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SECOND SEMISTER CHEMISTRY WORKSHEET-2 FOR G-11

I. CHOOSE THE MOST APPROPRIATE ANSWER FROM THE SUGGESTED OPTIONS

1. When the system **A(g) + B(g) ⇌ C(g) + D(g)** is at equilibrium,
   A. The sum of the concentrations of **A** and **B** must equal the sum of the concentrations of **C** and **D**.
   B. The forward reaction has stopped.
   C. Both the forward and the reverse reactions have stopped.
   D. Neither the forward nor the reverse reaction has stopped
2. **$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$**. The conventional equilibrium constant expression (K_c) for the system as described by the above equation is:
   A. $[SO_2]^2/[SO_3]$ B. $[SO_2]^2[O_2]/[SO_3]^2$ C. $[SO_3]^2/[SO_3]^2[O_2]$ D. $[SO_2]\,[O_2]$
3. Consider the following reversible reaction. In a 3.00-liter container, the following amounts are found in equilibrium at 400°C: 0.0420 mole N_2, 0.516 mole H_2 and 0.0357 mole NH_3. Evaluate K_c.
   $$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
   A. 0.202 B. 1.98 C. 16.0 D. 4.94 E. 0.503
4. If the equilibrium constant for the reaction: A(g) + 2B(g) ⇌ C(g) + 5/2D(g) has a value of 4.0, what is the value of the equilibrium constant for the reaction 2C(g) + 5D(g) ⇌ 2A(g) + 4B(g) at the same temperature?
   A. 0.25 B. 16 C. 2.0 D. 8.0
5. At 445°C, K_c for the following reaction is 0.020. $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$. A mixture of H_2, I_2, and HI in a vessel at 445°C has the following concentrations: [HI] = 2.0 M, $[H_2]$ = 0.50 M and $[I_2]$ = 0.10 M. Which one of the following statements concerning the reaction quotient, **Q_c**, is **true** for the above system?
   A. $Q_c = K_c$; the system is at equilibrium.
   B. $Q_c < K_c$; more HI will be produced.
   C. $Q_c < K_c$; more H_2 and I_2 will be produced.
   D. $Q_c > K_c$; more H_2 and I_2 will be produced.
6. Consider the following reaction mechanism
   i. $N_2O_5 \rightarrow NO_2 + NO_3$……. Fast
   ii. $N_2O_5 \rightarrow NO + NO_2 + O_2$…….slow
   iii. $NO_3 + NO \rightarrow 2NO_2$……fast, the intermediate/s is/are
   A. NO B. NO_3 C. NO_2 & O_2 D. NO & NO_3
7. Nitrosyl chloride, **NOCl**, dissociates on heating as shown below. When a 1.50g sample of pure NOCl is heated at 350°C in a volume of 1.00 liter, the percent dissociation is found to be 57.2%. Calculate K_c for the reaction as written. $NOCl(g) \rightleftharpoons NO(g) + 1/2\ Cl_2(g)$
   A. 0.1876 B. 0.105 C. 0.1099 D. 0.0421
8. A quantity of **HI** was sealed in a tube, heated to 425°C and held at this temperature until equilibrium was reached. The concentration of **HI** in the tube at equilibrium was found to be 0.0706 mol/L. Calculate the equilibrium $[H_2]$ & $[I_2]$. For the gas-phase reaction,
   $$H_2 + I_2 \rightleftharpoons 2HI \quad K_c = 54.6 \text{ at } 425^oC$$
   A. 9.55×10^{-3} M B. 1.17×10^{-3} M C. 1.85×10^{-4} M D. 4.78×10^{-3} M E. 2.34×10^{-3} M
9. Consider the reaction: $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ Kc = 0.10 at 2000**°C.** Starting with initial concentrations of 0.040 mol/L of N_2 and 0.040 mol/L of O_2, what is the equilibrium concentration of NO in mol/L?
   A. 0.055 mol/L B. 0.96 mol/L C. 0.012 mol/L D. 0.080 mol/L

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10. Given the $K_c = 0.040$ for the system below at 450°C. If a reaction is initiated with 0.40 mole of Cl_2 and 0.40 mole of PCl_3 in a 2.00 liter container, what is the equilibrium concentration of Cl_2 in the same system? $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
    A. 0.07 M B. 0.2 M C. 0.1 M D. 0.04 M
11. The reversible reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ has come to equilibrium in a vessel of specific volume at a given temperature. Before the reaction began, the concentrations of the reactants were 0.060 mol/L of SO_2 and 0.050 mol/L of O_2. After equilibrium is reached, the concentration of SO_3 is 0.040 mol/L. What is the equilibrium concentration of O_2?
    A. 0.010 M B. 0.020 M C. 0.030 M D. 0.040 M
12. Which of the following statements is **true** about reaction equilibrium?
    A. No more reactants are transformed in to products.
    B. There are equal number of reactants and products.
    C. The rate constant for the forward reaction equal to the reverse reaction.
    D. The rate for the forward reaction equals that of the reverse reaction
13. Given the equations:
    i. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $Kc = 3.6\times10^{8}$
    ii. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $Kc = 5\times10^{-3}$
    iii. $2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g)$, $Kc = 4.45\times10^{-24}$

