Chapter 15 Questions

Section 15.1(a)

1) Using data from Appendix 5, calculate the pH for each of the following solutions:
a) 0.10 M NaCN
b) 0.080 M $NaHCO_3$
c) 0.12 M NH_4NO_3
d) 0.45 M CH_3NH_3Cl
e) 0.60 M KOCl
f) 0.005 M $C_5H_5NHNO_3$

2) 15.6 g of NH_4Cl is dissolved in enough water to make a 100 mL solution. What is the pH of the solution?

3) 23.5 g of NaF is dissolved in enough water to make a 250 mL solution. What is the pH of the solution?

Section 15.1(b)

4a) What is the common-ion effect?
b) How does a salt like NaOCl increase the pH when added to a solution of HOCl?

5) For each of the following weak acids or bases, give an example of a salt that can affect the pH of the solution via the common-ion effect:
a) NH_3
b) $HClO_2$
c) H_2CO_3
d) CH_3NH_2
e) C_6H_5NH
f) HF

6) Does the pH increase, decrease or remain the same on addition of each of the following:
a) $NaNO_2$ to a solution of HNO_2
b) $(CH_3NH_3)Cl$ to a solution of CH_3NH_2
c) sodium formate to a solution of formic acid
d) potassium bromide to a solution of hydrobromic acid
e) HCl to a solution of $NaC_2H_3O_2$
f) ammonia to a solution of hydrochloric acid

7) Calculate the pH of the following solutions:
a) 0.090 M sodium formate, $NaCHO_2$, mixed with 0.100 M formic acid, $HCHO_2$
b) 0.0750 M pyridine, C_5H_5N, and 0.0850 M pyridinium chloride, C_5H_5NHCl.
c) 1.2 M $HC_2H_3O_2$ in 0.5 M $KC_2H_3O_2$
d) 0.45 M NH_4Cl in 0.25 M NH_3

Section 15.2 & 15.3

7) Explain why a mixture of HCl and KCl does not function as a buffer, whereas a mixture of $HC_2H_3O_2$ and $NaC_2H_3O_2$ does.

8) What factors determine the pH and the buffer capacity of the solution?

9) How do buffers prevent pH change when small amount of
a) acid is added? What does the acid react with?
b) base is added? What does the base react with?

10a) Calculate the pH of a buffer that is 0.15 M in lactic acid and 0.10 M in sodium lactate.
b) What is the pH of a solution made of 0.95 M ammonium nitrate and 0.75 M ammonia?
c) What is the pH of a solution made of 0.010 M potassium nitrite and 0.0080 M nitrous acid.
d) Calculate the pH of a buffer formed by mixing equal amounts of 0.08 M lactic acid with 0.15 M sodium lactate.
e) What is the pH of a solution in which 15.0 grams of sodium benzoate is dissolved in 100 mL of 0.100 benzoic acid.

11) A buffer is prepared by adding 20.0 g of acetic acid, $HC_2H_3O_2$, and 20.0 g of sodium acetate, $NaC_2H_3O_2$, to enough water to form 2.00 L of solution,
a) Determine the pH of the buffer.
b) Write the equation for the reaction that occurs when a few drops of hydrochloric acid are added to the buffer.
c) Write the equation for the reaction that occurs when a few drops of sodium hydroxide are added to the buffer.

12) How many grams of sodium hypobromite, NaBrO, should be added to 1.00 L of 0.050 M hypobromous acid, HBrO, to form a buffer solution of pH 8.80? Assume that no volume change occurs when the NaBrO is added.

13) A buffer is prepared by mixing 10.0 g of CH_3NH_3Cl in a 100 mL solution of CH_3NH_2 ($K_b = 4.4 \times 10^{-4}$). The pH is measured to be 10.2 for the mixture. What was the concentration for the base solution?

Section 15.4(a)

14) How many milliliters of 0.0850 M NaOH are required to titrate each of the following acid solutions to the equivalence point?
a) 40.0 mL of 0.0900 M HNO_3
b) 35.0 mL of 0.0720 M HBr
c) 50.0 mL of a solution that contains 1.85 g of HCl per liter
d) 15.0 mL of 0.120 M H_2SO_4

15) How many milliliters of 0.750 M $HClO_4$ are required to titrate each of the following acid solutions to the equivalence point?
a) 30.0 mL of 0.850 M NaOH
b) 15.0 mL of 0.270 M RbOH
c) 40.0 mL of a solution that contains 1.85 g of LiOH per liter
d) 200 mL of 1.00 M $Ca(OH)_2$

16) A 50.0 mL sample 0.150 M KOH is titrated to the equivalence point with 0.100 M HBr.
a) What volume of HBr was used to reach the equivalence point?
b) What is the pH at the equivalence point?

17) A 50.0 mL sample of 1.45 M HNO_3 is titrated to the equivalence point with 85.0 mL of LiOH.
a) What is the molarity of the LiOH
b) What is the pH at the equivalence point?

