

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 test 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 VERY IMPORTANT! Under IDENTIFICATION NUMBER, put in your 8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number) 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: <div style="text-align: center;"> Dr. K. Woodrum 107001, 107002 Dr. F. Bramwell 107003, 107004 Dr. S. Newman 107401 </div>
SIGNATURE:	You MUST sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.

Answering Questions:

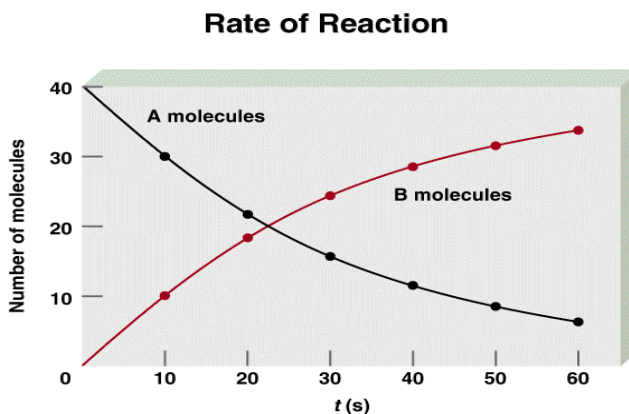
Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the 25 questions in this examination. Your score is the sum of the appropriate credit for each response. The day after the examination is finished, an examination key will be posted on Blackboard.

Grading and Reporting:

The examination scores will be posted in Blackboard within 96 hours after the examination. If an error has been made in scoring your answers, tell your instructor within 48 hours of the posting of your score.

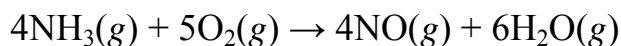
BE SURE THAT YOUR TEST HAS 25 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones and pagers are to be turned off and out of sight during the exams.

1. Looking at this graph, which of these statements is accurate?



- A. Both molecule A and B are reactants.
 B. The rate of formation of Molecule A is always higher than the formation of Molecule B.
 C. The rate of the reaction based on Molecule A is positive.
 D. The rate of formation of Molecule B is higher than the rate of consumption of Molecule A at 40 seconds into the reaction.

2. Consider the reaction



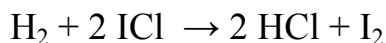
Suppose that at a particular moment during the reaction molecular oxygen is reacting at a rate of 12.5 M/s . At what rate is ammonia reacting?

- A. 12.5 M/s
 B. 2.50 M/s
 C. 3.13 M/s
 D. 10.0 M/s

3. Which of the following statements is **false**?

- A. The rate law expresses the relationship of the rate of a reaction to the rate constant.
 B. The rate law expresses the relationship of the rate of a reaction to the concentrations of the reactants raised to some powers.
 C. The overall reaction order is the sum of the powers to which all the reactant concentrations appearing in the rate law are raised.
 D. Rate laws are never determined experimentally but result only from theoretical calculations involving the activation energy and the order constant.

4. According to this reaction



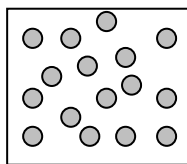
and using this table of information

$[\text{H}_2]$ (M)	$[\text{ICl}]$ (M)	Rate (M/s)
1.50	1.50	3.20×10^{-1}
1.50	3.00	1.28
3.00	1.50	6.40×10^{-1}

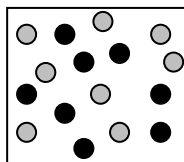
what is the order of this reaction with respect to H_2 ?

- A. Zero order
B. 1st order
C. 2nd order
D. 3rd order

5. Consider the first-order reaction $\text{A} \rightarrow \text{B}$ shown below. How many A (grey) and B (black) molecules are present at $t = 15$ s?



$t = 0$ s



$t = 5$ s

- A. A: 8, B: 8
B. A: 2, B: 2
C. A: 2, B: 14
D. A: 1, B: 15

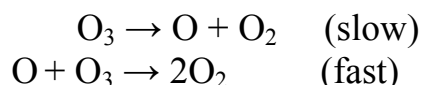
6. Which of the following is **true concerning the relationship between reactant concentration and reaction half-life?**

- A. For first-order reactions, the half-life is independent of the initial reactant concentration.
B. For first-order reactions, the rate constant, k , is determined by the initial reactant concentration.
C. For second-order reactions the half-life is independent of the initial reactant concentration.
D. For second-order reactions, the half-life remains constant throughout the course of the reaction concentration.
-

7. In a given reaction, the rate constant doubles when the temperature is increased from 200. K to 235K. What is the activation energy of this reaction?