The tendency of the reactions in increasing order to proceed towards completion would be arrayed as:
    A. i < ii < iii B. iii < ii < i C. ii < i < iii D. ii < iii < i
14. Consider the gas-phase equilibrium system represented by the equation: $2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$
Given that the forward reaction (the conversion of "left-hand" species to "right-hand" species) **endothermic**, which of the following changes will **decrease** the equilibrium amount of H_2O?
    A. Adding more $[O_2]$ C. Adding a solid phase calalyst
    B. Decreasing the volume of the container D. Increasing the temp.at constant pressure
15. The conventional equilibrium constant expression (K_c) for the system below is: $2ICl(s) \rightleftharpoons I_2(s) + Cl_2(g)$
    A. $[I_2][Cl_2]/[ICl]^2$ B. $[I_2][Cl_2]/2[ICl]$ C. $[Cl_2]$ D. $[I_2] + [Cl_2])/2[ICl]$
16. Consider the equilibrium system: $2ICl(s) \rightleftharpoons I_2(s) + Cl_2(g)$. Which of the following changes will increase the total amount of of Cl_2 that can be produced?
    A. Removing some of the $I_2(s)$ C. Adding more ICl(s)
    B. Decreasing the $[Cl_2]$ as it is formed D. Decreasing the volume of the container
17. At equilibrium, a 1.00-liter container was found to contain 0.20 moles of **A**, 0.20 moles of **B**, 0.40 moles of **C** and 0.40 mole of **D**. If 0.10 moles of **A** and 0.10 moles of **B** are added to this system, what will be the new equilibrium concentration of A? $A(g) + B(g) \rightleftharpoons C(g) + D(g)$
    A. 0.37 mol/L B. 0.40 mol/L C. 0.20 mol/L D. 0.15 mol/L
18. Consider the following system in a 1.00 L container: $A(g) + B(g) \rightleftharpoons 2C(g)$,The equilibrium concentrations at 200°C were determined to be:

    [A] = 0.200 M [B] = 3.00 M [C] = 0.500 M

How many moles of A must be added to increase the concentration of C to 0.700 M at 200°C?
    A. 0.225 mol B. 0.305 mol C. 0.417 mol D. 0.610 mol

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19. Consider the reversible reaction at equilibrium at 392°C: $2A(g) + B(g) \rightleftharpoons C(g)$, The partial pressures are found to be: A: 6.70 atm, B: 10.1 atm, C: 3.60 atm. Evaluate $\mathbf{K_p}$ for this reaction.
    A. 7.94×10^{-3} B. 0.146 C. 0.0532 D. 54.5
20. Given the equilibrium reaction; $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ with $K_c = 0.040$ mol/L at 450°C. what is the $\mathbf{K_p}$ for the reaction at 450°C?
    A. 0.40 B. 0.64 C. 2.37 D. 0.052
21. For a specific reaction, which of the following statement is true about the equilibrium constant, $\mathbf{K_c}$?
    A. It always remains the same at different reaction conditions
    B. It decreases if the concentration of one of the products is increased
    C. It changes with changes in the temperature
    D. It increases if the concentration of one of the reactants is increased
22. A sample of $S_8(g)$ is placed in an otherwise empty rigid container at 1325 K at an initial pressure of 1.00 atm, where it decomposes to $S_2(g)$ by the reaction**: $\mathbf{S_8(g) \rightleftharpoons 4S_2(g)}$**. At equilibrium, the partial pressure of S_8 is 0.25 atm. What is the value of **Kp** for this reaction at 1325 K?
    A. 81 B. 243 C. 324 D. 75
23. What role did Karl Haber Bosch play in development of the Haber-Bosch process?
    A. Haber was working in his lab with his instructor at the time he worked out the process
    B. He originally isolated ammonia from camel dung and found a method for purifying it
    C. He developed the equipment necessary for industrial production of ammonia
    D. He was the German industrialist who financed the research done by Haber
    E. He discovered the reaction conditions necessary for formation of ammonia
24. The ratio of Kc to Kp for the reaction: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is

