Quantitative Solution Calculations

1. a) $n = 3.2\ mol$

$C = ?$

$V = 800\ mL \rightarrow 0.800\ L$

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

$C = \frac{3.2\ mol}{0.800\ L}$

$C = 4.0\ mol/L$

$C = 4.0\ M$

b) $n = 0.538\ g \times \frac{1\ mol}{212.27\ g} = 0.00253\ mol$

$C = ?$

$V = 38\ mL \rightarrow 0.038\ L$

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

$C = \frac{0.00253\ mol}{0.038\ L}$

$C = 0.0667\ mol/L$

$C = 0.0667\ M$

c) $C_S = 5\ mL$

$V_S = 6\ M$

$C_D =$

$V_D = 1\ L \rightarrow 1000\ mL$

$C_D = \frac{C_S V_S}{V_D}$

$C_D = \frac{5\ mL \times 6\ M}{1000\ mL}$

$C_D = 0.03\ M$

2. a) $n = 0.258\ mol$

$C = 0.1\ mol/L$

$V = ?$

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

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

$V = 2.58\ L$

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

$C = 0.1\ mol/L$

$V = ?$

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

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

$V = 0.397\ L$

$V = 397\ mL$

c) $C_S = 1.5\ M$

$V_S = 13.1\ mL$

$C_D = 0.1\ M$

$V_D =$

$V_D = \frac{C_S V_S}{C_D}$

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

$V_D = 197\ mL$

$V_D = 0.197\ L$

3. a) $n = ?$

$C = 0.25\ mol/L$

$V = 450\ mL \rightarrow 0.450\ L$

$n = CV$

$n = 0.25\ mol/L \times 0.450\ L$

$n = 0.113\ mol$

b) $n = ?$

$C = 3.5\ mol/L$

$V = 380\ mL \rightarrow 0.380\ L$

$n = CV$

$n = 3.5\ mol/L \times 0.38\ L$

$n = 1.33\ mol$

$$1.33\ mol \times \frac{80.06\ g}{1\ mol} = 106.5\ g\ NH_4NO_3$$

c) $C_S = 6M$

$V_S = ?$

$C_D = 0.5M$

$V_D = 5.50\ L$

$$V_S = \frac{C_D V_D}{C_S}$$

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

$V_S = 0.458\ L$

$V_S = 458\ mL$

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

$$\underset{\substack{0.350\ \text{M}\\ 550\ \text{mL}}}{3\,BaCl_2(aq)} + \underset{\substack{0.250\ \text{M}\\ 575\ \text{mL}}}{2\,Na_3PO_4(aq)} \longrightarrow \underset{?\ \text{g}}{Ba_3(PO_4)_2(s)} + \underset{\substack{?\ \text{M}\\ 1.125\ \text{L}}}{6\,NaCl(aq)}$$

Consider $BaCl_2$:

$n = ?$
$C = 0.350\ \text{mol/L}$
$V = 550\ \text{mL} \rightarrow 0.550\ \text{L}$

$n = CV$
$n = 0.350\ \text{mol/L} \times 0.550\ \text{L}$
$n = 0.1925\ \text{mol}\ BaCl_2\ \text{avaiable}$
LIMITING

$$0.1925\ \text{mol}\ BaCl_2 \times \frac{2\ \text{mol}\ Na_3PO_4}{3\ \text{mol}\ BaCl_2} = 0.1283\ \text{mol}\ Na_3PO_4\ \text{required}$$

Consider Na_3PO_4 :

$n = ?$
$C = 0.250\ \text{mol/L}$
$V = 575\ \text{mL} \rightarrow 0.575\ \text{L}$

$n = CV$
$n = 0.250\ \text{mol/L} \times 0.575\ \text{L}$
$n = 0.1438\ \text{mol}\ Na_3PO_4\ \text{avaiable}$
EXCESS

$$0.1438\ \text{mol}\ Na_3PO_4 \times \frac{3\ \text{mol}\ BaCl_2}{2\ \text{mol}\ Na_3PO_4} = 0.2156\ \text{mol}\ BaCl_2\ \text{required}$$

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therefore the limiting reagent is $BaCl_2$

$$0.1925\ \text{mol}\ BaCl_2 \times \frac{1\ \text{mol}\ Ba_3(PO_4)_2}{3\ \text{mol}\ BaCl_2} \times \frac{601.93\ \text{g}\ Ba_3(PO_4)_2}{1\ \text{mol}\ Ba_3PO_4)_2} = 38.6\ \text{g}\ Ba_3(PO_4)_2$$

$$0.1925\ \text{mol}\ BaCl_2 \times \frac{6\ \text{mol NaCl}}{3\ \text{mol}\ BaCl_2} = 0.3850\ \text{mol NaCl}$$

$n = 0.3850\ \text{mol}$
$C = ?$
$V = 0.550\ \text{L} + 0.575\ \text{L} = 1.125\ \text{L}$

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

$$C = \frac{0..3850\ \text{mol}}{1.125\ \text{L}}$$

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

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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 togther (assume a total volume of 500 mL)

$$\underset{\substack{0.5\text{ M}\\200\text{ mL}}}{Sr(NO_3)_2(aq)} + \underset{\substack{0.3\text{ M}\\300\text{ mL}}}{Na_2CO_3(aq)} \longrightarrow \underset{\text{? g}}{SrCO_3(s)} + 2\,\underset{\substack{\text{? M}\\500\text{ ML}}}{NaNO_3(aq)}$$

Consider $Sr(NO_3)_2$:

$n = ?$
$C = 0.5$ mol/L
$V = 200$ mL $\rightarrow 0.200$ L

$n = CV$
$n = 0.5$ mol/L x 0.200 L
$n = 0.100$ mol $Sr(NO_3)_2$ avaiable
EXCESS

$$0.100 \text{ mol } Sr(NO_3)_2 \text{ x } \frac{1 \text{ mol } Na_2CO_3}{1 \text{ mol } Sr(NO_3)_2} = 0.100 \text{ mol } Na_2CO_3 \text{ required}$$

Consider Na_2CO_3 :

$n = ?$
$C = 0.3$ mol/L
$V = 300$ mL $\rightarrow 0.300$ L

$n = CV$
$n = 0.3$ mol/L x 0.300 L
$n = 0.0900$ mol Na_2CO_3 avaiable
LIMITING

$$0.0900 \text{ mol } Na_2CO_3 \text{ x } \frac{1 \text{ mol } Sr(NO_3)_2}{1 \text{ mol } Na_2CO_3} = 0.0900 \text{ mol } Sr(NO_3)_2 \text{ required}$$

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therefore the limiting reagent is Na_2CO_3

$$0.0900 \text{ mol } Na_2CO_3 \text{ x } \frac{1 \text{ mol } SrCO_3}{1 \text{ mol } Na_2CO_3} \text{ x } \frac{147.63 \text{ g } SrCO_3}{1 \text{ mol } SrCO_3} = 13.3 \text{ g } SrCO_3$$

$$0.0900 \text{ mol } Na_2CO_3 \text{ x } \frac{2 \text{ mol } NaNO_3}{1 \text{ mol } Na_2CO_3} = 0.180 \text{ mol } NaNO_3$$

$n = 0.1800$ mol
$C = ?$
$V = 0.200 \text{ L} + 0.300 \text{ L} = 0.500 \text{ L}$

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

$$C = \frac{0.180 \text{ mol}}{0.500 \text{ L}}$$

$$C = 0.360 \text{ M } NaNO_3$$
