

Keys

Chemistry 1220, Section 1  
First Hour Exam  
September 23, 2002  
Dr. Alexander I. Boldyrev

**Instructions:**

**Do not begin until 1:30 PM. The exam must be turned in by 2:20 PM.**

- ⇒ The exam has 25 questions. Each question is worth 4 points for a total of 100 points. A periodic table is located on the last page.
- ⇒ Use only a #2 pencil to mark the answer on the ScanTron sheet. You will turn in only the ScanTron sheet and you may keep the rest of the exam. Your exam results will be emailed to you. You can check your answers with the answer key that will be posted on-line on the next day after the exam.
- ⇒ On the ScanTron sheet print your name and identification number in the areas indicated. Indicate a four character code (any combination of letters and numbers) under "version#" for the purpose of reporting final grades.

Utah State UNIVERSITY  
General Purpose Test Answer Sheet  
INSTRUCTOR: Peters  
DEPT: CHEM  
COURSE: 1210  
Student ID#  
IDENTIFICATION NUMBER  
DATE: MO, DAY, YEAR  
Posting Code  
VERSION #  
1. Your Responses  
2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25.

## Information

For the reaction  $aA + bB = cC + dD$

$$rate = -\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = +\frac{1}{c} \frac{\Delta[C]}{\Delta t} + \frac{1}{d} \frac{\Delta[D]}{\Delta t}$$

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

1<sup>st</sup> order reactions:

$$\ln[A]_t = -kt + \ln[A]_0$$

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

2<sup>nd</sup> order reactions:

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

Arrhenius

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

$$\ln(k_1/k_2) = E_a/R(1/T_2 - 1/T_1)$$

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

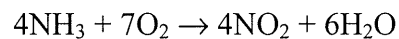
$$K_p = K_c(RT)^{\Delta n}$$

$$R = 0.0821 \text{ L}\cdot\text{atm}/(\text{mol}\cdot\text{K})$$

$$K_a = \frac{[H^+][X^-]}{[HX]}, \quad K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

$$K_a \times K_b = K_w, \quad pK_a + pK_b = pK_w = 14.00$$

(1) Which one of the following is **not** a valid expression for the rate of the reaction below?



a)  $-\frac{1}{7} \frac{\Delta[\text{O}_2]}{\Delta t}$

b)  $+\frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t}$

c)  $\frac{1}{6} \frac{\Delta[\text{H}_2\text{O}]}{\Delta t}$

d)  $-\frac{1}{4} \frac{\Delta[\text{NH}_3]}{\Delta t}$

e) All of these are valid expressions of the reaction rate

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(2) Which of the following does **not** play a part in determining the rate of a reaction

- a) temperature
  - b) the concentrations of reactants
  - c) the presence of a catalyst
  - d) the surface area of solid or liquid reactants
  - e) the equilibrium constant
- 

(3) The kinetics of the reaction below were studied and it was determined that the reaction rate increased by a factor of 9 when the concentration of B was tripled. The reaction is \_\_\_ order in B.



- a) zero
  - b) first
  - c) second
  - d) third
  - e) one-half
- 

(4) For a first order reaction, a plot of \_\_\_ versus \_\_\_ is linear

- a)  $\ln[\text{A}]_t$ ,  $1/t$
- b)  $\ln[\text{A}]_t$ ,  $t$
- c)  $1/[\text{A}]_t$ ,  $t$
- d)  $[\text{A}]_t$ ,  $t$
- e)  $t$ ,  $1/[\text{A}]_t$

(5) A first-order reaction has a rate constant of  $0.33 \text{ min}^{-1}$ . It takes \_\_\_ min for the reactant concentration to decrease from 0.13 M to 0.088 M.

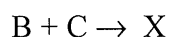
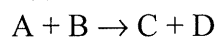
a) 1.2  
b) 2.4  
c) 0.51  
d) 0.13  
e) 0.850

$$\ln[A]_t = -kt + \ln[A]_0$$
$$t = \frac{\ln[A]_0 - \ln[A]_t}{k} = \frac{-2.040 - (-2.430)}{0.33 \text{ min}^{-1}} = 1.18 \text{ min}$$

(6) In general, as temperature goes up, reaction rate \_\_\_\_

- a) goes up if the reaction is exothermic  
b) goes up if the reaction is endothermic  
c) goes up regardless of whether the reaction is exothermic or endothermic  
d) stays the same regardless of whether the reaction is exothermic or endothermic  
e) stays the same if the reaction is first order

