

University of Kentucky

Department of Chemistry

**READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!**

It is *extremely* important that you fill in the answer sheet **EXACTLY** as indicated, otherwise your answer sheet may not be processed; **ALL** entries are to be made on **SIDE 1** of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete. Use only the following categories:

NAME:	Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the <u>correct</u> circles below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.						
STUDENT NUMBER:	This is <b>VERY IMPORTANT!</b> Under IDENTIFICATION NUMBER, put in your <b>8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number)</b> beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking "0" for "1").						
TEST FORM:	Fill in the "2" blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination II).						
SPECIAL CODES:	Use for course and section number; in positions K-P write in one of the following: <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Dr. Woodrum</td> <td>107-001</td> </tr> <tr> <td>Dr. Sault</td> <td>107-002, 107-003</td> </tr> <tr> <td>Dr. Ades</td> <td>107-004, 107-401</td> </tr> </table>	Dr. Woodrum	107-001	Dr. Sault	107-002, 107-003	Dr. Ades	107-004, 107-401
Dr. Woodrum	107-001						
Dr. Sault	107-002, 107-003						
Dr. Ades	107-004, 107-401						
SIGNATURE:	You <b>MUST</b> sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.						

Answering Questions:

Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the **30 questions** in this examination. Your score is the sum of the appropriate credit for each response. On the day following the examination, an examination key will be posted on Blackboard.

Grading and Reporting:

The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has occurred in scoring your answers, inform your instructor within 48 hours of the posting of your score.

**BE SURE THAT YOUR TEST HAS 30 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER.** You may **NOT** use your own scratch paper during this examination. Cell phones, computer, and pagers are to be turned off and out of sight during the exam.

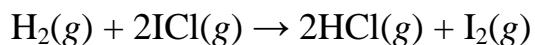
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1. Which statement is **false**?

- A. The units for the rate of a reaction are M/s.
- B. The rate of a reaction can be determined by monitoring the change in concentration of a reactant per unit time.
- C. The rate of a reaction can be determined by monitoring the change in concentration of a product per unit time.
- D. The rate of the reaction can be positive or negative, depending on the reaction.

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2. If H<sub>2</sub> disappears at a rate of 0.50 M/s at a particular moment during the reaction, what is the rate of appearance of HCl at the same time ?



- A. 0.50 M/s
- B. 0.25 M/s
- C. 1.0 M/s
- D. 2.0 M/s

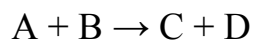
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3. A reaction is second order in reactant A and first order in reactant B. What is the effect on the rate when the concentration of A is tripled and the concentration of B is doubled?

- A. The rate is unchanged.
  - B. The rate increases by a factor of 6.
  - C. The rate increases by a factor of 12.
  - D. The rate increases by a factor of 18.
-

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4. Consider the reaction:



The initial rate of the reaction was measured at several different concentrations of the reactants with the following results:

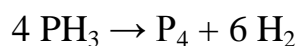
[A], (M)	[B], (M)	Initial Rate (M/s)
0.020	0.020	0.0070
0.040	0.020	0.0139
0.040	0.040	0.0197
0.080	0.080	0.0555

What is the order of the reaction with respect to B?

- A. half order in B  
B. first order in B  
C. second order in B  
D. zeroth order in B

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5. A plot of  $\ln[\text{PH}_3]$  versus time for the reaction



gives a straight line with a slope of  $-0.020 \text{ s}^{-1}$  at  $680^\circ\text{C}$ . Therefore the reaction is

- A. first order.  
B. zero order.  
C. second order.  
D. third order.

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6. The following reaction is a second order reaction. What is the concentration of  $\text{NO}_2$  after 85.0 seconds if its initial concentration was 0.0500 M? The rate constant for the reaction is  $0.0752 \text{ M}^{-1}\text{s}^{-1}$



- A. 0.0529 M  
B. 0.0189 M  
C.  $1.35 \times 10^{-4}$  M  
D. 0.0635 M
-



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11. Which one of the following statements is **false**?

