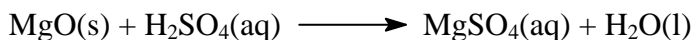


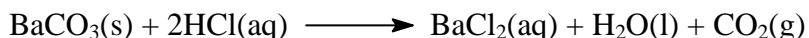
## Mole Concept, Back-titration, and Stoichiometry problems

*You should be able to do these problems without a calculator.*

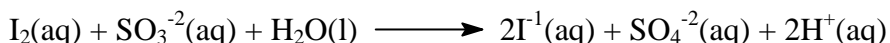
- 1) A 2.00 g impure sample of MgO (molar mass 40.3 grams) was completely dissolved in 50.0 mL of 1.000 M H<sub>2</sub>SO<sub>4</sub>. The excess acid was back-titrated with 25.0 mL of 0.800 M NaOH. Calculate the percent purity of the MgO sample. **[80.6 %]**



- 2) A sample of BaCO<sub>3</sub> (MM=197.3 g) has 20.00 mL of 0.250 M HCl added to it. A back-titration of the excess HCl required 20.00 mL of 0.1500 M NaOH. Determine the mass of the original sample of BaCO<sub>3</sub>. **[0.1973 g]**



- 3) In an analysis of M<sub>2</sub>CO<sub>3</sub>·3H<sub>2</sub>O, 40.00 mL of 2.000 M HCl was added to 7.597 g of the sample. A total of 40.00 mL of 1.000 M KOH was required to neutralize the excess acid. Calculate the molar mass of the hydrate and identify M. **[379.9 g/mol, metal is Cs]**
- 4) A sample of a sulphide of a metal M (formula M<sub>a</sub>S<sub>b</sub>) is analyzed. The sulphur in the sample is recovered as 120 mL of 0.250 M Na<sub>2</sub>S 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<sub>2</sub>S<sub>3</sub>]**
- 5) A sample of solid sodium sulphite (Na<sub>2</sub>SO<sub>3</sub>·XH<sub>2</sub>O) of mass 0.4322 g was dissolved in water and oxidized to sodium sulphate by adding exactly 0.8000 g of I<sub>2</sub>.

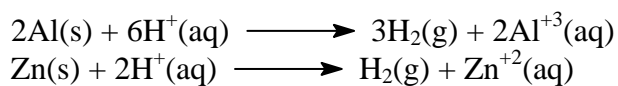


The resulting solution was then neutralized by the addition of exactly 40.00 mL of 0.100 M NaOH. Calculate the value of X. **[5]**

- 6) Calculate the molarity of the solution prepared by dissolving 6.00 g of NaOH in enough water to make 250.0 mL of solution. **[0.600 M]**
- 7) Calculate the molarity of NaOH if 10.00 mL of the solution from the previous question is diluted to a total volume of 60.00 mL. **[0.100 M]**
- 8) How many grams of NH<sub>4</sub>C<sub>2</sub>H<sub>3</sub>O<sub>2</sub> (molar mass 77.0 grams) are needed to make 750.0 mL of 0.666 M NH<sub>4</sub>C<sub>2</sub>H<sub>3</sub>O<sub>2</sub> solution? **[38.5 g]**
- 9) What is the molarity of the solution formed by mixing 25.0 mL of 0.500 M NaCl solution with 75.0 mL of 0.666 M NaCl solution? **[0.625 M]**

- 10) How many millilitres of 0.0500 M Ba(OH)<sub>2</sub> are needed to react with 40.00 mL of 0.0750 M HCl? **[30.00 mL]**
- 11) A 10.00 mL sample of vinegar, an aqueous solution of acetic acid (HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>, molar mass 60.0 grams) is titrated with 0.500 M NaOH. 15.00 mL of NaOH is required to reach the end point. If the density of vinegar is 1.00 g/mL, what is the mass percent of acetic acid in the vinegar? **[4.50 %]**
- 12) By titration 25.00 mL of 0.100 M NaOH is required to neutralize 0.1500 g of an unknown organic acid. What is the molar mass of the acid? You may assume that the acid is monoprotic. **[60.0 g]**
- 13) A 0.4861 g sample of metal was dissolved in 50.00 mL of 1.000 M HCl. After all the metal had dissolved, the leftover acid was titrated with 0.4000 M NaOH. If 25.00 mL of 0.4000 M NaOH were required to neutralize the leftover acid, what was the molar mass of the metal? The metal dissolved to form M<sup>+2</sup> ions in solution. **[24.3 g]**
- 14) A piece of CaCO<sub>3</sub> (molar mass 100. grams) reacts with 2.00 L of 2.50 M HCl. After dissolution of the CaCO<sub>3</sub>, a 25.00 mL sample of the remaining HCl(aq) is withdrawn and titrated with 12.50 mL of 1.000 M NaOH. What must have been the mass of the piece of CaCO<sub>3</sub>? **[200 g]**
- 15) An iron ore sample weighing 558.5 mg is dissolved in HCl(aq) and iron is obtained as Fe<sup>+2</sup>. This solution is then titrated with 25.00 mL of 0.02000 M K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>(aq). What is the % Fe by mass in the ore sample? **[30.00]**
- $$6\text{Fe}^{+2}(\text{aq}) + 14\text{H}^{+}(\text{aq}) + \text{Cr}_2\text{O}_7^{-2}(\text{aq}) \longrightarrow 6\text{Fe}^{+3}(\text{aq}) + 2\text{Cr}^{+3}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$$
- 16) A 10.00 gram sample of a mixture of CaCO<sub>3</sub>(s) (molar mass 100. grams) and KHCO<sub>3</sub>(s) (molar mass 100. grams) was heated and the two compounds decomposed. The decomposition yielded 90 mmol of CO<sub>2</sub> and 10 mmol of H<sub>2</sub>O. What percentage of the original mixture was CaCO<sub>3</sub>? **[80.0]**
- $$\begin{aligned} \text{CaCO}_3(\text{s}) &\longrightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \\ 2\text{KHCO}_3(\text{s}) &\longrightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g}) + \text{K}_2\text{CO}_3(\text{s}) \end{aligned}$$
- 17) A mixture of Na<sub>2</sub>O (molar mass 62.0 grams) and BaO (molar mass 153.3 grams) that has a mass of 5.00 g is treated with dilute H<sub>2</sub>SO<sub>4</sub>. Barium sulphate, BaSO<sub>4</sub>, precipitates from the solution, but sodium sulphate, Na<sub>2</sub>SO<sub>4</sub>, is soluble and remains in solution. The BaSO<sub>4</sub> (molar mass 233.3 grams) is collected by filtration and is dried and found to weigh 4.667 g. What percent of the original sample is BaO? **[61.3]**

18) A mixture of aluminum and zinc containing a total of 150 mmol of the two metals was completely dissolved in acid to give 3.92 L of hydrogen gas measured at STP. (1 mol of gas = 22.4 L at STP) What was the mole fraction of aluminum in the original mixture? **[1/3]**



19) A mixture of 10.00 mL of  $\text{H}_2\text{SO}_4$  and 30.00 mL of  $\text{HCl}$  required 20.00 mL of 2.500 M  $\text{NaOH}$  for complete reaction. When 30.00 mL of  $\text{H}_2\text{SO}_4$  and 10.00 mL of  $\text{HCl}$  were used, 28.00 mL of 2.500 M  $\text{NaOH}$  were required. What were the concentrations of the acids?  
**[Both were 1.000 M]**

