CHEM 188 – Spring, 2012

Hour Exam 1 (Early)

February 15, 2012

Instructions:

Your scantron answer sheet must show your **NAME**, **7-DIGIT KU ID NUMBER**, and **LAB SECTION**. (Begin these entries at the LEFT end of the space provided.)

In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. **USE A SOFT (No. 2) PENCIL**.

Useful information:

Gas constant, $R = 8.314\ J/K \cdot mol$
$= 0.08206\ L \cdot atm/K \cdot mol$

Integrated Rate Laws:

Zero-order: $[A] = [A]_0 - kt$

First-order: $[A] = [A]_0 e^{-kt}$

Second-order: $\frac{1}{[A]} = \frac{1}{[A]_0} + kt$

Arrhenius equation: $k = Ae^{-E_a/RT}$

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

Relation of K_P to K_C: $K_P = K_C(RT)^{\Delta n}$

Quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

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1. Consider the reaction

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

Suppose that at a particular moment during the reaction oxygen (O_2) is reacting at the rate of 0.025 *M*/s. At what **rate is NO_2** being formed?

A. –0.050 M/s B. –0.025 M/s C. +0.025 M/s D. +0.050 M/s E. +0.10 M/s

2. For the overall chemical equation, which one of the following can you rightly assume?

$$NH_4^+(aq) + NO_2^-(aq) \rightarrow N_2(g) + 2\ H_2O(l)$$

A. The reaction is first-order overall.
B. The reaction is second-order overall.
C. The reaction is third-order overall.
D. The rate law is, rate = k[NH_4^+][NO_2^-]
E. The rate law cannot be determined from the information given.

3. The rate law for the reaction A + 2B □ C + D is given by rate = *k*[A][B]. At 25°C, the rate constant is 0.25 $M^{-1}s^{-1}$. Calculate the **rate of the reaction** at this temperature if [A] = 0.50 *M* and [B] = 0.25 *M*.

A. 3.9 □ 10^{-3} *M/s* B. 7.8 □ 10^{-3} *M/s* C. 1.6 □ 10^{-2} *M/s*

D. 3.1 □ 10^{-2} *M/s* E. none of the above

4. Consider the hypothetical reaction A + 2B □ products. Use the following data to determine the **rate constant, k,** for the reaction.

Expt. #	$[A]_0$	$[B]_0$	Initial rate
1	0.20	0.20	0.73 M/min
2	0.20	0.40	0.73 M/min
3	0.40	0.20	1.46 M/min

A. 3.8 min^{-1} B. 7.3 min^{-1} C. 11 min^{-1} D. 22 min^{-1} E. 26 min^{-1}

5. If concentration is expressed in units of moles per liter (mol/L) and time in units of seconds (s), the **units of a second-order rate constant** are

A. L mol^{-1} s^{-1} B. L^2 mol^{-2} s^{-1} C. s^{-1}
D. s^{-2} E. mol L^{-1} s^{-1}

6. A certain first-order reaction A □ B is 25% complete in 16 minutes at 25°C. What is the **half-life** of the reaction?

A. 4.0 min B. 8.0 min C. 16 min D. 19 min E. 39 min

7. For a certain reaction, A □ products, it was found that 20 minutes were required for the concentration of A to decrease from 1.0 M to 0.50 M, and that an additional 10 minutes were required for [A] to decrease from 0.50 M to 0.25 M. What is the **rate law** for this reaction?

A. rate = $k[A]^{□1}$
B. rate = k
C. rate = k[A]
D. rate = $[A]^2$
E. cannot be determined from the information given

8. The rate constant for the second-order reaction

$$2NO_2(g) \square 2NO(g) + O_2(g)$$

is 0.54 $M^{□1}s^{□1}$ at 300°C. If the initial concentration of NO_2 was 0.50 M, what would the **concentration of NO_2** be after 3.0 sec?

A. 0.10 M B. 0.14 M C. 0.21 M D. 0.28 M E. 0.39 M

9. A certain first-order reaction A □ B is 25% complete in 8.7 min at 25°C. What the **rate constant, k,** for this reaction at 25°C?

A. 6.8 x $10^{□3}$ $min^{□1}$ B. 8.2 x $10^{□3}$ $min^{□1}$ C. 3.3 x $10^{□2}$ $min^{□1}$

D. -3.3 x $10^{□2}$ $min^{□1}$ E. 11 $min^{□1}$

10. The activation energy for the following first-order reaction is 102 kJ/mol.

$$N_2O_5(g) \square 2\,NO_2(g) + ½\,O_2(g)$$

The value of the rate constant (k) is 8.18 x $10^{□7}$ $s^{□1}$ at 0°C. What is the **value of k** at 20°C?

A. 8.20 x $10^{□7}$ $s^{□1}$ B. 4.00 x $10^{□6}$ $s^{□1}$ C. 1.76 x $10^{□5}$ $s^{□1}$

D. 7.00 x $10^{□5}$ $s^{□1}$ E. 2.55 x $10^{□4}$ $s^{□1}$

11. For a certain second-order reaction, rate constant (k) at 25°C is 0.235 $M^{□1}$ $s^{□1}$. At 50°C the rate constant is 0.959 $M^{□1}s^{□1}$. What is the **frequency factor, A**, for this reaction in units of $M^{□1}s^{□1}$?

A. 4.26 □ 10^4 B. 3.21 □ 10^5 C. 2.41 □ 10^6 D. 1.82 □ 10^7 E. 1.37 □ 10^8

12. The activation energy of a certain uncatalyzed reaction is 70 kJ/mol. In the presence of a catalyst, the E_a is 60 kJ/mol. How many **times faster** is the catalyzed than the uncatalyzed reaction at 500°C? (Assume the frequency factor remains the same.)

A. 4.7 times B. 10 times C. 23 times D. 49 times E. 106 times