- A. 7.74 kJ
B. -0.165 kJ
C. -8140 kJ
D. 0.198 kJ
-

8. The mechanism for the conversion of ozone to molecular oxygen, $2\text{O}_3 \rightarrow 3\text{O}_2$ is as follows:



Which statement is **false**?

- A. O is a catalyst in the mechanism.
B. For the overall reaction, rate = $k[\text{O}_3]$.
C. The first step is unimolecular.
D. The overall reaction is 1st order.
-

9. An automotive catalytic converter contains solid platinum, palladium, and rhodium compounds and converts NO to N_2 and O_2 . This conversion is an example of which of the following:

- A. Enzyme catalysis
B. Homogeneous catalysis
C. Heterogeneous catalysis
D. Sub-program catalysis
-

10. If K_c is 3.21×10^{-4} , what can you assume is true about the reaction?

- A. At equilibrium the concentration of the products is $3.21 \times 10^{-4} M$.
B. The reaction favors the products.
C. The reaction is slow to reach equilibrium.
D. At equilibrium the concentration of the reactants is larger than the products.
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11 Consider the following reaction at some high temperature, T.



When 4.2 moles of Br_2 are placed in a 6.0 L vessel, 1.20% of the Br_2 dissociates. Calculate K_c at temperature, T.

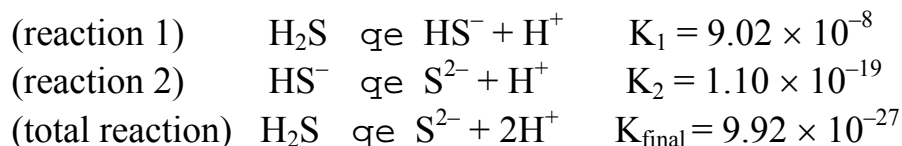
- A. 2.6×10^{-2} C. 4.1×10^{-4}
B. 3.5 D. 1.9×10^{-8}
-

12. K_1 is the equilibrium constant for the reaction $\text{H}_3\text{PO}_4 \rightleftharpoons \text{H}_2\text{PO}_4^{2-} + \text{H}^+$;
 K_2 is the equilibrium constant for the reaction $\text{H}_2\text{PO}_4^{2-} \rightleftharpoons \text{HPO}_4^- + \text{H}^+$;
 K_3 is the equilibrium constant for the reaction $\text{HPO}_4^- \rightleftharpoons \text{PO}_4^{3-} + \text{H}^+$.

What is the value of the equilibrium constant K in terms of K_1 , K_2 , and K_3 for the reaction $3\text{H}_3\text{PO}_4 \rightleftharpoons 3\text{PO}_4^{3-} + 9\text{H}^+$?

- A. $K = 3(K_1 + K_2 + K_3)$ C. $K = (K_1 K_2 K_3)^3$
B. $K = K_1 / (K_2 K_3)$ D. $K = (K_1 K_2) / K_3$
-

13. Given these two elementary steps and their K_c values, along with the K_c of the overall reaction, which of these statements are true about this system?



- A. The rate of the forward reaction of reaction 1 is higher than the rate of reverse reaction.
B. The rate of the reverse reaction is higher than the rate of the forward reaction in reaction 2.
C. The rate of the overall reaction is equal to the equilibrium constant of reaction 1.
D. The rate of the overall reaction is equal the sum of K_c of reaction 1 and 2.
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14. For the reaction of $A(g) + B(g) \rightleftharpoons 2C(g)$ $K_c = 1.0 \times 10^{-3}$ at 500 K.

At this temperature, an equal number of moles of each substance is placed into a 5.0 L container. Which statement is true?

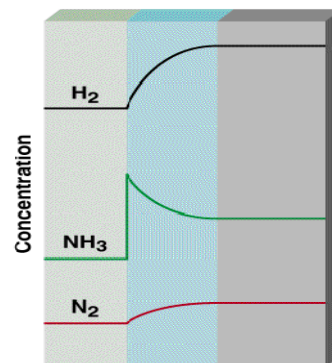
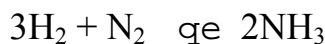
- A. To reach equilibrium, the reaction will shift to produce more products.
- B. To reach equilibrium, the reaction will shift to produce more reactants.
- C. The system is at equilibrium.
- D. The mole amounts must be given to predict the direction of the reaction.

15. The equilibrium constant for the reaction $Br_2(g) \rightleftharpoons 2Br(g)$ is $K_c = 2.64 \times 10^{-4}$ at 1400K.

What will the concentration of bromine atoms be if 0.250 mol Br_2 comes to equilibrium in a 0.500-L reaction vessel at this temperature?

