

Name _____
CHM 116

I.D.# _____
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.

$$R = 8.314 \text{ J/mol K}$$

Some potentially useful equations:

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

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

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

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

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

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

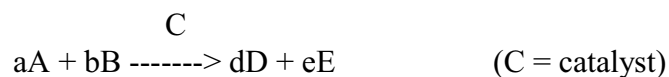
$$\ln \frac{k_1}{k_2} = \frac{-E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

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

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

2.

1. Consider the reaction



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

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

$$\text{Rate} = k[\text{ClO}_3^-][\text{I}^-][\text{H}^+]^2$$

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

- A) $\frac{\text{mol}}{\text{Ls}}$
- B) $\frac{\text{Ls}}{\text{mol}}$
- C) $\frac{\text{mol}^2}{\text{L}^2\text{s}}$
- D) $\frac{\text{L}^2}{\text{mol}^2\text{s}}$
- E) $\frac{\text{L}^3}{\text{mol}^3\text{s}}$

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

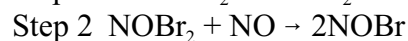
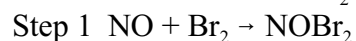
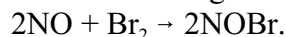
- A) a plot of [A] versus time will be a straight line.
- B) a plot of $\log[A]$ versus time will be a straight line.
- C) a plot of [A] versus 1/time will be a straight line.
- D) a plot of $1/[A]$ versus time will be a straight line.

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.

3.

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



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) $\text{rate} = k[\text{NO}]^2[\text{Br}_2]$
B) $\text{rate} = k[\text{NO}][\text{Br}_2]$
C) $\text{rate} = k[\text{NO}][\text{Br}_2]^2$
D) $\text{rate} = k[\text{NO}][\text{NOBr}_2]$
6. What would be the rate law if the second step were slow and the first step a rapidly established equilibrium?
- A) $\text{rate} = k[\text{NO}]^2[\text{Br}_2]$
B) $\text{rate} = k[\text{NO}][\text{Br}_2]$
C) $\text{rate} = k[\text{NO}][\text{Br}_2]^2$
D) $\text{rate} = k[\text{NO}]$
7. If a reaction is first order with a rate constant of $5.48 \times 10^{-2} \text{ min}^{-1}$, 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.

4.

9. For the reaction $\text{BaSO}_{3(s)} \rightleftharpoons \text{BaO}_{(s)} + \text{SO}_{2(g)}$
the mathematical expression for the equilibrium constant is

A) $K_c = \frac{[\text{SO}_2][\text{BaO}]}{[\text{BaSO}_3]}$

B) $K_c = \frac{[\text{SO}_2]}{[\text{BaSO}_3]}$

C) $K_c = \frac{[\text{BaO}]}{[\text{BaSO}_3]}$

D) $K_c = [\text{SO}_2]$

E) $K_c = \frac{1}{[\text{SO}_2]}$

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:

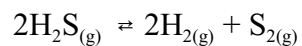


Which equation will give the larger yield of product?

A) 1 B) 2 C) 3 D) 4

E) all will yield same

11. For the reaction



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

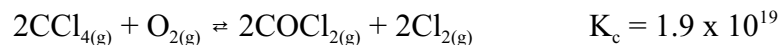
B) More H_2S will be formed

C) More H_2 will be formed than S_2

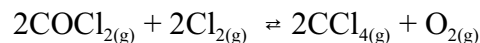
D) More S_2 will be formed than H_2

5.

12. For the following reaction

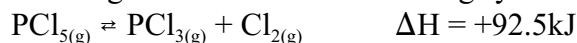


What is K_c for the following?



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

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



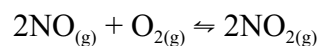
Use the following choices to predict the effect of each change on the equilibrium.

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

6.

Part II

1. (10 pts) $\text{NO}_{(g)}$ and $\text{O}_{2(g)}$ 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/liter for O_2 . When the reaction:



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_0	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?

7.

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