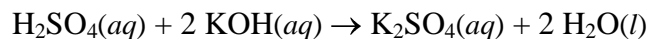


## Chapter 14

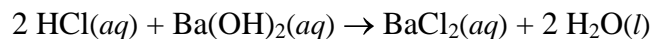
### End-of-Chapter Questions

1. Dilute sulfuric acid reacts with potassium hydroxide solution in a neutralization (double replacement) reaction to give a solution of potassium sulfate:



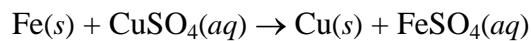
If 14.73 mL of  $0.2000 \text{ mol}\cdot\text{L}^{-1}$  sulfuric acid are needed to neutralize 25.00 mL of potassium hydroxide solution, what is the concentration of the potassium hydroxide solution?

2. Dilute hydrochloric acid reacts with barium hydroxide solution in a neutralization (double replacement) reaction to give a solution of barium chloride:



If 32.16 mL of hydrochloric acid are needed to neutralize 25.00 mL of a  $0.1000 \text{ mol}\cdot\text{L}^{-1}$  barium hydroxide solution, what is the concentration of the hydrochloric acid?

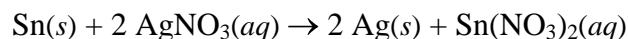
3. Copper(II) sulfate solution reacts with iron metal in a single replacement reaction to give copper metal and a solution of iron(II) sulfate:



If 0.279 g of iron metal are used:

- (a) What volume of  $0.200 \text{ mol}\cdot\text{L}^{-1}$  copper(II) sulfate is necessary for complete reaction of the iron metal?  
(b) What mass of copper metal is formed?

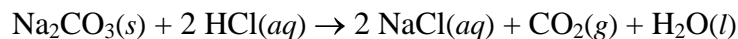
4. Silver nitrate solution reacts with tin metal in a single replacement reaction to give silver metal and tin(II) nitrate solution:



If 0.7845 g of tin are used:

- (a) What volume of  $0.1250 \text{ mol}\cdot\text{L}^{-1}$  silver nitrate solution is necessary for complete reaction with the tin metal?  
(b) What mass of silver metal is formed?

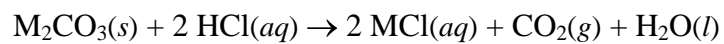
5. The reaction between hydrochloric acid and sodium carbonate produces a solution of sodium chloride, carbon dioxide gas, and water (one of the double replacement reactions producing a gas).



If 5.83 g of sodium carbonate is used:

- (a) What is the minimum volume of  $0.200 \text{ mol}\cdot\text{L}^{-1}$  hydrochloric acid needed for complete reaction?
- (b) What volume of carbon dioxide gas is produced at a temperature of  $19^\circ\text{C}$  and a pressure of  $98.7 \text{ kPa}$ ?
6. The white allotrope of phosphorus ( $\text{P}_4(\text{s})$ ) is produced industrially by reacting silicon dioxide (sand) and carbon (coke) with solid calcium phosphate at high temperature:
- $$2 \text{Ca}_3(\text{PO}_4)_2(\text{s}) + 6 \text{SiO}_2(\text{s}) + 5 \text{C}(\text{s}) \rightarrow \text{P}_4(\text{s}) + 6 \text{CaSiO}_3(\text{s}) + 5 \text{CO}_2(\text{g})$$
- To form  $1.00 \text{ kg}$  of white phosphorus:
- (a) What mass of calcium phosphate is required?
- (b) What volume of carbon dioxide is produced at a temperature of  $400^\circ\text{C}$  and a pressure of  $104.2 \text{ kPa}$ ?
7. A sample of an unidentified alkali metal carbonate,  $\text{M}_2\text{CO}_3$  (where M is the unknown metal ion), is received in an analytical chemistry laboratory. When  $0.1382 \text{ g}$  of the compound is dissolved in water and excess calcium chloride solution is added,  $0.1001 \text{ g}$  of calcium carbonate precipitates.
- (a) Write a balanced chemical equation for the reaction.
- (b) Calculate the molar mass of the unknown alkali metal carbonate,  $\text{M}_2\text{CO}_3$ .
- (c) Calculate the molar mass of the unknown metal, M.
- (d) Identify the unknown metal, M.
8. A sample of an unidentified alkali metal sulfate,  $\text{M}_2\text{SO}_4$  (where M is the unknown metal ion), is received in an analytical chemistry laboratory. When  $0.8715 \text{ g}$  of the compound is dissolved in water and excess barium chloride solution is added,  $1.1670 \text{ g}$  of barium sulfate precipitates.
- (a) Write a balanced chemical equation for the reaction.
- (b) Calculate the molar mass of the unknown alkali metal sulfate,  $\text{M}_2\text{SO}_4$ .
- (c) Calculate the molar mass of the unknown metal, M.
- (d) Identify the unknown metal, M.
9. Alkaline earth metal hydrides react with water to produce the metal hydroxide and hydrogen gas. In this example, an unidentified metal hydride,  $\text{MH}_2$ , is used:
- $$\text{MH}_2(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{M}(\text{OH})_2(\text{aq}) + 2 \text{H}_2(\text{g})$$
- If adding  $0.347 \text{ g}$  of  $\text{MH}_2$  to an excess of water results in the production of  $125 \text{ mL}$  of hydrogen gas at a temperature of  $25^\circ\text{C}$  and a pressure of  $98.7 \text{ kPa}$ :
- (a) Calculate the molar mass of the unknown alkaline earth metal hydride,  $\text{MH}_2$ .
- (b) Calculate the molar mass of the unknown alkaline earth metal, M.
- (c) Identify the unknown metal, M.

10. An unidentified metal carbonate,  $M_2CO_3$ , is reacted with an excess of dilute hydrochloric acid to give a solution of the metal chloride, carbon dioxide gas, and water:



If a 1.185 g sample of  $M_2CO_3$  was used and 225 mL of carbon dioxide gas was produced at a temperature of 25°C and a pressure of 94.4 kPa:

- Calculate the molar mass of the unknown metal carbonate,  $M_2CO_3$ .
- Calculate the molar mass of the unknown metal, M.
- Identify the unknown metal, M.