Practice Exam 1

1. Consider the reaction

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

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

a. rate = $-3\ \Delta[I^-]/\ \Delta t$
b. rate = $-1/3(\Delta[I^-])/\ \Delta t$
c. rate = $-2(\Delta[SO_4^{2-}])\Delta t$
d. rate = $-\ \Delta[I_3^-]/\ \Delta t$
e. rate = $-1/2(\Delta[SO_4^{2-}])/\Delta t$

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.

a. 1 only
b. 2 only
c. 3 only
d. 1 and 2 only
e. 1, 2, and 3

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}
b. 3.12×10^{-2}
c. 6.57×10^{-3}
d. 3.12×10^{3}
e. 7.32×10^{-2}

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

a. 1.50/min.
b. 1.05/min.
c. 4.34/min.
d. 0.405/min.
e. 0.231/min.

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

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

a. changing the size of the container
b. Introducing more I_2 into the container
c. measuring the molar concentrations instead of pressures
d. changing the temperature
e. none of these, it is always constant

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?

a. $2.61 \times 10^{-5}\ s^{-1}$
b. $6.01 \times 10^{-5}\ s^{-1}$
c. $6.59 \times 10^{-5}\ s^{-1}$
d. $3.79 \times 10^{-4}\ s^{-1}$
e. $4.24 \times 10^{-3}\ s^{-1}$

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

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

The accepted mechanism for the reaction is

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

What is the rate law expression for the reaction?

a. rate = $k[(CH_3)_3C^+],[OH^-]$
b. rate = $k[(CH_3)_3C^+][OH^-]$,
c. rate = $k[Cl^-]$
d. rate = $k[(CH_3)_3CCl]$
e. rate = $k[(CH_3)_3CCl][OH^-]$

8. The activation energy for $2N_2O(g) \longrightarrow 2N_2(g) + O_2(g)$ 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}
   b. 4.35×10^{-16}
   c. 0.113
   d. 0.216
   e. 1.57×10^{31}

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?

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

   a. 0.19
   b. 0.22
   c. 0.44
   d. 0.66
   e. 2.3

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
   b. 0.19
   c. 0.10
   d. 0.047
   e. 0.089

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.

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

   a. 9.6×10^{-3}
   b. 1.1×10^{-2}
   c. 9.8×10^{-2}
   d. 1.4×10^{-1}
   e. 5.7×10^{3}

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.

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

a. 0.033
b. 0.05
c. 0.25
d. 1.1
e. 0.33

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 $Mg(OH)_2$?

a. NH_3
b. NaOH
c. HCl
d. H_2O
e. $MgCl_2$

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?

a. The initial rates are equal.
b. The rate of disappearance of H_2 is 1/2 the rate of appearance of NH_3.
c. The rate of disappearance of H_2 is 3/2 the rate of appearance of NH_3.
d. The rate of disappearance of H_2 is 2/3 the rate of appearance of NH_3.
e. The rate of disappearance of H_2 is 1/3 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?

a. zero-order
b. first-order
c. second-order
d. third-order
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?

a. 0.82 seconds
b. 26 seconds
c. 32 seconds
d. 44 seconds
e. 180 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?

a. 8.52 seconds
b. 28.4 seconds
c. 63.8 seconds
d. 117 seconds
e. 180 seconds

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

a. 7.74 seconds
b. 32 seconds
c. 76.7 seconds
d. 178 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) = 3.46×10^{-5}/s and k (at 50 ºC) = 1.10×10^{-3}/s. R = $8.3145 \cdot 10^{-3}$ kJ/mol•K).

a. 231 kJ
b. 111 kJ
c. 99.3 kJ
d. 76.2 kJ
e. 56.5 kJ

20. In which case does the reaction go farthest to completion (to the products)?
a. $K = 10^4$
b. $K = 10^3$
c. $K = 1$
d. $K = 10^{-3}$
e. $K = 10^{-5}$

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

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

a. $K_C = [Fe]^2[H_2O]^2/[H_2]^2[FeO]^2$
b. $K_C = [H_2O]^2/[H_2]^2[FeO]^2$
c. $K_C = [Fe]^2/[H_2]^2[FeO]^2$
d. $K_C = [H_2O]^2/[H_2]^2$
e. $K_C = [2Fe]^2[2H_2O]^2/[2H_2]^2[2FeO]^2$

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?

a. [A] increases and [B] increases
b. [A] increases and [B] decreases
c. [A] decreases and [B] increases
d. [A] decreases and [B] decreases
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?

a. [A] increases and [B] increases
b. [A] increases and [B] decreases
c. [A] decreases and [B] increases
d. [A] decreases and [B] decreases
e. [A] and [B] remain the same

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
b. $[SO_3]$ increases; [NO] decreases
c. $[SO_3]$ decreases; [NO] decreases
d. $[SO_3]$ decreases; [NO] increases
e. all concentrations remain the same

25. For the equilibrium system

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

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.
b. the temperature would decrease and the mass of CO would decrease.
c. the temperature would remain constant and the mass of CO would increase.
d. the temperature would increase and the mass of CO would decrease.
e. the temperature would increase and the mass of CO would increase.