Answers:

1. $2CH_3COOH + Mg(OH)_2 \rightarrow Mg(CH_3COO)_2 + 2H_2O$

$$n_A = 2n_B$$
$$C_AV_A = 2C_BV_B$$
$$C_A = \frac{2C_BV_B}{V_A}$$
$$C_A = \frac{2 \text{ x } 0.468 \ {}^{mol}\!/\!_{L} \text{ x } 67.0 \text{ mL}}{50.0 \text{ mL}}$$
$$C_A = 1.25 \text{ M } CH_3COOH$$

2. $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

$$2n_A = 2n_B$$
$$2C_AV_A = 2C_BV_B$$
$$C_A = \frac{2C_BV_B}{2V_A}$$
$$C_A = \frac{2 \text{ x } 0.560 \ {}^{mol}\!/\!_{L} \text{ x } 24.5 \text{ mL}}{2 \text{ x } 10.0 \text{ mL}}$$
$$C_A = 1.372 \text{ M } H_2SO_4$$

3. $H_3PO_4(aq) + 2NaOH(aq) \rightarrow Na_2HPO_4(aq) + H_2O(l)$

Note that "to achieve the second endpoint means that the first and second proton only have been removed from the acid. The third proton remains intact. When titrating any polyprotic substance the proton removal, etc. is always sequential. This means that the phosphoric acid is treated as diprotic in this case!

$$2n_A = n_B$$

$$2C_AV_A = C_BV_B$$

$$V_B = \frac{2C_AV_A}{C_B}$$

$$V_B = \frac{2 \times 0.075 \ {}^{mol}/_{L} \times 25.0 \text{ mL}}{0.060 \ {}^{mol}/_{L}}$$

$$V_B = 62.5 \text{ mL NaOH}$$

4. $H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

First determine the average volume of KOH required for titration of 20.0 mL aliquots.

$$V_T = \frac{V_1 + V_2 + V_3}{3}$$

$$V_T = \frac{23.0 \text{ mL} + 24.0 \text{ mL} + 23.5 \text{ mL}}{3}$$

$$V_T = 23.5 \text{ mL NaOH}$$

Then!!

$$2n_A = n_B$$

$$2C_AV_A = C_BV_B$$

$$C_A = \frac{C_BV_B}{2V_A}$$

$$C_A = \frac{0.100 \ {}^{mol}/_{L} \times 23.5 \text{ mL}}{2 \times 20.0 \text{ mL}}$$

$$C_A = 0.05875 \text{ M } H_2SO_4$$

5. $2H_3PO_4 + 3Ba(OH)_2 \rightarrow Ba_3(PO_4)_2 + 6H_2O$

$$3n_A = 2n_B$$
$$3C_AV_A = 2C_BV_B$$
$$C_A = \frac{2C_BV_B}{3V_A}$$
$$C_A = \frac{2 \times 0.560\ \text{mol}/\text{L} \times 76.00\ \text{mL}}{3 \times 25.0\ \text{mL}}$$
$$C_A = 1.135\ \text{M}\ \ H_3PO_4$$

6. $HC_6H_7O_6 + NaOH \rightarrow NaC_6H_7O_6 + H_2O$

$$n_A = n_B$$
$$n_A = C_BV_B$$
$$n_A = 0.200\ \text{mol}/\text{L} \times 0.046\ \text{L}$$
$$n_A = 0.00920\ \text{mol}\ \ HC_6H_7O_6$$

$$0.00920\ \text{mol}\ \ HC_6H_7O_6 \times \frac{176.13\ \text{g}\ HC_6H_7O_6}{1\ \text{mol}\ HC_6H_7O_6} = 1.62\ \text{g}\ HC_6H_7O_6$$

$$\%\ \text{purity} = \frac{\text{pure mass}}{\text{impure sample mass}} \times 100\ \%$$
$$\%\ \text{purity} = \frac{1.62\ \text{g}}{2.06\ \text{g}} \times 100\ \%$$
$$\%\ \text{purity} = 78.6\ \%$$

7. Cannot write a neutralization reaction for a multi-component problem!

$$2n_A^{H_2SO_4} + 3n_A^{H_3PO_4} = n_B^{NaHCO_3} + n_B^{NaOH} + 2n_B^{Ca(OH)_2}$$

$$2C_A^{H_2SO_4}V_A^{H_2SO_4} + 3C_A^{H_3PO_4}V_A^{H_3PO_4} = n_B^{NaHCO_3} + C_B^{NaOH}V_B^{NaOH} + 2n_B^{Ca(OH)_2}$$

$$n_B^{NaHCO_3} = \left[2C_A^{H_2SO_4}V_A^{H_2SO_4} + 3C_A^{H_3PO_4}V_A^{H_3PO_4}\right] - \left[C_B^{NaOH}V_B^{NaOH} + 2n_B^{Ca(OH)_2}\right]$$

$$n_B^{NaHCO_3} = 2C_A^{H_2SO_4}V_A^{H_2SO_4} + 3C_A^{H_3PO_4}V_A^{H_3PO_4} - C_B^{NaOH}V_B^{NaOH} - 2n_B^{Ca(OH)_2}$$

$$n_B^{NaHCO_3} = \left(2 \text{ x } 18.0 \text{ mol/L x } 0.025 \text{ L}\right) + \left(3 \text{ x } 14.8 \text{ mol/L x } 0.050 \text{ L}\right) - \left(6.0 \text{ mol/L x } 0.125 \text{ L}\right) - \left(2 \text{ x } 12.5 \text{ g } Ca(OH)_2 \text{ x } \frac{1 \text{ mol } Ca(OH)_2}{74.09 \text{ g } Ca(OH)_2}\right)$$

$$n_B^{NaHCO_3} = 2.033 \text{ mol } NaHCO_3$$

$$2.033 \text{ mol } NaHCO_3 \text{ x } \frac{84.01 \text{ g } NaHCO_3}{1 \text{ mol } NaHCO_3} = 171 \text{ g } NaHCO_3$$