WKS
Solution Stoichiometry 2

Name Answer Key
Period _____

1. 34.57 mL of $HC_2H_3O_2$ (acetic acid) solution of unknown concentration is used to neutralize 25.19 mL of NaOH (sodium hydroxide) with concentration 0.4295 M according to the following balanced equation:

$$HC_2H_3O_2(aq) + NaOH(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l)$$

   a. How many moles of acetic acid are used?

$$?\ \text{mol}\ HC_2H_3O_2 = 25.19\ \cancel{\text{mL NaOH}} \times \underbrace{\frac{0.4295\ \cancel{\text{mol NaOH}}}{1000\ \cancel{\text{mL NaOH}}}}_{0.01082\ \text{mol NaOH}} \times \frac{1\ \text{mol}\ HC_2H_3O_2}{1\ \cancel{\text{mol NaOH}}} = \boxed{0.01082\ \text{mol}\ HC_2H_3O_2}$$

   b. What is the concentration of the acetic acid solution, in M?

$$M_{HC_2H_3O_2} = \frac{0.01082\ \text{mol}\ HC_2H_3O_2}{34.57\ \text{mL}} \times \frac{1\ \text{mL}}{1\times10^{-3}\ \text{L}} = \boxed{0.3130\ \text{M}\ HC_2H_3O_2}$$

2. When 321 mL of HCl (hydrochloric acid) solution of unknown concentration reacts with Na_2CO_3 (sodium carbonate), it forms NaCl (sodium chloride), water, and 11.1 g of CO_2 (carbon dioxide):

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g).$$

   a. How many moles of HCl are used in the reaction?

$$?\ \text{mol HCl} = 11.1\ \cancel{\text{g}\ CO_2} \times \underbrace{\frac{1\ \cancel{\text{mol}\ CO_2}}{44.01\ \cancel{\text{g}\ CO_2}}}_{0.252\ \text{mol}\ CO_2} \times \frac{2\ \text{mol HCl}}{1\ \cancel{\text{mol}\ CO_2}} = \boxed{0.504\ \text{mol HCl}}$$

   b. What was the concentration of the HCl solution, in M?

$$M_{HCl} = \frac{0.504\ \text{mol HCl}}{321\ \text{mL}} \times \frac{1\ \text{mL}}{1\times10^{-3}\ \text{L}} = \boxed{1.57\ \text{M HCl}}$$

3. Gravimetric analysis is a method of determining the concentration of a compound in solution by measuring the mass of a precipitate. In one experiment, 1.18 g AgCl precipitates when 25.0 mL of $AgNO_3$ solution reacts with excess NaCl solution in the following reaction:

$$\_1\_\ AgNO_3\ (aq) + \_1\_\ NaCl\ (aq) \rightarrow \_1\_\ NaNO_3\ (aq) + \_1\_\ AgCl\ (s)$$

   a. Balance the equation.
   b. How many moles of $AgNO_3$ were reacted?

$$\text{MM (AgCl)} = 107.87\ \text{g} + 35.45\ \text{g} = 143.3\ \text{g/mol}$$

$$?\ \text{mol}\ AgNO_3 = \underbrace{1.18\ \text{g AgCl} \times \frac{1\ \text{mol AgCl}}{143.3\ \text{g AgCl}}}_{8.23\times10^{-3}\ \text{mol AgCl}} \times \frac{1\ \text{mol}\ AgNO_3}{1\ \text{mol AgCl}} = \boxed{8.23\times10^{-3}\ \text{mol}\ AgNO_3}$$

   c. What is the concentration of $AgNO_3$ solution, in M?

$$M_{AgNO_3} = \frac{8.23\times10^{-3}\ \text{mol}\ AgNO_3}{25.0\ \text{mL}} \times \frac{1\ \text{mL}}{1\times10^{-3}\ \text{L}} = \boxed{0.329\ \text{M}}$$

4. For the double replacement reaction described here, 57.2 mL of potassium phosphate solution of unknown concentration is needed to completely react with 40.0 mL of 0.650 M of cobalt(II) nitrate to produce aqueous potassium nitrate and solid cobalt(II) phosphate.

   a. Write and balance the equation

$$2\ K_3PO_4\ (aq) + 3\ Co(NO_3)_2\ (aq) \rightarrow 6\ KNO_3\ (aq) + Co_3(PO_4)_2\ (s)$$

   b. Determine the number of moles of potassium phosphate used.

$$?\ mol\ K_3PO_4 = \underbrace{40.0\ mL\ Co(NO_3)_2 \times \frac{0.650\ mol\ Co(NO_3)_2}{1000\ mL\ Co(NO_3)_2}}_{0.0260\ mol\ Co(NO_3)_2} \times \frac{2\ mol\ K_3PO_4}{3\ mol\ Co(NO_3)_2} = \boxed{0.0173\ mol\ K_3PO_4}$$

   c. What is the concentration of the potassium phosphate solution, in M?

$$M_{K_3PO_4} = \frac{0.0173\ mol\ K_3PO_4}{57.2\ mL\ K_3PO_4} \times \frac{1\ mL}{1 \times 10^{-3}\ L} = \boxed{0.303\ M\ K_3PO_4}$$