- A. $1.15 \times 10^{-2} M$
- B. $1.32 \times 10^{-2} M$
- C. $8.10 \times 10^{-3} M$
- D. $1.62 \times 10^{-2} M$

16. What can you determine about this reaction from this graph?



- A. The reaction reached equilibrium but then was unable to return to equilibrium after an input of NH_3 .
 - B. The forward reaction rate increased to consume the added NH_3 .
 - C. The reaction never reached equilibrium.
 - D. The reaction returned to equilibrium by increasing the rate of the reverse reaction.
-

17. The equilibrium constant K_c for the reaction $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2\text{HBr}(\text{g})$ is 2.18×10^6 at 730°C .

The system is at equilibrium with $[\text{HBr}] = 0.100\text{M}$ and $[\text{H}_2] = [\text{Br}_2] = 6.17 \times 10^{-5}\text{M}$.
HBr is added to give a $[\text{HBr}] = 0.200\text{M}$.

(1) Which way will the equilibrium shift and (2) what is the final concentration of H_2 ?

- A. (1) Right, (2) $1.46 \times 10^{-6}\text{M}$ C. (1) Left, (2) $1.80 \times 10^{-2}\text{M}$
B. (1) Right, (2) $2.91 \times 10^{-5}\text{M}$ D. (1) Left, (2) $1.36 \times 10^{-4}\text{M}$
-

18. Predict the effect of compression on the direction of the net reaction in each of the following:

- i) $\text{H}_2(\text{g}) + \text{Br}_2(\text{l}) \rightleftharpoons 2\text{HBr}(\text{g})$
ii) $2\text{ClBr}(\text{g}) \rightleftharpoons \text{Cl}_2(\text{g}) + \text{Br}_2(\text{g})$
iii) $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

- A. i) no change; ii) shift left; iii) shift right
B. i) shift left; ii) shift right; iii) no change
C. i) shift right; ii) no change; iii) shift right
D. i) shift left; ii) no change; iii) shift left
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19. Which of these is a correct Brønsted conjugate acid-base pair?

- A. $\text{NH}_4^+ / \text{NH}_3$ C. $\text{H}_3\text{O}^+ / \text{OH}^-$
B. $\text{NO}_3^- / \text{NO}_2^-$ D. $\text{Ba}(\text{OH})_2 / \text{OH}^-$
-

20. Which statement is true concerning a 10.0M strong monoprotic acid?

- A. $\text{pH} > \text{pOH}$ C. $\text{pH} = 1.0$
B. $[\text{H}^+] > [\text{OH}^-]$ D. $\text{pOH} = 13.0$
-

21. What is the pH of $1.3 \times 10^{-3}\text{M}$ $\text{Ca}(\text{OH})_2$?

- A. 2.88 C. 11.41
B. 2.58 D. 11.12
-

22. Which of these is a strong acid with the correct reasoning?

- A. H_2SO_4 , because both protons dissociate 100%.
- B. HBr , because it dissociates 100%.
- C. NH_3 , because it receives a proton.
- D. NaOH , dissociates to Na^+ and OH^- .

23. Which of the following lists the solutions from lowest to highest pH? Each solution is 0.10 M. (Note: K_a of CH_3COOH is 1.8×10^{-5} and the K_a of HF is 7.1×10^{-4})

- A. $\text{pH}(\text{HF}) < \text{pH}(\text{CH}_3\text{COOH}) < \text{pH}(\text{HCl})$
- B. $\text{pH}(\text{HCl}) < \text{pH}(\text{CH}_3\text{COOH}) < \text{pH}(\text{HF})$
- C. $\text{pH}(\text{HCl}) < \text{pH}(\text{HF}) < \text{pH}(\text{CH}_3\text{COOH})$
- D. $\text{pH}(\text{CH}_3\text{COOH}) < \text{pH}(\text{HF}) < \text{pH}(\text{HCl})$

24. What is the pH of a 0.15 M benzoic acid solution? Consider benzoic acid to be monoprotic. $K_a = 6.5 \times 10^{-5}$

- A. 2.51
- B. 3.12
- C. 2.21
- D. 3.42

25. Which of these statements best describe the relationship between ionization constants?

- A. The larger the K_b , the stronger the acid.
 - B. The product of a K_a and K_b of conjugate acid-base pair is K_w .
 - C. The K_b is the reciprocal of the conjugate acid's K_a .
 - D. K_a is the equilibrium constant of the dissociation of a base to its conjugate acid.
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CHE 107 Exam 2 March 4, 2010																									
Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Correct Answer	C	D	D	B	C	A	A	A	C	D	C	C	ALL	B	A	D	D	D	A	B	C	B	C	A	B
Partial Credit																B=2					D=2				