- A. For an elementary step of a mechanism, the coefficients of the reactants determine to what power the concentration of each reactant is raised.
- B. For a two-step mechanism, the rate of a reaction is the sum of the rates of the two elementary steps in the mechanism.
- C. The rate of the slow step in a mechanism limits the rate of the overall reaction.
- D. If the slow step of a mechanism is the first step of a mechanism *and* is bimolecular the overall reaction will be second order.

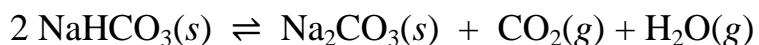
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12. Which one of the following statements is **true**?

- A. Catalysts decrease the activation energy of a reaction.
- B. Catalysts decrease the enthalpy of a reaction.
- C. Catalysts increase the activation energy of a reaction.
- D. Catalysts increase the enthalpy of a reaction.

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13. Which one of the following is the correct equilibrium constant expression of the reaction below?



A. 
$$K_c = \frac{[\text{NaHCO}_3]^2}{[\text{Na}_2\text{CO}_3][\text{CO}_2][\text{H}_2\text{O}]}$$

B. 
$$K_c = [\text{Na}_2\text{CO}_3] + [\text{CO}_2] + [\text{H}_2\text{O}] - 2[\text{NaHCO}_3]$$

C. 
$$K_c = [\text{CO}_2] [\text{H}_2\text{O}]$$

D. 
$$K_c = \frac{[\text{Na}_2\text{CO}_3]}{[\text{NaHCO}_3]^2}$$

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14. Consider the reaction:



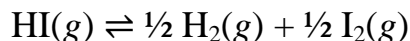
When equal concentrations of hydrogen and bromine are placed in a reaction chamber and allowed to reach equilibrium, what can be said about the reaction mixture?

- A. There is twice as much HBr as there is  $\text{H}_2$  and  $\text{Br}_2$  at equilibrium.
  - B. The amount of HBr far exceeds the amount of  $\text{H}_2$  and  $\text{Br}_2$  at equilibrium.
  - C. The amount of  $\text{H}_2$  and  $\text{Br}_2$  far exceeds the amount of HBr at equilibrium.
  - D. The amount of  $\text{H}_2$  and  $\text{Br}_2$  is approximately equal to the amount of HBr at equilibrium.
- 

15. Given

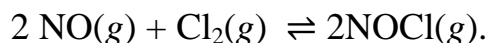


what is the equilibrium constant for the reaction shown below?



- |          |         |
|----------|---------|
| A. 0.015 | C. 0.13 |
| B. 0.035 | D. 0.28 |
- 

16. At 300 °C  $K_c = 128$  for the reaction



What is  $K_p$  for the reaction at 300 °C ?

- |                       |         |
|-----------------------|---------|
| A. 2.72               | C. 58.9 |
| B. $6.05 \times 10^4$ | D. 64.0 |
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17. Consider the following reaction:

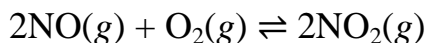


Carbon monoxide and hydrogen gas are placed in a reaction vessel with initial concentrations of  $\text{CO} = 0.40 \text{ M}$  and  $\text{H}_2 = 0.50 \text{ M}$ . At a certain temperature, the reaction is allowed to come to equilibrium. Upon analysis, it is determined that the concentration of  $\text{CH}_3\text{OH} = 0.15 \text{ M}$ . Determine  $K_c$  for the reaction.

- A. 3.5  
B. 1.3  
C. 0.70  
D. 15

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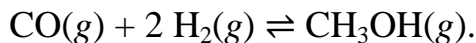
18. The concentration of each species in the reaction below is  $0.015 \text{ M}$ . Which way does the reaction proceed to reach equilibrium, given  $K_c = 32$ ?



- A. To the left because  $Q_c < K_c$   
B. To the left because  $Q_c > K_c$   
C. To the right because  $Q_c < K_c$   
D. To the right because  $Q_c > K_c$

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19.  $K_c = 4.28$  for the reaction

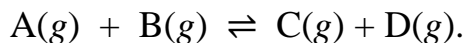


What is the equilibrium concentration of  $\text{CO}$  when the equilibrium concentration of  $\text{H}_2$  is  $0.400 \text{ M}$  and  $\text{CH}_3\text{OH}$  is  $0.200 \text{ M}$ ?

