Limiting reagent question(two masses on reactants)

(f) Sodium reacts with sulphur to form sodium sulphide.

$$2Na + S \rightarrow Na_2S$$

An 11.5 g sample of sodium is reacted with 10 g of sulphur. All of the sodium reacted but there was an excess of sulphur.
Calculate the mass of sulphur left unreacted.

(i) Number of moles of sodium atoms reacted = ...
[2 moles of Na react with 1 mole of S]

(ii) Number of moles of sulphur atoms that reacted = ...

$2Na + S \rightarrow Na_2S$ Balance

2mol 1mol 1mol $\Rightarrow$ Ratio of moles on balanced chemical equation

mass Na = 11.5g

mass S = 10g

Determine the limiting reagent btn Na and S

$n = \frac{m}{MM_{Na}} = \frac{11.5g}{23g/mol} = 0.5$ moles of Na

$n = \frac{m}{MM_S} = \frac{10g}{32g/mol} = 0.3125$ moles of S

$R_{Na} = \frac{n}{\text{coefficient of Na}} = \frac{n}{2} = \frac{0.5 \text{ moles}}{2} = 0.25 \text{ moles}$

$R_S = \frac{n}{\text{coefficient of S}} = \frac{n}{1} = \underline{0.3125} \text{ mole} = 0.3125 \text{ mole}$

Determine R_{Na} and R_S of smaller value.

→ R_{Na} is the smallest = 0.25 mole, hence Na is the limiting reagent.

(i) number of Na reacted $(n) = \frac{m}{M} = \frac{11.5g}{23g/mol} = 0.5$ moles of Na

(ii) ~~no~~ number of mole of sulphur that reacted

Na	:	S
2 mol		1 mol
0.5 mol		x

$2x = 0.5 \Rightarrow x = \frac{0.5}{2}$

$= 0.25$ mole of S reacted

6 (a) The following method is used to make crystals of hydrated nickel sulphate.

An excess of nickel carbonate, 12.0 g, was added to 40 cm^3 of sulphuric acid, 2.0 mol/dm^3. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.

$$NiCO_3 + H_2SO_4 \longrightarrow NiSO_4 + CO_2 + H_2O$$

$$NiSO_4 + 7H_2O \longrightarrow NiSO_4.7H_2O$$

Mass of one mole of $NiSO_4.7H_2O$ = 281 g
Mass of one mole of $NiCO_3$ = 119 g

(i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H_2SO_4 in 40 cm^3 of 2.0 mol/dm^3 acid = 0.08

Number of moles of $NiCO_3$ reacted = ...

Mass of nickel carbonate reacted = ... g

Mass of unreacted nickel carbonate = ... g [3]

(ii) The experiment produced 10.4 g of hydrated nickel sulphate. Calculate the percentage yield.

The maximum number of moles of $NiSO_4.7H_2O$ that could be formed =

....

The maximum mass of $NiSO_4.7H_2O$ that could be formed = ... g

The percentage yield = ... % [3]

$M = \frac{\text{moles}}{\text{Volume}}$

$\text{moles of } H_2SO_4 = M \times \text{Volume}$ ← $40\,cm^3$

$= 2\,\text{Moles}/dm^3 \times \frac{40}{1000}\,dm^3$

$= 0.08\,\text{mol}$

$NiCO_3$	:	H_2SO_4
1 mol		1 mol
x		0.08 moles

$x = 0.08$ moles $NiCO_3$

$m = n \times MM = 0.08 \times 119\,g/mol = 9.52\,g\ NiCO_3$

$n = \frac{m}{MM} = \frac{12\,g}{119\,g/mol} = 0.100840336$ moles $NiCO_3$

Unreacted moles $= 12\,g - 9.52\,g = 2.48\,g$ of $NiCO_3$

$12g - 9.52g - \underline{2.48}\ g$

$NiSO_4 + 7H_2O \longrightarrow NiSO_4 \cdot 7H_2O$

$NiSO_4 : NiSO_4 \cdot 7H_2O$

1mol 1mol

0.08mol 0.08 moles

$m = n \times Mr = 0.08\ \text{moles} \times 281\ g/mol$

$= \underline{22.48g}\ NiSO_4 7 \cdot H_2O$

$\text{Percentage yield} = \frac{10.40}{22.480} \times 100 = \underline{46.3\%}$

Q. $K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$

You react 6.9g of K_2CO_3 with HCl

calculate the volume of CO_2 produced at rtp (room temperature and pressure)

1 mole = 24 dm^3 at rtp

$$K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$$

1mol 2mol 2mole 1mol 1mol

$$\text{mole}(K_2CO_3) \rightarrow \frac{m(K_2CO_3)}{M_r(K_2CO_3)} = \frac{6.9g}{39\times2 + 16\times3} = \frac{6.9g}{126\ g/mol} = 0.05\text{mole } K_2CO_3$$

K_2CO_3 : CO_2

1 mole   1 mole

0.05 moles   0.05 moles

1 mole $\rightarrow$ $24\ dm^3$ (volume CO_2)

0.05 mole $-$ x

$x = 0.05 \times 24 = 1.2\ dm^3 = 1.2 \times 1000 = 1200\ cm^3$

of CO_2

(c) The equation for the reaction between copper(II) chloride and silver nitrate is

$$CuCl_2(aq) + 2AgNO_3(aq) \rightarrow 2AgCl(s) + Cu(NO_3)_2(aq)$$

1mol 2mol 2mol 1mol

Balanced eqn
mole ratio

A student measures 25.0 cm³ of 0.500 mol/dm³ copper(II) chloride solution and reacts it with silver nitrate solution.

(i) Name a piece of apparatus suitable for measuring 25.0 cm³ of copper(II) chloride solution.

(1)

burette

....

(ii) Calculate the maximum mass, in grams, of silver chloride that could be produced.

[M_r of AgCl = 143.5]

(3)

$M = \frac{\text{moles}}{V}$

moles = $M \times V$ = 0.5 mol/dm³ × $\frac{25}{1000}$ dm³ = 0.0125 moles of $CuCl_2$

$CuCl_2$: AgCl

1 mol 2 moles

0.0125 moles x

$x \times 1 = 0.0125 \times 2 = 0.025$ moles AgCl

$$\text{moles} = \frac{\text{mass}}{M_r} = \frac{m}{M_r\ (M_r)}$$

$$m = \text{moles} \times M_r\ (M_r)$$

$$= 0.025 \text{ moles} \times 143.5 \text{ g/mol}$$

$$\text{mass} = 3.59\text{g} \quad \text{to } 3 \text{ s.f.}$$