Name _____

CHEM 1474
Test #2
Fall 2010 (Buckley)

Circle the letter corresponding to the best answer for each of the following multiple choice questions. Each multiple choice question is worth 2 points.

For questions 1 – 4 consider the reaction below:

$$2\ NO\ (g) + 2\ H_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$$

1. The rate of the reaction in terms of NO is given as:

   a. $\frac{2\Delta[NO]}{\Delta t}$ b. $-\frac{\Delta[NO]}{2\Delta t}$ c. $\frac{\Delta[NO]}{2\Delta t}$ d. $\frac{\Delta[NO]}{\Delta t}$ e. $-\frac{\Delta[NO]}{\Delta t}$

2. The rate of formation of H_2O is:

   a. one-half the rate of the reaction
   b. one-half the rate of formation of N_2 (g)
   c. equal to the rate of the reaction
   d. twice the rate of the reaction
   e. one-half the rate of destruction of NO

3. If the rate of the reaction under a particular set of conditions is 0.10 M/s, the rate of destruction of H_2 (g) is:

   a. 0.20 M/s b. 0.10 M/s c. 0.05 M/s d. 0.40 M/s e. 0.025 M/s

4. Which of the following changes would result in an increased rate of reaction?

   a. increase the concentration of only NO
   b. decrease the concentration of only N_2
   c. increase the concentration of either NO or H_2
   d. increase the concentration of only H_2
   e. cannot tell from the information given

Consider the following set of initial rate data for questions 5-9.

The chemical reaction is:

$$2\ ClO_2\ (aq)\ +\ 2\ OH^-\ (aq)\ \rightarrow\ ClO_3^-\ (aq)\ +\ ClO_2^-\ (aq)\ +\ H_2O\ (\ell)$$

Initial Rate Data for Reaction Above			
Experiment #	$[ClO_2]$ (M)	$[OH^-]$ (M)	Rate (M/s)
1	0.030	0.010	2.07×10^{-3}
2	0.010	0.010	2.3×10^{-4}
3	0.030	0.030	6.21×10^{-3}

5. What is the order of the reaction with respect to ClO_2?

   a. zeroth b. first c. second d. third e. fourth

6. What is the order of the reaction with respect to OH^-?

   a. zeroth b. first c. second d. third e. fourth

7. The rate law for the reaction is:

   a. Rate = $k\ [ClO_2]^2[OH^-]$
   b. Rate = $k\ [ClO_2][OH^-]^2$
   c. Rate = $k\ [ClO_2]^2[OH^-]^2$
   d. Rate = $k\ [ClO_2]^2$
   e. Rate = $k\ [ClO_2][OH^-]$

8. The value of the rate constant for the reaction is:

   a. $6.9\ M^{-1}s^{-1}$
   b. $230\ M^{-2}s^{-1}$
   c. $2.3 \times 10^4 M^{-3}s^{-1}$
   d. $0.207\ s^{-1}$
   e. $0.069\ s^{-1}$

9. Under the conditions in Experiment #2, the rate of destruction of ClO_2 is:

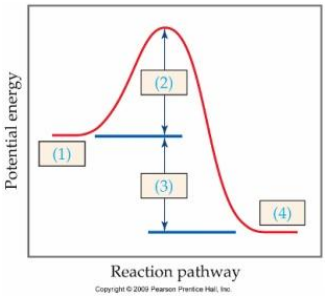
   a. $1.15 \times 10^{-4}\ Ms^{-1}$
   b. $2.3 \times 10^{-4}\ Ms^{-1}$
   c. $0.030\ Ms^{-1}$
   d. $4.6 \times 10^{-4}\ Ms^{-1}$
   e. $9.2 \times 10^{-4}\ Ms^{-1}$

10. Place an X in the ***all boxes below*** corresponding to true statements about a first-order reaction.

- ☐ the half-life depends on the initial concentration
- ☐ a plot of ln[A] vs. time will be linear
- ☐ a plot of 1/[A] vs. time will be linear
- ☐ the half-life does not depend on the initial concentration
- ☐ the rate of the reaction does not change with concentration

