

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 ?

$$XO = 56$$

$$O = 16$$

$$X = Ca$$

$$\therefore X = 40$$

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 ?

$$XCl_2 = 80$$

$$Cl_2 = 71$$

$$X = Be$$

$$\therefore X = 9$$

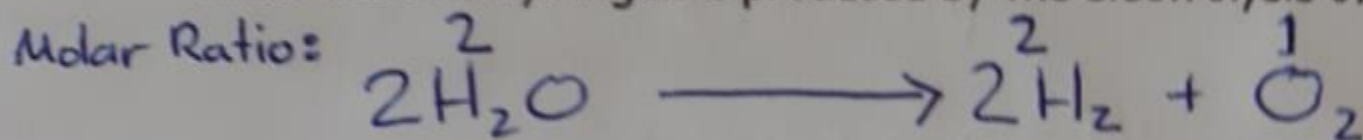


Calculating Reacting Masses of Products and Reactants

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?



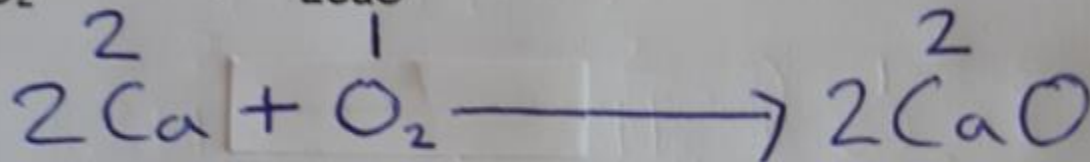
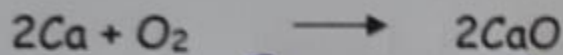
$$\frac{6\text{g}}{18} = 0.3\text{moles} \text{ -----} \rightarrow 0.3\text{moles}$$

$$0.3\text{moles} \times \text{Mr}$$

$$0.3\text{moles} \times 2 = 0.6\text{g}$$



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

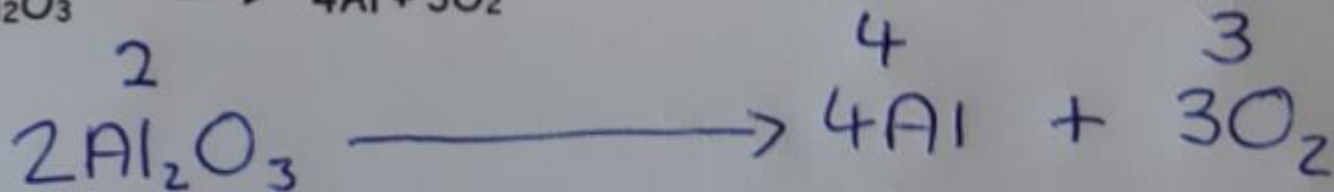


$$\frac{10\text{g}}{40} = 0.25\text{moles} \text{ -----} \rightarrow 0.25\text{moles}$$

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



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

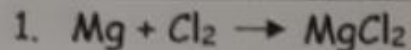


$$\frac{100\text{g}}{102} = 0.98\text{moles} \text{ ----- } \rightarrow 1.96\text{moles}$$

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



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

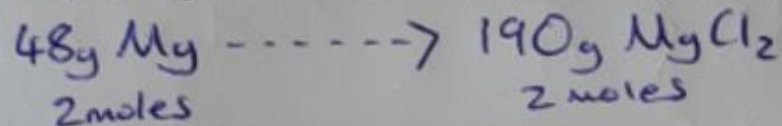
$$\therefore 1\text{mole MgCl}_2 \text{ produced} = 95\text{g}$$

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

$$\begin{aligned} \% \text{ Yield} &= \frac{90}{95} \times 100 \\ &= 94.7\% \end{aligned}$$

← 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?

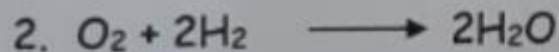


If we only got 120g what would the percentage yield be?

$$\begin{aligned} \% \text{ Yield} &= \frac{120}{190} \times 100 \\ &= 63.2\% \end{aligned}$$

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





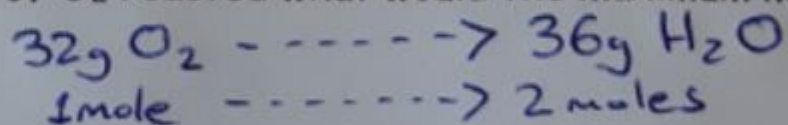
a. What is the M_r of O_2 ?

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?

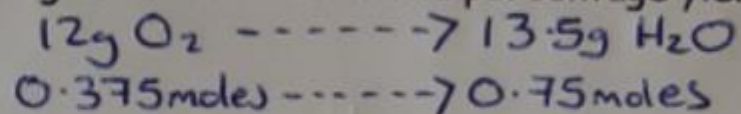


If we got 32g of water what is the percentage yield?

$$\begin{aligned} \% \text{ yield} &= \frac{32}{36} \times 100 \\ &= 88.9\% \end{aligned}$$

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?



$$\begin{aligned} \% \text{ Yield} &= \frac{10}{13.5} \times 100 \\ &= 74.1\% \end{aligned}$$

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

$$\text{Percentage atom economy} = \frac{\text{Mr of desired product}}{\text{total Mr of all products}} \times 100$$

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

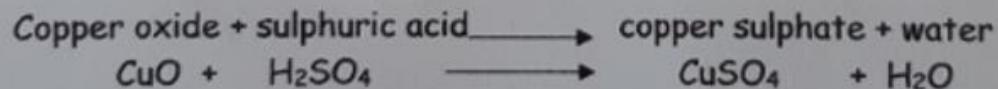
- b. What is the M_r of calcium oxide (CaO)?

56

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

$$\begin{aligned} \% \text{ Atom Economy} &= \frac{56}{100} \times 100 \\ &= 56\% \end{aligned}$$

2. Copper sulphate can be made in the following reaction



Calculate the percentage atom economy of the reaction

$$\begin{aligned} \% \text{ Atom Economy} &= \frac{159.5}{177.5} \\ &= 89.9\% \end{aligned}$$

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.