(7) The mechanism for formation of the product X is:



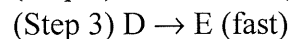
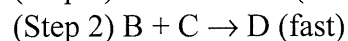
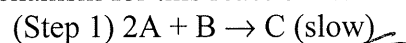
The intermediate reactant in the reaction is \_\_\_\_\_

- a) A  
b) B  
c) C  
d) D  
e) X

(8) The stoichiometric equation for a reaction is:



The mechanism for this reaction is:



Of the following rate laws, \_\_\_\_ is the rate law for this reaction mechanism

- a) Rate =  $k_1[A][B]$   
b) Rate =  $k_1k_3[A]^2[E]$   
c) Rate =  $k_1[A]^2[B]$   
d) Rate =  $k_2k_3[B][C]$   
e) Rate =  $k[A][B]^2$

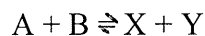
(9) At equilibrium, \_\_\_\_\_

- a) all chemical processes have ceased
- b) the rate of the forward reaction equals that of the reverse
- c) the rate constant for the forward reaction equals that of the reverse
- d) none of the above

(10) The equilibrium expression depends on the \_\_\_\_\_ of the reaction.

- a) stoichiometry
- b) mechanism
- c) stoichiometry and mechanism
- d) rate
- e) equilibrium position

(11) The reaction



has  $K_c = 997$  at 472 K. At equilibrium, \_\_\_\_\_  $K_c > 1$

- a) products predominate
- b) reactants predominate
- c) roughly equal molar amounts of products and reactants are present
- d) only products exist
- e) only reactants exist

(12) Consider the gaseous equilibrium:  $2A \rightleftharpoons 2B + C$

Determine the value of the missing B concentration at equilibrium

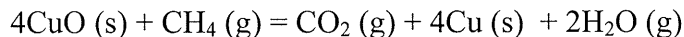
Exp#    [A] at equilibrium                      [B] at equilibrium                      [C] at equilibrium

|   |        |        |         |
|---|--------|--------|---------|
| 1 | 0.10 M | 0.10 M | 0.20 M  |
| 2 | 0.20 M | 0.50 M | 0.032 M |
| 3 | 0.35 M | ? X    | 0.15 M  |

a) 0.71  
b) 0.35  
 c) 0.40  
d) 0.045  
e) 0.20

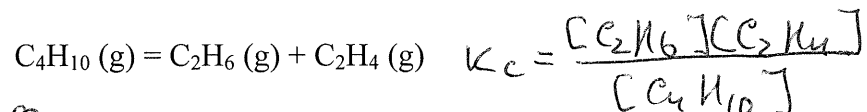
$$\frac{[B]_1^2 [C]_1}{[A]_1^2} = \frac{[B]_3^2 [C]_3}{[A]_3^2}$$
$$X^2 = [B]_3^2 = \frac{[C]_3 [A]_3^2}{[A]_3^2} = \frac{0.2 \times (0.35)^2}{0.15} = 0.163$$
$$X = [B]_3 = 0.40 \text{ M}$$

(13) The expression for  $K_c$  for the reaction below is \_\_\_\_\_



- a)  $[\text{CuO}]/[\text{Cu}]$
- b)  $[\text{CuO}]^4/[\text{Cu}]^4$
- c)  $[\text{Cu}]^4/[\text{CuO}]^4$
- d)  $[\text{CO}_2][\text{H}_2\text{O}]^2/[\text{CH}_4]$
- e)  $[\text{CH}_4]/[\text{CO}_2][\text{H}_2\text{O}]^2$

(14) The value of  $K_c$  for the following reaction is 0.070. What is the equilibrium concentration (M) of  $\text{C}_4\text{H}_{10}$  if the equilibrium concentrations of  $\text{C}_2\text{H}_6$  and  $\text{C}_2\text{H}_4$  are both 0.035 M?



- a) 0.018
- b) 57
- c) 0.50
- d) 2.0
- e) 0.10

$$[\text{C}_4\text{H}_{10}] = \frac{[\text{C}_2\text{H}_6][\text{C}_2\text{H}_4]}{K_c} = \frac{(0.035)^2}{0.070} = 0.0175$$

(15) In which of the following reactions would increasing pressure at constant temperature **not** change the concentrations of reactants and products?