11. Which of the numbered boxes in the diagram represents the activation energy for the indicated reaction?

a. 1
b. 2
c. 3
d. 4



12. Which of the following equations is the equilibrium expression for the reaction:

$$C_2H_4(g) + 2\,H_2O(g) \rightleftarrows C_2H_6(g) + O_2(g)$$

a. $K_c = \dfrac{[C_2H_4][H_2O]^2}{[C_2H_6][O_2]}$

b. $K_c = \dfrac{[C_2H_6][O_2]^2}{[C_2H_4][H_2O]^2}$

c. $K_c = [C_2H_4][H_2O]^2$

d. $K_c = \dfrac{[C_2H_6]^2[O_2]}{[C_2H_4][H_2O]^2}$

e. $K_c = \dfrac{[C_2H_6][O_2]}{[C_2H_4][H_2O]^2}$

13. The equilibrium expression for the chemical reaction:
$4\,HCl(aq) + O_2(g) \rightleftarrows 2H_2O(\ell) + 2Cl_2(g)$

is:

a. $K_c = \dfrac{[Cl_2]^2}{[HCl]^4[O_2]}$

b. $K_c = \dfrac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]}$

c. $K_c = \dfrac{[HCl]^4[O_2]}{[Cl_2]^2}$

d. $K_c = \dfrac{[HCl]^4[O_2]}{[H_2O]^2[Cl_2]^2}$

e. $K_c = \dfrac{[HCl]^4[O_2]}{[Cl_2]^2}$

14. At a particular temperature the equilibrium constant for the following reaction is 5.8×10^{-2}.

$$PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$$

What is the value of the equilibrium constant for the reaction:

$$2\,PCl_3(g) + 2Cl_2(g) \rightleftarrows 2PCl_5(g)$$

a. 5.8×10^{-2} b. 17.2 c. 297 d. 3.36×10^{-3} e. 0.241

15. The equilibrium constant, K_p, is 8.9×10^{-5} for the reaction:

$$N_2(g) + 3H_2(g) \rightleftarrows 2\,NH_3(g)$$

Which of the following combinations of pressures represents a system that is at equilibrium?

a. $P_{N_2} = 0.050$ atm, $P_{H_2} = 0.24$ atm, $P_{NH_3} = 0.0035$ atm

b. $P_{N_2} = 11$ atm, $P_{H_2} = 0.24$ atm, $P_{NH_3} = 0.0045$ atm

c. $P_{N_2} = 0.35$ atm, $P_{H_2} = 9.0$ atm, $P_{NH_3} = 3.5$ atm

d. $P_{N_2} = 18$ atm, $P_{H_2} = 0.25$ atm, $P_{NH_3} = 0.0050$ atm

e. $P_{N_2} = 0.050$ atm, $P_{H_2} = 0.0050$ atm, $P_{NH_3} = 1.5$ atm

Problems. Show your work to receive full credit.

16. (10 points) Show your work.
A first order reaction has the form A → B with a rate constant of 1.45×10^{-3} s^{-1}.

a. If the initial concentration of A is 0.250 M, how long would it take for the concentration of A to drop to 0.100 M?

b. What is the half-life of the reaction?

c. What concentration of A is left after a period of 4.0 minutes?

d. If the third-life is defined to be the period of time required for the concentration of A to be one-third of its initial value, what is the third-life of this reaction?

17. (10 points) Show your work.
A second-order reaction has the form A → B.

a. If it takes 1500 s for the concentration of A to drop from 0.500 M to 0.280 M, what is the rate constant for the reaction? Include the units.

b. What is the half-life for the reaction if the initial concentration of A is 0.500 M?

c. How long would it take for the concentration of A to drop from 0.500 M to 0.150 M?

d. What is the concentration of A after 1000 s starting from the 0.500 M concentration?

18. (10 points) Show your work.

a. A particular reaction has a preexponential factor, A, of 4.5×10^{11} Ms^{-1} and an activation energy of 45 kJ/mol. What is the value of this reaction's rate constant at a temperature of 125 ºC?

b. At what temperature would the reaction have a rate constant of 1×10^{4} Ms^{-1}?

$$k = Ae^{-E_a/RT} \qquad R = 8.314 J / mol \bullet K$$

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