    A. 1 B. RT C. $(RT)^{-1}$ D. 2

25. The value of Kc for the equilibrium $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is 794 at 25 °C. What is the value of Kc for the equilibrium below? $1/2H_2(g) + 1/2I_2(g) \rightleftharpoons HI(g)$
    A. 1588 B. 0.035 C. 28 D. 397 E. 0.0013
26. How does the reaction quotient of a reaction (Q_c) differ from the equilibrium constant (Kc) of the same reaction?
    A. Q_c does not change with temperature.
    B. Q_c does not depend on the concentrations or partial pressures of reaction components.
    C. K_c does not depend on the concentrations or partial pressures of reaction components.
    D. K_c does not change with temperature, whereas Q_c is temperature dependent.
    E. Q_c is the same as Kc when a reaction is at equilibrium.
27. following reaction is at equilibrium: $Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g)$. How will the system respond if the pressure is decreased at a constant temperature?
    A. The reaction will shift to the left C. There will be no change to the equilibrium position
    B. The concentration of the product will increase D. The reaction will shift to the right
28. At 200°C, the Kp for the reaction below is 2.4×10^3. $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$. A closed vessel is charged with 36.1 atm of NO. At equilibrium, the partial pressure of O2 in atm would be:
    A. 18.1 B. 1.5×10^{-2} C. 294 D. 6.00 E. 35.7

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29. Consider the following equilibrium: $N_2(g) + O_2(g) + q \rightleftharpoons 2NO(g)$. When the temperature is increased, the equilibrium shifts to the:
    A. Left and K**c** increases. C. Right and K**c** decreases
    B. Left and K**c** decreases D. Right and K**c** increases
30. The equilibrium of the reaction: $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ will shift to product side when:
    A. Kp >1 B. Q < Kp C. Q = Kp D. Q = 2Kp
31. The relationship between the rate constants for the forward and reverse reactions and the equilibrium constant for the process is K_{eq} = _____.
    A. kf/kr B. (kf.kr) C. kf - kr D. kr/kf
32. The indicator phenolphthalein can be described by the following equilibrium equation:
    $HIn(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + In^-(aq)$. Color changes from Colorless to pink
    HCl is added to a slightly pink sample of this indicator. After equilibrium has been re- established, how do the **$[H_3O^+]$** and the color of the solution compare with the original equilibrium?
    A. $[H_3O^+]$ decreases, Color of Solution turn pink
    B. $[H_3O^+]$ decreases, Color of Solution turns colorless
    C. $[H_3O^+]$ increase, Color of Solution turns pinker
    D. $[H_3O^+]$ increase, Color of Solution turns colorless
33. The equilibrium constants for each of the following reactions are given:
    i. $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$, $K_1 = 4.3x10^{-25}$ ii. $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$, $K_2 = 6.4x10^{9}$
    What is **Kc** for the combined reaction? $N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$
    A. $3.7x\ 10^{-13}$ B. 6.1×10^{-14} C. $2.8\ x10^{-15}$ D. 8.9×10^{-16}
34. At equilibrium;
    A. All chemical reactions have ceased
    B. The rate constants of the forward and reverse reactions are equal
    C. The rates of the forward and reverse reactions are equal
    D. The value of the equilibrium constant is 1
    E. The limiting reagent has been consumed
35. The equilibrium constant (Kc) expression depends on the _____ of the reaction.
    A. The quantities of reactants and products initially present C. Stoichiometry and mechanism
    B. Stoichiometry D. Temperature
36. The equilibrium constant for the gas phase reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is $Kc = 4.34\times10^{-3}$ at 300°C. At equilibrium, _____.
    A. Roughly equal amounts of products and reactants are present C. Products predominate
    B. Reactants predominate D. Only reactants are present
37. The equilibrium constant for the gas phase reaction $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ is Kc = 230 at 300°C. At equilibrium, _____.
    A. Reactants predominate C. Products predominate
    B. Only products are present D. Roughly equal amounts of products and reactants are present

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II. ANSWER THE FOLLOWING QUESTIONS ACCORDINGLY

38. Considering the previous reaction, what happens with the system if:
    $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$, $\Delta H = 2.85$ kJ/mol
    i. The concentration of CO(g) is decreased to 0.500 M
    ii. The temperature of the system is decreased
    iii. If volume of container is decreased
39. When the following reaction is at equilibrium and the volume of the container is decreased,
    $COCl_2(g) \rightarrow CO(g) + Cl_2(g)$
    i. Forward reaction rate increases
    ii. Forward reaction rate decreases
    iii. Reverse reaction rate increases
    iv. Equilibrium remains unchanged
40. Suppose we have the following reaction at equilibrium; $PCl_5(s) \rightarrow PCl_3(g) + Cl_2(g)$. Identify false statement(s).
    a. Adding PCl_3 to the container shifts the equilibrium to form more PCl_5
    b. Decreasing the volume of the container shifts the equilibrium to form more PCl5
    c. Removing PCl_5 from the container shifts the equilibrium to form more PCl_3

41. For the reaction below, which change would cause the equilibrium to shift to the right?
    $CH_4(g) + 2H_2S(g) \leftrightarrow CS_2(g) + 4H_2(g)$
    a. Decrease the concentration of dihydrogen sulfide
    b. Increase the temperature of the system.
    c. Decrease the concentration of methane
    c. Increase the pressure on the system
    d. Increase the concentration of (S= C=S)
42. In a reaction, 2.00M CO(g) is mixed with 1.00M $H_2O(g)$. If Kc is 1.56, what are the equilibrium concentrations of all species? $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$