REVIEW QUESTIONS
Chapter 17

1. A buffer is prepared by adding 20.0 g of acetic acid ($HC_2H_3O_2$) and 20.0 g of sodium acetate ($NaC_2H_3O_2$) in enough water to prepare 2.00 L of solution. Calculate the pH of this buffer? ($K_a = 1.8x10^{-5}$)

2. What is the ratio of HCO_3^- to H_2CO_3 in blood of pH 7.4? (K_a for $H_2CO_3 = 4.3x10^{-7}$)

3. How many grams of NaBrO should be added to 1.00 L of 0.200 M HBrO to form a buffer with a pH of 8.80? (K_a for $HBrO = 2.5x10^{-9}$)

4. Acetylsalicylic acid (aspirin, $HC_9H_7O_4$) is a weak acid with Ka = 2.75×10^{-5} at 25°C. 3.00 g of sodium acetylsalicylate ($NaC_9H_7O_4$) is added to 200.0 mL of 0.100 M solution of this acid. Calculate the pH of the resulting solution at 25°C.

5. The equations and dissociation constants for three different acids are given below:

$$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-} \qquad K_a = 4.2 \times 10^{-7}$$
$$H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-} \qquad K_a = 6.2 \times 10^{-8}$$
$$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-} \qquad K_a = 1.3 \times 10^{-2}$$

Identify the conjugate pair that is best for preparing a buffer with a pH of 7.2. Clearly explain your choice.

6. A sample of 25.0 mL of 0.100 M solution of HBr is titrated with 0.200 M NaOH. Calculate the pH of solution after 10.0 mL of the base is added.

7. A buffer solution is prepared by adding 0.10 L of 2.0 M acetic acid solution to 0.10 L of 1.0 M NaOH solution.
   a) Calculate the pH of this buffer solution.

   b) 0.10 L of 0.20 M HCl is added to 0.40 L of the buffer solution above. What is the pH of the resulting solution?

8. A 10.0 mL solution of 0.100 M NH_3 ($K_b = 1.8x10^{-5}$) is titrated with a 0.100 M HCl solution. Calculate the pH of this solution at equivalence point.

9. A 10.0-mL solution of 0.300 M NH_3 is titrated with a 0.100 M HCl solution. Calculate the pH after the following additions of the HCl solution: (a) 0.0 mL, (b) 10.0 mL, (c) 30.0 mL

10. A 45.0-mL sample of 0.200 M acetic acid is titrated with 0.180 M NaOH. Calculate the pH of the solution (a) before addition of NaOH, (b) after addition of 20.0 mL of NaOH and (c) at the equivalence point.

11. Calculate the molar solubility of AgBr ($K_{sp}= 5.0 \times 10^{-13}$) in 0.50 M NaBr solution.

12. A solution is made by mixing 10.0 mL of 0.10 M $Pb(NO_3)_2$ and 10.0 mL of 0.0010 M Na_2SO_4. Will a precipitate form? (Ksp for $PbSO_4 = 1.06 \times 10^{-8}$)

13. The solubility of iron (II) hydroxide, $Fe(OH)_2$, is 1.43×10^{-3} g/L.
    a) Calculate the Ksp for iron (II) hydroxide.

    b) Calculate pH of a saturated solution of iron (II) hydroxide.

    c) A 50.0 mL sample of 3.00×10^{-3} M $FeSO_4$ solution is added to 50.0 mL of 4.00×10^{-6} M NaOH solution. Does a precipitate form?

14. Lead iodate , $Pb(IO_3)_2$, is a slightly soluble salt with a Ksp of 2.6×10^{-13} at 25°C. To 35.0 mL of 0.150 $Pb(NO_3)_2$ solution is added 15.0 mL of 0.800 M KIO_3. A precipitate of $Pb(IO_3)_2$ results. What are the $[Pb^{2+}]$ and $[IO_3^-]$ in the final solution?

15. Consider a solution that is 0.010 M in Ba^{2+} and 0.020 M in Ca^{2+}. If sodium sulfate is added to this solution to selectively precipitate one of the cations, which will precipitate first? What is the minimum concentration of Na_2SO_4 that would trigger the precipitation of this cation?

16. What is the Cr^{3+} concentration when 0.010 mol of $Cr(NO_3)_3$ is dissolved in a liter of solution buffered at pH of 10.0. Cr^{3+} forms a complex ion with hydroxide shown below:

$$Cr^{3+}\,(aq) + 4\,OH^{-}\,(aq) \rightleftharpoons Cr(OH)_4^{-}\,(aq) \qquad K_f = 8 \times 10^{29}$$

17. A 0.10-mol sample of $AgNO_3$ is dissolved in 1.00 L of 1.00 M NH_3. If 0.010 mol of NaCl is added to this solution, will AgCl ($K_{sp} = 1.8 \times 10^{-10}$) precipitate? ($Ag^+$ and NH_3 form the complex ion $[Ag(NH_3)_2]^+$ with $K_f = 1.6 \times 10^7$)

18. $AgNO_3$ is added to a solution that is 0.10 M in NaCl and 0.010 M K_2CrO_4. Assume no dilution caused by the addition of $AgNO_3$. Given the Ksp values below:

Ksp for AgCl = 1.6×10^{-10}
Ksp for Ag_2CrO_4 = 9.0×10^{-12}

a) Which precipitates first, AgCl or Ag_2CrO_4? Calculate the $[Ag^+]$ when precipitation first begins.

b) What is the $[Cl^-]$ when Ag_2CrO_4 first begins to precipitate?

19. Blood is buffered by H_2CO_3/HCO_3^- system. Normal blood plasma is 0.024 M HCO_3^- and 0.0012 M H_2CO_3. pK_a for H_2CO_3 at body temperature is 6.1.

    a) What is pH of blood plasma?

    b) If the volume of blood in a normal adult is 5.0 L, what mass of HCl can be neutralized by the buffering system in blood before the pH falls below 7.0 (which would result in death)?

    c) For the same adult in (b), what mass of NaOH can be neutralized before the pH rises above 7.8?

20. An important buffer used in biochemical analysis is made by dissolving TRIS $[(HOCH_2)_3CNH_2]$ in dilute HCl. A biochemist prepares a buffer by dissolving an unknown amount of TRIS in 1L of 0.095 M HCl solution. The pH of the resulting buffer solution was measured to be 8.53. How many grams of TRIS was used in this buffer? Assume volume of solution did not change after addition of TRIS.
    (Molar mass of TRIS = 121.14 g/mol; pK_b of TRIS = 5.91)