

# Quantitative Solution Calculations

1. a)  $n = 3.2 \text{ mol}$   $C = \frac{n}{V}$   
 $C = ?$   
 $V = 800 \text{ mL} \rightarrow 0.800 \text{ L}$   $C = \frac{3.2 \text{ mol}}{0.800 \text{ L}}$   
 $C = 4.0 \text{ mol/L}$   
 $C = 4.0 \text{ M}$

b)  $n = 0.538 \text{ g} \times \frac{1 \text{ mol}}{212.27 \text{ g}} = 0.00253 \text{ mol}$   $C = \frac{n}{V}$   
 $C = ?$   $C = \frac{0.00253 \text{ mol}}{0.038 \text{ L}}$   
 $V = 38 \text{ mL} \rightarrow 0.038 \text{ L}$   $C = 0.0667 \text{ mol/L}$   
 $C = 0.0667 \text{ M}$

c)  $C_s = 5 \text{ mL}$   $C_D = \frac{C_s V_s}{V_D}$   
 $V_s = 6 \text{ M}$   
 $C_D =$   $C_D = \frac{5 \text{ mL} \times 6 \text{ M}}{1000 \text{ mL}}$   
 $V_D = 1 \text{ L} \rightarrow 1000 \text{ mL}$   $C_D = 0.03 \text{ M}$

2. a)  $n = 0.258 \text{ mol}$

$$V = \frac{n}{C}$$

$C = 0.1 \text{ mol/L}$

$$V = \frac{0.258 \text{ mol}}{0.1 \text{ mol/L}}$$

$V = ?$

$$V = 2.58 \text{ L}$$

b)  $n = 15.2 \text{ g} \times \frac{1 \text{ mol}}{383.00 \text{ g}} = 0.0397 \text{ mol}$

$$V = \frac{n}{C}$$

$C = 0.1 \text{ mol/L}$

$$V = \frac{0.0397 \text{ mol}}{0.1 \text{ mol/L}}$$

$V = ?$

$$V = 0.397 \text{ L}$$

$$V = 397 \text{ mL}$$

c)  $C_s = 1.5 \text{ M}$

$$V_D = \frac{C_s V_s}{C_D}$$

$V_s = 13.1 \text{ mL}$

$C_D = 0.1 \text{ M}$

$$V_D = \frac{1.5 \text{ M} \times 13.1 \text{ mL}}{0.1 \text{ M}}$$

$V_D =$

$$V_D = 197 \text{ mL}$$

$$V_D = 0.197 \text{ L}$$

3. a)

$$n = ?$$

$$C = 0.25 \text{ mol/L}$$

$$V = 450 \text{ mL} \rightarrow 0.450 \text{ L}$$

$$n = CV$$

$$n = 0.25 \text{ mol/L} \times 0.450 \text{ L}$$

$$n = 0.113 \text{ mol}$$

b)

$$n = ?$$

$$C = 3.5 \text{ mol/L}$$

$$V = 380 \text{ mL} \rightarrow 0.380 \text{ L}$$

$$n = CV$$

$$n = 3.5 \text{ mol/L} \times 0.380 \text{ L}$$

$$n = 1.33 \text{ mol}$$

$$1.33 \text{ mol} \times \frac{80.06 \text{ g}}{1 \text{ mol}} = 106.5 \text{ g } \text{NH}_4\text{NO}_3$$

c)

$$C_s = 6 \text{ M}$$

$$V_s = ?$$

$$C_d = 0.5 \text{ M}$$

$$V_d = 5.50 \text{ L}$$

$$V_s = \frac{C_d V_d}{C_s}$$

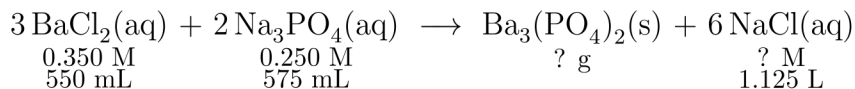
$$V_s = \frac{0.5 \text{ M} \times 5.50 \text{ L}}{6 \text{ M}}$$

$$V_s = 0.458 \text{ L}$$

$$V_s = 458 \text{ mL}$$

4. If 550 mL of 0.350 M barium chloride solution and 575 mL of 0.250 M sodium phosphate solution are mixed together, determine the following:

- the limiting reagent
- the name and the mass of the precipitate that forms
- the concentration of the remaining ionic solution (assume a total volume of 1.125 L)



Consider  $\text{BaCl}_2$  :

$$\begin{array}{ll}
 n = ? & n = CV \\
 C = 0.350 \text{ mol/L} & n = 0.350 \text{ mol/L} \times 0.550 \text{ L} \\
 V = 550 \text{ mL} \rightarrow 0.550 \text{ L} & n = 0.1925 \text{ mol BaCl}_2 \text{ available} \\
 & \text{LIMITING}
 \end{array}$$

$$0.1925 \text{ mol BaCl}_2 \times \frac{2 \text{ mol Na}_3\text{PO}_4}{3 \text{ mol BaCl}_2} = 0.1283 \text{ mol Na}_3\text{PO}_4 \text{ required}$$

