Limiting Excess Reagent Problems – Answers

1. $2Fe(NO_3)_3 + 3Na_2S \rightarrow Fe_2S_3 + 6NaNO_3$
   50.0 g, 50.0 g

Consider from the point of view of iron(III) nitrate:

$$50.0\text{ g }Fe(NO_3)_3 \times \frac{1\text{ mol }Fe(NO_3)_3}{241.86\text{ g }Fe(NO_3)_3} \times \frac{1\text{ mol }Fe_2S_3}{2\text{ mol }Fe(NO_3)_3} \times \frac{207.89\text{ g }Fe_2S_3}{1\text{ mol }Fe_2S_3} = 21.5\text{ g }Fe_2S_3$$

Consider from the point of view of sodium sulphide:

$$50.0\text{ g }Na_2S \times \frac{1\text{ mol }Na_2S}{78.05\text{ g }Na_2S} \times \frac{1\text{ mol }Fe_2S_3}{3\text{ mol }Na_2S} \times \frac{207.89\text{ g }Fe_2S_3}{1\text{ mol }Fe_2S_3} = 44.4\text{ g }Fe_2S_3$$

therefore the maximum possible mass of Fe_2S_3 is 21.5 g

2. $N_2 + 3I_2 \rightarrow 2NI_3$
   0.5 mol, 500 g

Consider from the point of view of N_2:

$$0.5\text{ mol }N_2 \times \frac{2\text{ mol }NI_3}{1\text{ mol }N_2} \times \frac{394.72\text{ g }NI_3}{1\text{ mol}} = 394.72\text{ g }NI_3$$

Consider from the point of view of I_2:

$$500\text{ g }I_2 \times \frac{1\text{ mol }I_2}{253.81\text{ g }I_2} \times \frac{2\text{ mol }NI_3}{3\text{ mol }I_2} \times \frac{394.72\text{ g }NI_3}{1\text{ mol}} = 518.39\text{ g }NI_3$$

therefore the max possible mass of NI_3 is 394.72 g

3. $3Ca(NO_3)_2 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6NaNO_3$
   95.0 g, 70.0 g

Consider from the point of view of $Ca(NO_3)_2$

$$95.0\text{ g }Ca(NO_3)_2 \times \frac{1\text{ mol }Ca(NO_3)_2}{164.10\text{ g }Ca(NO_3)_2} \times \frac{1\text{ mol }Ca_3(PO_4)_2}{3\text{ mol }Ca(NO_3)_2} \times \frac{310.18\text{ g }Ca_3(PO_4)_2}{1\text{ mol }Ca_3(PO_4)_2} = 59.86\text{ g }Ca_3(PO_4)_2$$

Consider from the point of view of Na_3PO_4

$$70.0\text{ g }Na_3PO_4 \times \frac{1\text{ mol }Na_3PO_4}{163.94\text{ g }Na_3PO_4} \times \frac{1\text{ mol }Ca_3(PO_4)_2}{2\text{ mol }Na_3PO_4} \times \frac{310.18\text{ g }Ca_3(PO_4)_2}{1\text{ mol }Ca_3(PO_4)_2} = 66.2\text{ g }Ca_3(PO_4)_2$$

therefore the max possible mass of $Ca_3(PO_4)_2$ is 59.86 g

4. $2LiNO_3 + Na_2CO_3 \rightarrow Li_2CO_3 + 2NaNO_3$

60.0 g   60.0 g

$$60.0 \text{ g } LiNO_3 \times \frac{1 \text{ mol } LiNO_3}{68.95 \text{ g } LiNO_3} \times \frac{1 \text{ mol } Li_2CO_3}{2 \text{ mol } LiNO_3} \times \frac{73.89 \text{ g } Li_2CO_3}{1 \text{ mol } Li_2CO_3} = 32.1 \text{ g } Li_2CO_3$$

$$60.0 \text{ g } Na_2CO_3 \times \frac{1 \text{ mol } Na_2CO_3}{105.99 \text{ g } Na_2CO_3} \times \frac{1 \text{ mol } Li_2CO_3}{1 \text{ mol } Na_2CO_3} \times \frac{73.89 \text{ g } Li_2CO_3}{1 \text{ mol } Li_2CO_3} = 41.8 \text{ g } Li_2CO_3$$

therefore the maximum possible mass of Li_2CO_3 is 32.1 g

5. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

500 mL   400 mL   900 mL*

2.0 M   5.0 M

Consider the point of view of H_2SO_4:

n = ?
C = 2.0 M
V = 500 mL → 0.5 L

n = CV
$n = 2.0 \text{ mol/L} \times 0.5 \text{ L}$
$n = 1.0 \text{ mol } H_2SO_4$

$$1.0 \text{ mol } H_2SO_4 \times \frac{1 \text{ mol } Na_2SO_4}{1 \text{ mol } H_2SO_4} = 1.0 \text{ mol } Na_2SO_4$$

$n = 1.0 \text{ mol } Na_2SO_4$
C = ?
V = 900 mL → 0.9 L*
(500 mL + 400 mL)*

$C = \frac{n}{V}$
$C = \frac{1.0 \text{ mol}}{0.9 \text{ L}}$
$C = 1.1\dot{1}$ M

Consider the point of view of NaOH:

n = ?
C = 5.0 M
V = 400 mL → 0.4 L

n = CV
$n = 5.0 \text{ mol/L} \times 0.4 \text{ L}$
n = 2.0 mol NaOH

$$2.0 \text{ mol NaOH} \times \frac{1 \text{ mol } Na_2SO_4}{2 \text{ mol NaOH}} = 1.0 \text{ mol } Na_2SO_4$$

$n = 1.0 \text{ mol } Na_2SO_4$
C = ?
V = 900 mL → 0.9 L*
(500 mL + 400 mL)*

$C = \frac{n}{V}$
$C = \frac{1.0 \text{ mol}}{0.9 \text{ L}}$
$C = 1.1\dot{1}$ M

Therefore the maximum possible concentration of sodium sulphate would be 1.11 M. This mixture is an optimum mixture given equal answers!!