18) A 50.0 mL sample of 0.300 M HCl is titrated with 0.500 M NaOH. Determine the pH of the solution after the following volumes of base have been added:
a) 0.0 mL
b) 29.0 mL
c) 30.0 mL
d) 31.0 mL

19) A 100.0 mL sample of 0.040 M KOH is titrated with 0.160 M HBr. Determine the pH of the solution after the following volumes of base have been added:
a) 0.0 mL
b) 24.0 mL
c) 25.0 mL
d) 30.0 mL

Section 15.4(b)

20) How does titration of a strong acid with a strong base differ from a titration of a weak acid with a strong base with respect to the following? (assume equal concentrations of acids)
a) pH at the beginning of the titration
b) quantity of base required to reach the equivalence point
c) pH at the equivalence point
d) pH after the equivalence point (excess base)
e) choice of indicator for determining the equivalence point

21) At the equivalence point, the pH of a weak acid/strong base titration is above 7. Explain which component in the solution causes the pH to be above 7 even though the amount of acid and base are equal.

22) How many mL of 0.74 M LiOH will needed to reach the equivalence point for each of the following acids?
a) 250 mL of 0.88 M HClO
b) 19.6 mL of 1.23 M HCN
c) 104 mL of 0.054 M $HBrO_3$

23) A 20.0 mL sample of 0.200 M HF is titrated with 0.400 M NaOH. Determine the pH of the solution after the following volumes of base have been added:
a) 0.0 mL
b) 9.5 mL
c) 10.0 mL
d) 10.5 mL

24) A 15.0 mL sample of 0.200 M HNO_2 is titrated with 0.100 M LiOH. Determine the pH of the solution after the following volumes of base have been added:
a) 0.0 mL
b) 30.0 mL

25) A 10.0 mL sample of 0.200 M HNO_2 is titrated with 0.100 M LiOH. Determine the volume of LiOH needed to reach the equivalence point. Then, determine the pH at the equivalence point.

26) Calculate the pH at the equivalence point for titration of 25.0 ml the following acids with 0.400 M KOH: (Be careful – you need to know how much base you have to add!)
a) 0.400 M $HC_2H_3O_2$
b) 0.200 M HF
c) 0.050 M HOCl
d) 0.800 M $HClO_2$

Section 15.4(c)

27) Assume that 30.0 mL of a 0.10 M solution of a weak base B is titrated with a 0.10 M solution of the monoprotic strong acid HX.
a) How many moles of HX have been added at the equivalence point?
b) At the equivalence point, in what form does the weak base exist as?
c) What factor(s) determine the pH at the equivalence point?
d) Which indicator, phenolphthalein or methyl red, would be a better choice for this titration?

28) At the equivalence point, the pH of a weak base/strong acid titration is below 7. Explain why this happens.

29) Consider the titration of 30.0 mL of 0.100 M NH_3 with 0.150 M HCl. Calculate the pH after the following volumes of titrant have been added:
a) 0 mL
b) 20.0 mL
c) 30.0 mL

30) A 10.0 mL sample of 0.300 M $C_2H_5NH_2$ is titrated with 0.600 M HCl. Determine the pH of the solution after the following volumes of base have been added:
a) 0.0 mL
b) 4.5 mL
c) 5.0 mL
d) 6 mL

31) A 40.0 mL sample of 0.300 M $HOHN_2$ is titrated with 0.100 M $HClO_4$. Determine the volume of $HClO_4$ needed to reach the equivalence point. Then, determine the pH at the equivalence point.

32) Calculate the pH at the equivalence point for titration of 30.0 ml the following bases with 0.200 M HBr:
a) 0.200 M $HONH_2$
b) 0.100 M $C_6H_5NH_2$
c) 0.150 M NH_3
d) 0.600 M H_2NNH_2

Review

1) Write net ionic equations for each of the following reactions:
a) magnesium is ignited in air
b) a small piece of calcium is placed in an aqueous solution of copper chloride.
c) a solution of calcium iodide is mixed with lead (II) nitrate
d) electrolysis is performed on a sample of sodium chloride

2) Determine the volume of gas produced by the reaction of 3.00 g of Mg in excess phosphoric acid in a room at 735 torr and 23.0 ^{O}C.

3) 200 mL of A 0.45 M solution of nitric acid is needed for a particular lab. If the stock solution of the nitric acid is 14.8 M, describe how you would make the solution,

4) Hypochlorous acid has a K_a of 3.0×10^{-8}. A 1.5 M solution of the acid is made.
a) Determine the conjugate base for hypochlorous acid.
b) Determine the K_b for the conjugate base
c) Determine the pH of the acid solution

5) The Kc for the reaction

$$H_2\ (g) + I_2\ (g) \text{ <==> } 2\ HI\ (g)$$

is 51. If 0.30 mol of each reactant are placed in a 2.0 L flask, what will be the concentration of each material at equilibrium?

6) Determine the oxidation state of phosphorous in the following materials.
a) P_4
b) $Ca_3(PO_3)_2$
c) NaH_2PO_4
d) P_3O_8