Solutions for Practice Exam 1

1. Consider the reaction

$$S_2O_8^{2-} + 3\ I^- \longrightarrow 2SO_4^{2-} + I_3^-$$

which one of the following rate expressions would give the same value as the rate of disappearance of $S_2O_8^{2-}$?

b. rate = $-1/3(\Delta[I^-])/\ \Delta t$

2. The exponents (= orders) in a rate law are determined by

    1. the coefficients in the balance equation.
    2. experiment.
    3. the physical states of the reactants and products.

b. 2 only

3. After five half-life periods for a first-order reaction, what is the molarity of a reagent initially at 0.366 M?

a. 1.14×10^{-2}

4. If the half-life of a first-order process is 3.00 minutes, the rate constant for the process is

e. 0.231/min.

5. Under which of the following conditions does the equilibrium constant K change for the reaction

$$H_2(g) + I_2(g) \leftrightarrow 2HI(g)$$

d. changing the temperature

6. Hydrogen peroxide decays into water and oxygen in a first-order process.

$$H_2O_2(aq) \longrightarrow H_2O(\rangle) + 1/2\ O_2(g)$$

where the rate expression is $-\Delta[H_2O_2]/\ \Delta t = k[H_2O_2]$. If we begin with 0.100 M H_2O_2 and find that after 3200 seconds, the peroxide concentration falls to 0.0825 M, what is the rate constant, k, at the temperature at which the experiment is performed?

b. $6.01 \times 10^{-5}\ s^{-1}$

7. In basic solution, $(CH_3)_3CCl$ reacts according to the equation

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

The accepted mechanism for the reaction is

$$(CH_3)_3CCl \rightarrow (CH_3)_3C^+ + Cl^- \text{ (slow)}$$
$$(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH \text{ (fast)}$$

What is the rate law expression for the reaction?

d. rate = $k[(CH_3)_3CCl]$

8. The activation energy for $2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$ is 250. kJ. If k for this reaction is 0.380 $M^{-1}s^{-1}$ at 1001 K, what will k be at room temperature, 298 K?

a. 6.36×10^{-32}

9. If $K_C = 0.44$ for the reaction $2NOBr(g) \leftrightarrow 2NO(g) + Br_2(g)$ at a particular temperature, what is K_C for the following reaction?

$$NOBr(g) \leftrightarrow NO(g) + 1/2Br_2(g)$$

d. 0.66

10. A chemist prepared a sealed tube with 0.85 atm of PCl_5 at 500 K. The pressure increased as the following reaction occurred. When equilibrium was achieved, the pressure in the tube had increased to 1.25 atm. Calculate K_p.

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

a. 0.36

11. A 1.00 liter flask contained 0.24 mol NO_2 at 700 K which decomposed according to the following equation. When equilibrium was achieved, 0.14 mol NO was present. Calculate K_C.

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

d. 1.4×10^{-1}

12. A mixture of 0.30 mol NO and 0.30 mole CO_2 is placed in a 2.00 L flask and allowed to reach equilibrium at a given temperature. Analysis of the equilibrium mixture indicated that 0.10 mol of CO was present. Calculate K_C for the reaction.

$$NO(g) + CO_2(g) \leftrightarrow NO_2(g) + CO(g)$$

c. 0.25

13. A flask contains the following system at equilibrium:

$$Mg(OH)_2(s) \leftrightarrow Mg^{2+}(aq) + 2\ OH^-(aq)$$

Which of the following reagents could be added to increase the solubility of $Mg(OH)_2$?

c. HCl

14. For the gas phase reaction, $3H_2 + N_2 \rightarrow 2NH_3$, how does the rate of disappearance of H_2 compare to the rate of production of NH_3?

c. The rate of disappearance of H_2 is 3/2 the rate of appearance of NH_3.

15. The reaction

$$CH_3CHO(g) \rightarrow CH_4(g) + CO(g)$$

proceeds via the rate expression $\Delta[CO]/\Delta t = [CH_3CHO]^{3/2}$. What is the overall order of the reaction?

e. three-halves-order

16. The half-life for a first-order reaction at 550 ºC is 85 seconds. How long would it take for 23% of the reactant to decompose?

c. 32 seconds

17. The decomposition of phosphine, PH_3, follows first-order kinetics:

$$4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$$

The half-life for the reaction at 550 ºC is 81.3 seconds. How long does it take for the reaction to be 78.5% complete?

e. 180 seconds

18. What is the half-life of a first-order reaction which is 15% complete after 210 seconds?

e. 895 seconds

19. Calculate the activation energy, Eº, for

$$N_2O_5(g) \rightarrow 2NO_2(g) + 1/2\ O_2(g)$$

given k (at 25 ºC) = 3.46 x 10^{-5}/s and k (at 50 ºC) = 1.10 x 10^{-3}/s. R = 8.3145•10^{-3} kJ/mol•K).

b. 111 kJ

20. In which case does the reaction go farthest to completion (to the products)?

a. $K = 10^4$

21. For the reaction below, what is the expression for K_C?

$$2H_2(g) + 2FeO(s) \leftrightarrow 2Fe(s) + 2H_2O(g)$$

d. $K_C = [H_2O]^2/[H_2]^2$

22. Consider the reaction $2A(g) \leftrightarrow B(g)$ where $K_C = 0.5$ at the temperature of the reaction. If 2.0 moles of A and 2.0 moles of B are introduced into a 1.00 liter flask, what change in concentrations (if any) would occur in time?

e. [A] and [B] remain the same

23. Consider the reaction $A(g) \leftrightarrow 2B(g)$ where $K_c = 1.5$ at the temperature of the reaction. If 3.0 moles of A and 3.0 moles of B are introduced into a 1.00 liter flask, what change in concentrations (if any) would occur in time?

b. [A] increases and [B] decreases

24. Exactly 0.50 mole of sulfur trioxide, 0.10 mole of sulfur dioxide, 0.20 mole of nitrogen monoxide and 0.30 mole nitrogen dioxide are sealed in a 1.0-L flask at 1500 ºC. The equilibrium constant K_C is 0.24 for the following reaction.

$$SO_3(g) + NO(g) \leftrightarrow SO_2(g) + NO_2(g) \qquad K_C = 0.24$$

When equilibrium is achieved, what changes in concentrations of SO_3 and NO will be observed?

a. [SO_3] increases; [NO] increases

25. For the equilibrium system

$$H_2O(g) + CO(g) \leftrightarrow H_2(g) + CO_2(g) \quad \Delta H = -42\ kJ/mol$$

K equals 0.62 at 1260 K. If 0.10 mol each of H_2O, CO, H_2 and CO_2 (all at 1260 K) were placed in a 1.0 L thermally insulated vessel which was also at 1260 K, then when the system came to equilibrium

a. the temperature would decrease and the mass of CO would increase.