Chem 1110 Mole Concept, Back-titration, and Stoichiometry problems

1. A 0.984 g impure sample of MgO was completely dissolved in 40.0 mL of 0.600 M H_2SO_4. The excess acid was back-titrated with 25.0 mL of 0.320 M NaOH. Calculate the percent purity of the MgO sample. **[81.9 %]**

2. A sample of $BaCO_3$ (MM=197.3) has 25.00 mL of 0.2120 M HCl added to it. A back-titration of the excess HCl required 22.48 mL of 0.1082 M NaOH. Determine the mass of $BaCO_3$. **(0.283 g)**

3. In an analysis of $M_2CO_3 \cdot 3H_2O$, 40.00 mL of 0.8450 M HCl was added to 5.00 g of the sample. A total of 51.14 mL of 0.1460 M KOH was required to neutralize the excess acid. Calculate the molar mass of the hydrate and identify M. **(379 g/mol, $Cs_2CO_3 \cdot 3H_2O$)**

4. A sample of a sulphide of a metal M (formula M_aS_b) is analyzed. The sulphur in the sample is recovered as 120 mL of 0.250 M Na_2S solution. The metal in the sample is recovered as 40.0 mL of 0.500 M solution of the metal. If the molar mass of the metal sulphide is 150 grams, determine the formula of the sulphide and identify the metal. **(Al_2S_3)**

5. A sample of solid sodium sulphite ($Na_2SO_3 \cdot XH_2O$) of mass 0.4322 g was dissolved in water and oxidized to sodium sulphate by adding exactly 0.8000 g of I_2.

   $I_2(aq) + SO_3^{-2}(aq) + H_2O(l) \longrightarrow 2I^-(aq) + SO_4^{-2}(aq) + 2H^+(aq)$

   The resulting solution was then neutralized by the addition of exactly 40.00 mL of 0.100 M NaOH. Calculate the value of X. **(5)**

6. Calculate the molarity of the solution prepared by dissolving 5.623 g of NaOH in enough water to make 250.0 mL of solution. **(0.5623 M)**

7. Calculate the molarity of NaOH if 10.00 mL of the solution from question 6 is added to 50.00 mL of water. **(0.1125 M)**

8. How many grams of $NH_4C_2H_3O_2$ are needed to make 750.0 mL of 0.225 M $NH_4C_2H_3O_2$ solution? **(13.0 g)**

9. What is the molarity of the solution formed by mixing 25.0 mL of 0.375 M NaCl solution with 42.0 mL of 0.632 M NaCl solution? **(0.5360 M)**

10. How many millilitres of 0.0487 M $Ba(OH)_2$ are needed to react with 35.67 mL of 0.0748 M HCl? **(27.40 mL)**

11. A 10.00 mL sample of vinegar, an aqueous solution of acetic acid ($HC_2H_3O_2$) is titrated with 0.5062 M NaOH. 16.55 mL of NaOH is required to reach the end point. If the density of vinegar is 1.006 g/mL, what is the mass percent of acetic acid in the vinegar? **(5.00 %)**

12. By titration 24.68 mL of 0.1017 M NaOH is required to neutralize 0.1506 g of an unknown organic acid. What is the formula of the acid assuming that the acid is monoprotic, that is, that the formula is $HC_nH_mO_p$? **($HC_2H_3O_2$)**

13. A 0.2726 g sample of metal was dissolved in 50.00 mL of 0.500 M HCl. After all the metal had dissolved, the leftover acid was titrated with 0.1054 M NaOH. If 24.36 mL of 0.1054 M NaOH were required to neutralize the leftover acid, what was the atomic mass of the metal? The metal dissolved to form M^{+2} ions in solution. **(24.3 g)**

14. A piece of marble (assume it to be $CaCO_3$) reacts with 2.00 L of 2.52 M HCl. After dissolution of the marble, a 10.00 mL sample of the remaining HCl(aq) is withdrawn and titrated with 24.87 mL of 0.9987 M NaOH. What must have been the mass of the piece of marble? **(3.66 g)**

15. An iron ore sample weighing 0.8765 g is dissolved in HCl(aq) and iron is obtained as Fe^{+2}. This solution is then titrated with 29.43 mL of 0.04212 M $K_2Cr_2O_7$(aq). What is the % Fe by mass in the ore sample? **(47.39 %)**

$$6FeCl2(aq) + 14HCl(aq) + K2Cr2O7(aq) \longrightarrow 6FeCl3(aq) + 2KCl(aq) + 2CrCl3(aq) + 7H2O(l)$$

16. An alloy of copper and silver weighing 0.5000 grams is dissolved in HNO_3 and treated with H_2S to precipitate both CuS and Ag_2S. It is found that the solid sulphides weigh 0.7300 grams. Calculate the percentage of Ag in the alloy. **(12.9 %)**

$$2Ag^+(aq) + H_2S(aq) \longrightarrow Ag_2S(s) + 2H^+(aq)$$
$$Cu^{+2}(aq) + H_2S(aq) \longrightarrow CuS(s) + 2H^+(aq)$$

17. A mixture of aluminum and zinc weighing 1.67 g was completely dissolved in acid to give 1.69 L of hydrogen gas measured at STP. (1 mol of gas = 22.4 L at STP) What is the weight of aluminum in the original mixture? The equations are:

$$2Al(s) + 6H^+(aq) \longrightarrow 3H_2(g) + 2Al^{+3}(aq)$$
$$Zn(s) + 2H^+(aq) \longrightarrow H_2(g) + Zn^{+2}(aq)$$

(1.24 g)

18. A mixture of rubidium chloride, RbCl, and sodium chloride, NaCl, that weighed 0.2380 g, was dissolved in water. Enough silver nitrate, $AgNO_3(aq)$, was then added to the solution to precipitate all the chloride ions as silver chloride, AgCl. After filtering and drying the silver chloride was found to weigh 0.4302 g. Calculate the percentage of RbCl in the original mixture. The equations are:

$$RbCl(aq) + AgNO_3(aq) \longrightarrow RbNO_3(aq) + AgCl(s)$$
$$NaCl(aq) + AgNO_3(aq) \longrightarrow NaNO_3(aq) + AgCl(s)$$

(50.92 %)

19. A mixture of NaI and KI weighing 3.9762 g was dissolved in water and treated with $Ag^+(aq)$. All of the iodide in the mixture was recovered as 5.8622 g of AgI(s). What was the percentage by weight of KI in the original sample? **(60.31 %)**

20. A 9.90 g sample of a mixture of $CaCO_3(s)$ and $NaHCO_3(s)$ is heated and the compounds decompose. The decomposition of the sample yielded 2.70 g of CO_2 and 0.990 g of H_2O. What percentage of the original mixture is $CaCO_3$?

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$
$$2NaHCO_3(s) \longrightarrow H_2O(g) + CO_2(g) + Na_2CO_3(s)$$

(6.70 %)

21. A mixture of Na_2O and BaO that weighs 6.00 g is dissolved in water, and the solution is then treated with dil. H_2SO_4. Barium sulphate, $BaSO_4$, precipitates from the solution, but sodium sulphate, Na_2SO_4, is soluble and remains in solution. The $BaSO_4$ is collected by filtration and is dried and found to weigh 6.00 g. What percent of the original sample is BaO? **(65.7 %)**