- a)  $\text{N}_2 \text{ (g)} + 3\text{H}_2 \text{ (g)} = 2\text{NH}_3 \text{ (g)}$
- b)  $\text{N}_2\text{O}_4 \text{ (g)} = 2\text{NO}_2 \text{ (g)}$
- c)  $\text{N}_2 \text{ (g)} + 2\text{O}_2 \text{ (g)} = 2\text{NO}_2 \text{ (g)}$
- d)  $2\text{N}_2 \text{ (g)} + \text{O}_2 \text{ (g)} = 2\text{N}_2\text{O (g)}$
- e)  $\text{N}_2 \text{ (g)} + \text{O}_2 \text{ (g)} = 2\text{NO (g)}$

(16) Consider the following reaction at equilibrium:



adding  $\text{O}_2 \text{ (g)}$  to the container will \_\_\_\_\_.

- a) increase the concentration of  $\text{CO (g)}$  at equilibrium
- b) decrease the concentration of  $\text{CO}_2 \text{ (g)}$  at equilibrium
- c) increase the value of the equilibrium constant
- d) cause the reaction to shift to the left
- e) decrease the value of the equilibrium constant

(17) The effect of a catalyst on a chemical reaction is to \_\_\_\_\_

- a) increase the rate of the forward reaction only
  - b) increase the equilibrium constant so that products are favored
  - c) slow the reverse reaction only
  - d) increase the rate at which equilibrium is achieved without changing the composition of the equilibrium mixture
  - e) shift the equilibrium to the right
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(18) According to Arrhenius, an acid is a substance that \_\_\_\_\_

- a) increases  $[H^+]$  when placed in  $H_2O$
  - b) increases  $[OH^-]$  when placed in  $H_2O$
  - c) tastes bitter
  - d) can accept a pair of electrons to form a covalent bond
  - e) decreases  $[H^+]$  when placed in  $H_2O$
- 

(19) Which one of following is a Bronsted-Lowry base?

- a)  $(CH_3)_3NH^+$
  - b)  $NH_3$
  - c)  $HNO_3$
  - d)  $NaCl$
  - e) all of these
- 

(20) What is the conjugate acid of  $HSO_4^-$  ?

- a)  $OH^-$
  - b)  $H_2SO_4$
  - c)  $SO_4^{2-}$
  - d)  $HSO_4^+$
  - e)  $H_3SO_4^+$
- 

(21) What is the pH of an aqueous solution at  $25^\circ C$  in which  $[H^+]$  is 2.00 M?

- a) +0.3
- b) -0.3
- c) 1.8
- d) 11.8
- e) 7.0



(22) The  $K_a$  of HClO is  $3.0 \times 10^{-8}$ . What is the pH of a 0.020 M solution of HClO?

a) +2.45  
b) -2.45  
c) +1.85  
d) +9.22  
e) +4.61

$$K_a = \frac{[\text{H}^+][\text{ClO}^-]}{[\text{HClO}]} = \frac{x^2}{0.02-x} = 3.0 \times 10^{-8}$$

$K_a$  is very small  $0.02-x \approx 0.02$   
 $x^2 = 0.020 \times 3.0 \times 10^{-8}$ ;  $x = 2.45 \times 10^{-5}$ ;  $\text{pH} = 4.61$

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(23) Calculate the pH of 0.50 M aqueous solution of  $\text{NH}_3$ . The  $K_b$  of  $\text{NH}_3$  is  $1.8 \times 10^{-5}$ .

a) 8.95  
b) 11.48  
c) 2.52  
d) 7.5  
e) 5.8

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{x^2}{0.5-x} = 1.8 \times 10^{-5}$$

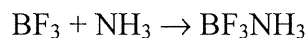
$0.5-x \approx 0.5$   $x^2 = 0.5 \times 1.8 \times 10^{-5}$   
 $x = 3.0 \times 10^{-3}$ ;  $\text{pOH} = 2.52$ ;  $\text{pH} = 14.0 - 2.52 = 11.48$

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(24) An aqueous solution of \_\_\_\_\_ will produce a basic solution.

- a)  $\text{NH}_4\text{Cl}$   
b)  $\text{NaNO}_3$   
c)  $\text{NaCl}$   
d)  $\text{HClO}_4$   
e)  $\text{CH}_3\text{COONa}$
- 

(25) In the reaction



$\text{BF}_3$  acts as an \_\_\_\_\_ acid

- a) Arrhenius  
b) Bronsted-Lowry  
c) Lewis  
d) Arrhenius, Bronsted-Lowry, and Lewis  
e) Arrhenius and Bronsted-Lowry
-