CHEM 188 – Spring, 2013

Hour Exam 1 (Early)

February 13, 2013

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, $R = 8.314\ \text{J/K} \cdot \text{mol}$
$= 0.08206\ \text{L} \cdot \text{atm/K} \cdot \text{mol}$

Integrated Rate Laws:

$$\text{Zero-order: } [A] = [A]_0 - kt$$
$$\text{First-order: } [A] = [A]_0 e^{-kt}$$
$$\text{Second-order: } \frac{1}{[A]} = \frac{1}{[A]_0} + kt$$

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

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1. For the reaction

$$4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g)$$

the rate of loss of molecular oxygen, $-d[O_2]/dt$ is 0.024 M/s at a particular time during the reaction. What is the rate, $\mathbf{d[N_2O_5]/dt}$, at which N_2O_5 is being formed?

A. 0.012 M/s B. 0.024 M/s C. 0.036 M/s D. 0.048 M/s E. none of these

2. The reaction of peroxydisulfate ion ($S_2O_8^{2-}$) with iodide ion (I^-) is

$$S_2O_8^{2-}(aq) + 3\ I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_3^-(aq)$$

From the following data collected at a certain temperature, determine the **rate law**.

Expt. #	**$[S_2O_8^{2-}]_0$ (M)**	**$[I^-]_0$ (M)**	**Initial rate (M/s)**
1	0.080	0.034	2.2×10^{-4}
2	0.080	0.017	1.1×10^{-4}
3	0.16	0.017	2.2×10^{-4}

A. rate = $k[S_2O_8^{2-}]$
B. rate = $k[S_2O_8^{2-}]^2$
C. rate = $k[S_2O_8^{2-}][I^-]$
D. rate = $k[S_2O_8^{2-}]^2[I^-]$
E. rate = $k[S_2O_8^{2-}]^2[I^-]^2$

3. If concentration is expressed in units of molecules per cubic centimeter (molec/cm^3) and time in units of seconds (s), the **units of a second-order rate constant** are

A. $cm^3\ molec^{-1}\ s^{-1}$ B. $cm^6\ molec^{-2}\ s^{-1}$ C. s^{-1}
D. s^{-2} E. $molec\ cm^{-3}\ s^{-1}$

4. The chemical reaction A → products is known to have a rate law of the general type

$$rate = k[A]^n.$$

A plot of <u>1/[A] versus time</u> was found to give a straight line with a positive slope. What is **n, the order of reaction**?

A. zero B. first C. second D. third E. none of these

5. A certain reaction, A → products, is <u>zero-order</u> in [A]. At 25°C, it was found that 20 minutes were required for the concentration of A to decrease from 2.0 M to 1.0 M. At this temperature, **how much time** would be required for [A] to decrease from 1.0 M to 0.50 M?

A. 5.0 min B. 10 min C. 20 min D. 40 min E. 80 min

6. A certain first-order reaction, A → B, has a rate constant of 7.6×10^{-3} s^{-1}. The **time** required for the reaction to be 60% complete is

A. 0.0038 s B. 0.69 s C. 68 s D. 120 s E. 300 s

7. At 25°C, the second-order reaction

$$NOCl(g) \rightarrow NO(g) + \tfrac{1}{2} Cl_2(g)$$

is 50% complete after 5.82 hours when the initial concentration of NOCl is 4.46 M. What is the value of the **rate constant** (in units of $M^{-1}hr^{-1}$) for this reaction?

A. 0.039 B. 0.077 C. 0.17 D. 1.3 E. 2.6

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

$$N_2O_5(g) \rightarrow 2\ NO_2(g) + \tfrac{1}{2}\ O_2(g)$$

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

A. 8.20×10^{-7} s^{-1} B. 4.00×10^{-6} s^{-1} C. 1.76×10^{-5} s^{-1}

D. 7.00×10^{-5} s^{-1} E. 2.55×10^{-4} s^{-1}

9. For a certain reaction, the rate constant, k, at 35°C is twice the value of the rate constant at 25°C. What is the **activation energy, E_a**, for this reaction in units of kJ/mol?

A. 31 B. 53 C. 72 D. 85 E. 107

10. The activation energy of a certain uncatalyzed reaction is 70 kJ/mol. In the presence of a catalyst, the E_a is 55 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

11. When the concentrations of reactant molecules are increased, the rate of reaction increases. The **best explanation** is: As the reactant concentrations increase, …

A. the average kinetic energy of the molecules increases.
B. the frequency of molecular collisions increases.
C. the rate constant increases.
D. the activation energy decreases.
E. the order of the reaction increases.