

Relative Formula masses (M_r) and Atomic Masses (A_r)

1. What is the M_r of the following

a. MgO $24 + 16 = 40$

b. CO_2 $12 + 16 + 16 = 44$

c. $ZnCl_2$ $65 + 35.5 + 35.5 = 136$

d. $FeCl_3$ $56 + (35.5 \times 3) = 162.5$

e. Al_2O_3 $(27 \times 2) + (16 \times 3) = 102$

f. $Mg(NO_3)_2$ $24 + (14 \times 2) + (16 \times 6) = 148$

g. $Al_2(SO_4)_3$ $(27 \times 2) + (32 \times 3) + (16 \times 12) = 342$

h. HNO_3 $1 + 14 + (16 \times 3) = 63$

i. $CuCO_3$ $63.5 + 12 + (16 \times 3) = 123.5$

2. If a metal oxide has a M_r of 56 and a formula of XO , X being the unknown metal. What is X ?

$$\begin{aligned} XO &= 56 \\ O &= 16 \\ \therefore X &= 40 \\ X &= Ca \end{aligned}$$

3. If a metal chloride has a M_r of 80 and a formula of XCl_2 , X being the unknown metal. What is X ?

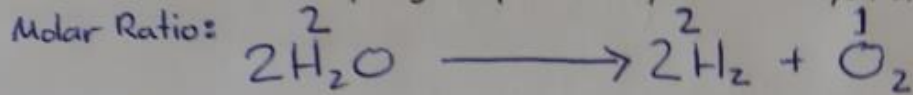
$$\begin{aligned} XCl_2 &= 80 \\ Cl_2 &= 71 \\ \therefore X &= 9 \\ X &= Be \end{aligned}$$

Calculating Reacting Masses of Products and Reactants

1. When water is electrolysed it breaks down into hydrogen and oxygen:



What mass of hydrogen is produced by the electrolysis of 6g of water?

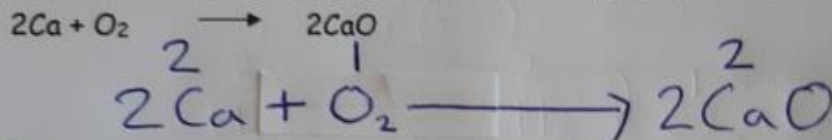


$$\frac{6\text{g}}{18} = 0.33\text{moles} \text{ -----} \rightarrow 0.33\text{moles}$$

$$0.33\text{moles} \times \text{Mr}$$

$$0.33\text{moles} \times 2 = 0.6\text{g}$$

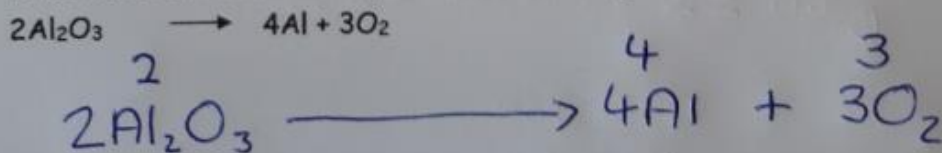
2. What mass of calcium oxide is produced when 10g of calcium burns?



$$\frac{10\text{g}}{40} = 0.25\text{moles} \text{ -----} \rightarrow 0.25\text{moles}$$

$$0.25 \times 56 = 14\text{g}$$

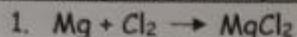
3. What mass of aluminium is produced from 100g of aluminium oxide?



$$\frac{100\text{g}}{102} = 0.98\text{moles} \text{ -----} \rightarrow 1.96\text{moles}$$

$$1.96 \times 27 = 52.92\text{g}$$

Maximum (Theoretical) Yield and percentage yield



a. What is the A_r of Mg? 24

b. What is the M_r of MgCl_2 ? 95

c. If 24g of Mg reacted what would the maximum mass of MgCl_2 be?

$24\text{g Mg} = 1\text{mole Mg}$

Molar ratio is 1:1

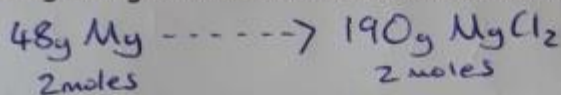
$\therefore 1\text{mole MgCl}_2 \text{ produced} = 95\text{g}$

If we only got 90g what is the percentage yield?

$$\% \text{ yield} = \frac{90}{95} \times 100 = 94.7\%$$

← Assuming no side reactions or loss of reactants or products

d. If 48g of Mg reacted what would the maximum mass of MgCl_2 be?



If we only got 120g what would the percentage yield be?

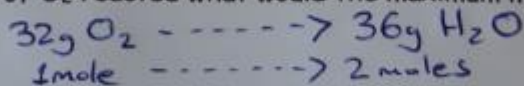
$$\% \text{ yield} = \frac{120}{190} \times 100 = 63.2\%$$



a. What is the M_r of O_2 ? 32

b. What is the M_r of H_2O ? 18

c. If 32g of O_2 reacted what would the maximum mass of H_2O be?



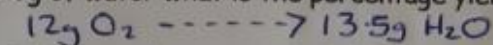
If we got 32g of water what is the percentage yield?

$$\% \text{ yield} = \frac{32}{36} \times 100 = 88.9\%$$

$\text{Percentage yield} = \frac{\text{actual yield}}{\text{predicted yield}} \times 100$

d. If 12g of O_2 reacted what would the maximum mass of H_2O be?

If we got 10g of water what is the percentage yield?



$$\% \text{ Yield} = \frac{10}{13.5} \times 100$$

$$= 74.1\%$$

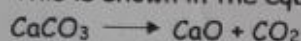
3. Why do we want a high percentage yield for a reaction?

So that we make as much product as we can from the mass of reactants that we started with.

Percentage Atom Economy

Percentage atom economy	=	$\frac{\text{Mr of desired product}}{\text{total Mr of all products}}$	$\times 100$
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1. Calcium oxide is made by the thermal decomposition of calcium carbonate
This is shown in the equation below:



a. What is the M_r of calcium carbonate ($CaCO_3$)?

100

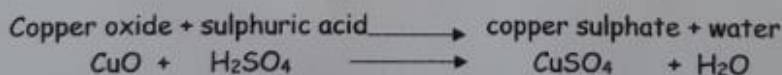
b. What is the M_r of calcium oxide (CaO)?

56

c. What is the percentage atom economy in this reaction?

$$\% \text{ Atom Economy} = \frac{56}{100} \times 100$$
$$= 56\%$$

2. Copper sulphate can be made in the following reaction



Calculate the percentage atom economy of the reaction

$$\% \text{ Atom Economy} = \frac{159.5}{177.5}$$
$$= 89.9\%$$

3. Why do we want a high atom economy in a reaction?

More of the mass of the reactant ends up in the useful product. This means less reactant is needed and less waste product is produced making the process more sustainable.