- A. 0.292 M  
B. 0.200 M  
C. 0.800 M  
D. 0.137 M
-

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20. At 25 °C,  $K = 81$  for the reaction

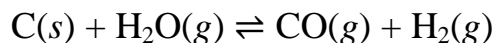


Initially, 0.100 mol of  $C(g)$  and 0.100 mol of  $D(g)$  are injected into a 1.00 L reaction vessel. What is the concentration of  $A(g)$  when the reaction has come to equilibrium at 25°C?

- A. 0.100M  
B. 0.005 M  
C. 0.010 M  
D. 0.111 M

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21. The following endothermic reaction is allowed to reach equilibrium:



Which set of conditions will increase the production of carbon monoxide?

- A. Lowering the temperature.  
B. Addition of carbon.  
C. Addition of hydrogen gas.  
D. Addition of water vapor.

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22. Which one of the following reactions at equilibrium will not be affected by a change in volume?

- A.  $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$   
B.  $2NO_2(g) \rightleftharpoons N_2O_4(g)$   
C.  $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$   
D.  $CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(l)$

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23. Select the Brønsted-Lowery acid on the reactant side of each reaction below.

- (1)  $H_2CO_3(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$   
(2)  $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

- A. (1)  $H_2CO_3$ ; (2)  $H_2O$   
B. (1)  $H_2CO_3$ ; (2)  $NH_3$   
C. (1)  $H_2O$ ; (2)  $H_2O$   
D. (1)  $H_2O$ ; (2)  $NH_3$
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24. Which one of the following is the weakest acid?

- A. Formic acid,  $K_a = 1.8 \times 10^{-4}$       C. Hypochlorous acid,  $K_a = 2.9 \times 10^{-8}$   
B. Chlorous acid,  $K_a = 1.2 \times 10^{-2}$       D. Hydrocyanic acid,  $K_a = 4.9 \times 10^{-10}$
- 

25. At  $10^\circ\text{C}$ ,  $pK_w = 14.535$ . Which statement is **true** for pure water at  $10^\circ\text{C}$ ?

- A.  $\text{pH} = 7.000$       C.  $[\text{OH}^-] = 5.40 \times 10^{-8} \text{ M}$   
B.  $[\text{H}_3\text{O}^+] = 1.00 \times 10^{-7} \text{ M}$       D.  $\text{pOH} = 14.535$
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26. What is the pH of an aqueous solution of 0.200 M hypochlorous acid? The  $K_a$  of hypochlorous acid is  $2.9 \times 10^{-8}$ .

- A. 7.35      C. 8.27  
B. 4.12      D. 3.87
- 

27. A 0.250 M aqueous solution of an unknown substance was determined to have a  $\text{pH} = 2.50$ . Therefore the solution is a

- A. weak acid.      C. weak base.  
B. strong acid.      D. strong base.
- 

28. A 0.0200 M solution of an acid is 25.0 % ionized. What is  $K_a$  for the acid?

- A. 0.250      C.  $1.67 \times 10^{-3}$   
B.  $6.72 \times 10^{-3}$       D.  $4.28 \times 10^{-4}$
-

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29. Determine the pH of a 0.35 M solution of aniline ( $\text{C}_6\text{H}_5\text{NH}_2$ ).  $K_b = 3.9 \times 10^{-10}$ .

A. 10.40

C. 4.88

B. 9.07

D. 8.22

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30. Which one of the following statements is **true**?

A. A reaction with a large equilibrium constant always occurs at a fast rate.

B. A reaction with a small equilibrium constant always occurs at a slow rate.

C. Equilibrium constants change by the same factor as the rate constant with increases in temperature.

D. The rate of a reaction is independent of the equilibrium constant of the reaction.

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CHE 107 SPRING 2012 Exam 2 Key

1. D
2. C
3. D
4. A
5. A
6. A
7. D
8. B
9. B
10. C
11. B
12. A
13. C
14. C
15. C
16. A
17. D
18. B
19. A
20. C
21. D
22. C
23. A
24. D
25. C
26. B
27. A
28. C
29. B
30. D