]$

E) $K_c = \dfrac{1}{[SO_2]}$

10. Suppose you have a choice of four different reactions for the preparation of some desired product. They obey the equations with their equilibrium constants as follows:

1) $A + B \rightleftarrows C$ $\quad K_c = x$
2) $D + E \rightleftarrows C$ $\quad K_c = 3x$
3) $F + G \rightleftarrows C$ $\quad K_c = 4x$
4) $M + N \rightleftarrows C$ $\quad K_2 = 1/2x$

Which equation will give the larger yield of product?

A) 1 B) 2 C) 3 D) 4
E) all will yield same

11. For the reaction

$$2H_2S_{(g)} \rightleftarrows 2H_{2(g)} + S_{2(g)}$$

at a certain temperature K_2 equals 4500. What will happen when 0.0050 mol of H_2S, 0.50 mol of H_2 and 0.75 mol of S_2 are added to a 1.0 L container and the system is brought to the temperature at which $K_c = 4500$.

A) Nothing, the system is at equilibrium
B) More H_2S will be formed
C) More H_2 will be formed than S_2
D) More S_2 will be formed than H_2

12. For the following reaction

$$2CCl_{4(g)} + O_{2(g)} \rightleftarrows 2COCl_{2(g)} + 2Cl_{2(g)} \qquad K_c = 1.9 \times 10^{19}$$

What is K_c for the following?

$$2COCl_{2(g)} + 2Cl_{2(g)} \rightleftarrows 2CCl_{4(g)} + O_{2(g)}$$

A) 5.3×10^{-20}
B) 2.3×10^{-10}
C) 4.4×10^{9}
D) -1.9×10^{19}
E) 1.9×10^{-19}

13-15. For questions 13 through 15 consider the following system at equilibrium

$$PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)} \qquad \Delta H = +92.5kJ$$

Use the following choices to predict the effect of each change on the equilibrium.

A) Shift to the right
B) Shift to the left
C) None
D) Cannot predict

13. Pressure on the system is decreased by an increase in volume.

14. A catalyst is introduced into the system.

15. The temperature of the reaction is decreased.

16. Which of the following is not a strong acid?

A) H_2SO_4 B) HF C) HCl D) HBr E) HI

17. Morphine is a narcotic that is used to relieve pain. A solution of morphine has a pH of 9.61 at 25°C. What is the hydroxide ion concentration of this solution?

A) 2.5×10^{-10}
B) 4.1×10^{9}
C) 4.1×10^{-5}
D) 1.0×10^{-14}
E) -4.1×10^{9}

18. What is the conjugate base of HSO_4^-?

A) H_2SO_4 B) OH^- C) H_2O D) SO_4^{2-} E) H_3O^+

Part II

1. (10 pts) $NO_{(g)}$ and $O_{2(g)}$ were mixed in a container of fixed volume kept at 1000°K. Their initial concentrations were 0.0200 mole/liter for NO and 0.03000 mole/1iter for O_2. When the reaction:

$$2NO_{(g)} + O_{2(g)} \leftrightharpoons 2NO_{2(g)}$$

had come to equilibrium the concentration of NO_2 was 2.20×10^{-3} mole/liter.

A) Complete the following table (assume a volume of 1 liter)

	NO	O_2	NO_2
t_o	0.02000	0.03000	0
change	_____	_____	_____
t_e	_____	_____	2.20×10^{-3}

B) Calculate the equilibrium constant.

2. (12 pts) Co-64 decays by a first-order process. The Co-64 isotope has a half-life of 7.8 min. How long will it take for 31/32 of the cobalt to undergo decay?

3. (8pts) 2. The rate constant for a reaction is $1.5 \times 10^{-2}\ s^{-1}$ at 502°C and $3.5 \times 10^{-1} s^{-1}$ at 552°C. What is the activation energy?

4. (12 points) Define and give **two examples** of each of the following:

a) Arrhenius acid:

b) Bronsted-Lowry base:

c) Lewis acid