Stoichiometry Workshop 2 - Solutions

Question 1:

73. a. $MgCl_2(aq) + 2\ AgNO_3(aq) \rightarrow 2\ AgCl(s) + Mg(NO_3)_2(aq)$

$$0.641 \text{ g AgCl} \times \frac{1 \text{ mol AgCl}}{143.4 \text{ g AgCl}} \times \frac{1 \text{ mol MgCl}_2}{2 \text{ mol AgCl}} \times \frac{95.21 \text{ g}}{\text{mol MgCl}_2} = 0.213 \text{ g MgCl}_2$$

$$\frac{0.213 \text{ g MgCl}_2}{1.50 \text{ g mixture}} \times 100 = 14.2\% \text{ MgCl}_2$$

b. $$0.213 \text{ g MgCl}_2 \times \frac{1 \text{ mol MgCl}_2}{95.21 \text{ g}} \times \frac{2 \text{ mol AgNO}_3}{\text{mol MgCl}_2} \times \frac{1 \text{ L}}{0.500 \text{ mol AgNO}_3} \times \frac{1000 \text{ mL}}{1 \text{ L}}$$

$$= 8.95 \text{ mL AgNO}_3$$

Question 2:

83. $$\text{Mol } C_6H_8O_7 = 0.250 \text{ g } C_6H_8O_7 \times \frac{1 \text{ mol } C_6H_8O_7}{192.1 \text{ g } C_6H_8O_7} = 1.30 \times 10^{-3} \text{ mol } C_6H_8O_7$$

Let H_xA represent citric acid, where x is the number of acidic hydrogens. The balanced neutralization reaction is:

$$H_xA(aq) + x\ OH^-(aq) \rightarrow x\ H_2O(l) + A^{x-}(aq)$$

$$\text{Mol OH}^- \text{ reacted} = 0.0372 \text{ L} \times \frac{0.105 \text{ mol OH}^-}{\text{L}} = 3.91 \times 10^{-3} \text{ mol OH}^-$$

$$x = \frac{\text{mol OH}^-}{\text{mol citric acid}} = \frac{3.91 \times 10^{-3} \text{ mol}}{1.30 \times 10^{-3} \text{ mol}} = 3.01$$

Therefore, the general acid formula for citric acid is H_3A, meaning that citric acid has three acidic hydrogens per citric acid molecule (citric acid is a triprotic acid).

Question 3: (Chapter 4 #71) Answer = 173 ml evaporated

71. $$\text{Mol CaCl}_2 \text{ present} = 0.230 \text{ L CaCl}_2 \times \frac{0.275 \text{ mol CaCl}_2}{\text{L CaCl}_2} = 6.33 \times 10^{-2} \text{ mol CaCl}_2$$

The volume of $CaCl_2$ solution after evaporation is:

$$6.33 \times 10^{-2} \text{ mol CaCl}_2 \times \frac{1 \text{ L CaCl}_2}{1.10 \text{ mol CaCl}_2} = 5.75 \times 10^{-2} \text{ L} = 57.5 \text{ mL CaCl}_2$$

Volume H_2O evaporated = 230. mL − 57.5 mL = 173 mL H_2O evaporated

Question 4: (Chapter 4 #69, with modifications) Answers: Part b = 49.4 ml; Part c = 2.5 M [Mg^{2+}]

69. $Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

$$3.00\text{ g Mg} \times \frac{1\text{ mol Mg}}{24.31\text{ g Mg}} \times \frac{2\text{ mol HCl}}{\text{mol Mg}} \times \frac{1\text{ L HCl}}{5.0\text{ mol HCl}} = 0.0494\text{ L} = 49.4\text{ mL HCl}$$

Question 5: (Chapter 4 #79) Answer = 2.00 M

79. $Cr(NO_3)_3(aq) + 3\ NaOH(aq) \rightarrow Cr(OH)_3(s) + 3\ NaNO_3(aq)$

$$\text{Mol NaOH used} = 2.06\text{ g } Cr(OH)_3 \times \frac{1\text{ mol } Cr(OH)_3}{103.02\text{ g}} \times \frac{3\text{ mol NaOH}}{\text{mol } Cr(OH)_3} = 6.00 \times 10^{-2}\text{ mol}$$

to form precipitate

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

$$\text{Mol NaOH used} = 0.1000\text{ L} \times \frac{0.400\text{ mol HCl}}{\text{L}} \times \frac{1\text{ mol NaOH}}{\text{mol HCl}} = 4.00 \times 10^{-2}\text{ mol}$$

to react with HCl

$$M_{NaOH} = \frac{\text{total mol NaOH}}{\text{volume}} = \frac{6.00 \times 10^{-2}\text{ mol} + 4.00 \times 10^{-2}\text{ mol}}{0.0500\text{ L}} = 2.00\ M\text{ NaOH}$$