Consider  $\text{Na}_3\text{PO}_4$  :

$$\begin{array}{ll}
 n = ? & n = CV \\
 C = 0.250 \text{ mol/L} & n = 0.250 \text{ mol/L} \times 0.575 \text{ L} \\
 V = 575 \text{ mL} \rightarrow 0.575 \text{ L} & n = 0.1438 \text{ mol Na}_3\text{PO}_4 \text{ available} \\
 & \text{EXCESS}
 \end{array}$$

$$0.1438 \text{ mol Na}_3\text{PO}_4 \times \frac{3 \text{ mol BaCl}_2}{2 \text{ mol Na}_3\text{PO}_4} = 0.2156 \text{ mol BaCl}_2 \text{ required}$$

therefore the limiting reagent is  $\text{BaCl}_2$

$$0.1925 \text{ mol BaCl}_2 \times \frac{1 \text{ mol Ba}_3(\text{PO}_4)_2}{3 \text{ mol BaCl}_2} \times \frac{601.93 \text{ g Ba}_3(\text{PO}_4)_2}{1 \text{ mol Ba}_3(\text{PO}_4)_2} = 38.6 \text{ g Ba}_3(\text{PO}_4)_2$$

$$0.1925 \text{ mol BaCl}_2 \times \frac{6 \text{ mol NaCl}}{3 \text{ mol BaCl}_2} = 0.3850 \text{ mol NaCl}$$

$$n = 0.3850 \text{ mol} \qquad C = \frac{n}{V}$$

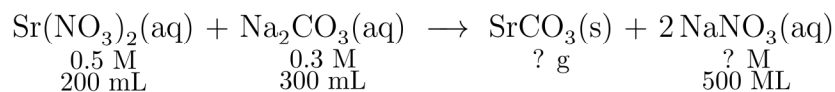
$$C = ?$$

$$V = 0.550 \text{ L} + 0.575 \text{ L} = 1.125 \text{ L}$$

$$C = \frac{0.3850 \text{ mol}}{1.125 \text{ L}}$$

$$C = 0.342 \text{ M NaCl}$$

5. Calculate the mass of precipitate and the concentration of sodium nitrate solution the forms when 200 mL of 0.5 M strontium nitrate solution and 300 mL of 0.3 M sodium carbonate solution are mixed together (assume a total volume of 500 mL)



Consider  $\text{Sr(NO}_3)_2$  :

$$\begin{array}{ll} n = ? & n = CV \\ C = 0.5 \text{ mol/L} & n = 0.5 \text{ mol/L} \times 0.200 \text{ L} \\ V = 200 \text{ mL} \rightarrow 0.200 \text{ L} & n = 0.100 \text{ mol Sr(NO}_3)_2 \text{ available} \\ & \text{EXCESS} \end{array}$$

$$0.100 \text{ mol Sr(NO}_3)_2 \times \frac{1 \text{ mol Na}_2\text{CO}_3}{1 \text{ mol Sr(NO}_3)_2} = 0.100 \text{ mol Na}_2\text{CO}_3 \text{ required}$$


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Consider  $\text{Na}_2\text{CO}_3$  :

$$\begin{array}{ll} n = ? & n = CV \\ C = 0.3 \text{ mol/L} & n = 0.3 \text{ mol/L} \times 0.300 \text{ L} \\ V = 300 \text{ mL} \rightarrow 0.300 \text{ L} & n = 0.0900 \text{ mol Na}_2\text{CO}_3 \text{ available} \\ & \text{LIMITING} \end{array}$$

$$0.0900 \text{ mol Na}_2\text{CO}_3 \times \frac{1 \text{ mol Sr(NO}_3)_2}{1 \text{ mol Na}_2\text{CO}_3} = 0.0900 \text{ mol Sr(NO}_3)_2 \text{ required}$$


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therefore the limiting reagent is  $\text{Na}_2\text{CO}_3$

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$$0.0900 \text{ mol Na}_2\text{CO}_3 \times \frac{1 \text{ mol SrCO}_3}{1 \text{ mol Na}_2\text{CO}_3} \times \frac{147.63 \text{ g SrCO}_3}{1 \text{ mol SrCO}_3} = 13.3 \text{ g SrCO}_3$$


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$$0.0900 \text{ mol Na}_2\text{CO}_3 \times \frac{2 \text{ mol NaNO}_3}{1 \text{ mol Na}_2\text{CO}_3} = 0.180 \text{ mol NaNO}_3$$

$$\begin{array}{ll} n = 0.1800 \text{ mol} & C = \frac{n}{V} \\ C = ? & \\ V = 0.200 \text{ L} + 0.300 \text{ L} = 0.500 \text{ L} & C = \frac{0.180 \text{ mol}}{0.500 \text{ L}} \\ & C = 0.360 \text{ M NaNO}_3 \end{array}$$


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