1. If an equation for a reaction is multiplied by $n$, the value of $K_c$ is altered by:

_______________________________________________________________________________

2. A reaction that can proceed in both the forward and reverse directions is said to be:

_______________________________________________________________________________

3. ____________________________________________________________________________ says that a system at equilibrium, when disturbed, will shift in the direction that relieves the stress of the disturbance.

4. True or false: The smaller the value of $K_c$ the more reactant favored the reaction.____________

5. What is the conjugate base of:
   a) HBr
   b) $\text{H}_2\text{SO}_4$

6. What is the conjugate acid of:
   a) $\text{H}_2\text{O}$
   b) $\text{HCO}_3^-$

7. Identify the Lewis Acid and Lewis Base in the reactants of:
   a) $\text{Cu}^{2+} + 4 \text{NH}_3 \rightleftharpoons \text{Cu(NH}_3)_4^{2+}$
   b) $\text{Zn(OH)}_2 + 2 \text{OH}^- \rightleftharpoons \text{Zn(OH)}_4^{2-}$

8. For a solution of $7.6 \times 10^{-3}$ M $\text{NaOH}$, determine
   a) $[\text{OH}^-]$
   b) $[\text{H}_3\text{O}^+]$
   c) $\text{pOH}$
   d) $\text{pH}$

9. Which is the stronger acid,
   a) the one with $K_a = 5.6 \times 10^{-2}$ or
   b) the one with $K_a = 6.8 \times 10^{-4}$?

10. For the reaction between carbonic acid and cyanide ion:
    a) Write the balanced Rxn:
    b) Identify the conjugate pairs:
    c) To which side does the equilibrium lie?
Chem. 401 Unit 2 of 4 Review

11. Predict whether the following solutions are acidic, basic, or neutral.
   a) KNO₃
   b) LiCN
   c) AlCl₃

12. HNO₃ is a strong acid. Which of the following is NOT true?
   a) HNO₃ is essentially 100% dissociated.
   b) A 1.0 M solution of HNO₃ would have a [H₃O⁺] = 1.0 M
   c) The conjugate base, NO₃⁻, is a strong base.

13. Write the equilibrium constant expression for the reaction below in terms of Kc.
    \[ \text{CaCO}_3(\text{s}) + 2\text{H}_3\text{O}^+(\text{aq}) \leftrightarrow \text{Ca}^{2+} + 2\text{H}_2\text{O(l)} + \text{CO}_2(\text{g}) \]

14. The following exothermic reaction is at equilibrium:
    \[ 4\text{NH}_3(g) + 3\text{O}_2(g) \leftrightarrow 6\text{H}_2\text{O}(g) + 2\text{N}_2(g) \]
    How will the equilibrium shift if:
    a. The volume is increased:
    b. A catalyst is added:
    c. The temperature is increased:

15. For the reaction: \( \text{A} + \text{B} \leftrightarrow \text{C} + \text{D} \)
    a) \( \text{rate}_f = \text{rate}_r \)
    b) \( k_f = k_r \)
    c) \( k_f > k_r \)
    d) \( k_f < k_r \)

16. What is the equilibrium constant, \( K_p \), for the reaction below if the following partial pressures were measured at equilibrium at 25°C: \( P_{\text{SO}_2} = 0.55 \, \text{atm} \), \( P_{\text{O}_2} = 0.30 \, \text{atm} \), and \( P_{\text{SO}_3} = 0.15 \, \text{atm} \).
    Also determine \( K_c \).
    Unbalanced reaction: \( \text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons \text{SO}_3(g) \).
17. What is the equilibrium constant for a reaction that has $\Delta G_{\text{rxn}}^\circ = 0.450\text{kJ/mol}$ at 25°C?

18. Consider the following equation:

\[ 2 \text{HBr}_(g) \leftrightarrow \text{H}_2(g) + \text{Br}_2(g); \quad K_c = 1.8 \times 10^{-9} \text{ at some temperature } T. \]

A 4.50 L container has 1.69 mol each of HBr and Br$_2$ and 5.45 x 10$^{-5}$ mol H$_2$ at temperature T. Is the system at equilibrium? If not, will it shift towards reactants or products?

19. This equation is at equilibrium: $\text{CO}_(g) + \text{H}_2\text{O}_(g) \leftrightarrow \text{CO}_2(g) + \text{H}_2 (g)$

a. If a 10.00L vessel has 8.00 mol CO$_2$ and H$_2$, and 1.00 mol CO and H$_2$O gas at 588°K, which way will the reaction proceed? ($K_c = 31.4$ at 588 K)

b. What are the concentrations of all species at equilibrium?
20. What are the \([H_3O^+]\) and pH of a 0.35M solution of NH₄NO₃? (Ans: \(1.4 \times 10^{-5}\); 4.85)

21. What is the \(K_b\) for methylamine, CH₃NH₂, if a solution prepared by dissolved 0.82 mol of methylamine in 425 mL of H₂O has a pH of 12.46? (Ans: \(4.4 \times 10^{-4}\))

22. A 0.100 M solution of formic acid, HCOOH, is 4.0% dissociated. Calculate \(K_a\) for formic acid. (Ans: \(1.7 \times 10^{-4}\))