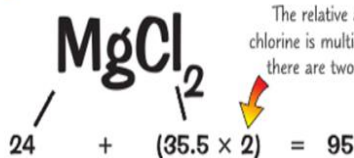


## Relative Formula Mass, $M_r$ — Also Easy Peasy

If you have a compound like  $MgCl_2$  then it has a **relative formula mass**,  $M_r$ , which is just all the relative atomic masses **added together**.

For  $MgCl_2$  it would be:



The relative atomic mass of chlorine is multiplied by 2 because there are two chlorine atoms.

So  $M_r$  for  $MgCl_2$  is simply **95**.

You can easily get  $A_r$  for any element from the periodic table (see inside front cover), but in a lot of questions they give you them anyway. And that's all it is. A big fancy name like **relative formula mass** and all it means is "**add up all the relative atomic masses**". What a swizz, eh?

## HOW TO WORK OUT MASS OF SOLUTE IN A SOLUTION

$$\text{concentration (g/dm}^3\text{)} = \frac{\text{amount of solute (g)}}{\text{volume of solution (cm}^3\text{)}} \times 1000$$

$$\text{concentration (g/dm}^3\text{)} = \frac{\text{amount of solute (g)}}{\text{volume of solution (dm}^3\text{)}}$$

As an example, imagine that you make a solution of sodium hydroxide in water. You dissolve exactly 40.0 g of sodium hydroxide in enough water to make exactly 3.00 dm<sup>3</sup> of solution. You can calculate the concentration of the solution in g/dm<sup>3</sup>:

$$\frac{40.0 \text{ g}}{3.0 \text{ dm}^3} = 13.3 \text{ g/dm}^3$$

Mass of solute

Conc

Vol of sol (cm<sup>3</sup>)

A hydrocarbon contains 75% carbon and 25% hydrogen by mass. What is its empirical formula? (C=12, H=1)

Elements	Carbon C	Hydrogen H
Percentage (%)	75	25
Mass (g)	Don't need this row as	we have % data
RAM	12	1
Moles (Mass or %/Mr)	75/12 = 6.25	25/1 = 25
Ratio	Divide through by the smallest (so 1.56) 6.25/6.25 = 1                      25/6.25 = 4 the ratio is 1 : 4 the formula is CH <sub>4</sub>	

## Relative atomic/formula mass

This is the combined masses of all atoms within a compound. e.g.  $M_r$  of  $H_2O$  ( $H=1$ ,  $O=16$ )  
 $= (2 \times H) + (1 \times O)$   
 $= (2 \times 1) + (1 \times 16)$   
 $= 18$

**Law of conservation of mass**  
 During chemical reactions, mass is never lost or gained.



## FT Trilogy Chemistry Quantitative chemistry

When gases are produced in a reaction, the mass of the total reactants will decrease.

## Calculating % Mass of an Element in a Compound

This is actually dead easy — so long as you've learnt this formula:

$$\text{Percentage mass OF AN ELEMENT IN A COMPOUND} = \frac{A_r \times \text{No. of atoms (of that element)}}{M_r \text{ (of whole compound)}} \times 100$$

If you don't learn the formula then you'd better be pretty smart — or you'll struggle.

**EXAMPLE:** Find the percentage mass of sodium in sodium carbonate,  $Na_2CO_3$ .

**ANSWER:**

$A_r$  of sodium = 23,  $A_r$  of carbon = 12,  $A_r$  of oxygen = 16

$M_r$  of  $Na_2CO_3$  =  $(2 \times 23) + 12 + (3 \times 16)$  = 106

Now use the formula:

$$\text{Percentage mass} = \frac{A_r \times n}{M_r} \times 100 = \frac{23 \times 2}{106} \times 100 = 43.4\%$$

And there you have it. Sodium makes up **43.4%** of the mass of sodium carbonate.

## A "MOLE"

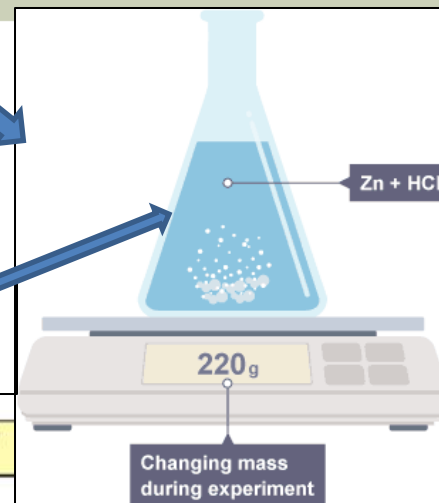
### Definition

A mole of a substance is the relative formula mass of that substance in grams

For example, 12g of carbon would be 1 mole of carbon...

...and 44g of carbon dioxide ( $CO_2$ ) would be 1 mole etc...

**Saying moles is just like saying 'relative atomic mass in grams' or 'relative formula mass in grams'.**



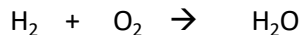
# C2 REVISION - CHAPTER 3 - HOW MUCH?

## Conservation of mass and balanced equations

What is the law of conservation of mass?

Why is it important to balance all atoms in a symbol equation.

Balance the equation and say how many moles of each substance there are:



Write the balanced symbol equation of this:

Methane + water  $\rightarrow$  Carbon dioxide + water

## Relative formula mass

What is the RFM of a molecule/compound?

Work out the RFM of the following

1  $\text{F}_2$

2  $\text{Fe}$

3  $\text{H}_2\text{SO}_4$

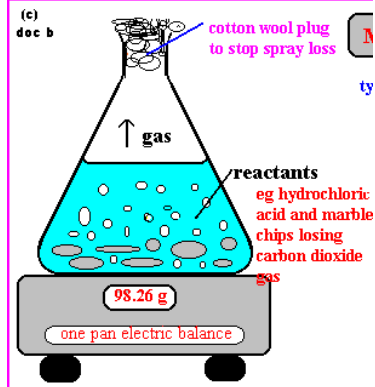
4  $\text{Al}_2\text{O}_3$

5  $\text{Mg}(\text{OH})_2$

6  $\text{Al}(\text{NO}_3)_3$

7  $(\text{NH}_4)_2\text{SO}_4$

## Conservation of mass when product is a gas.



What would you expect to see (in terms of the mass) after 2 mins of the products have reacted?

Why?

Does this disprove the conservation of mass theory?

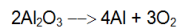
How could one keep the mass the same?

Ask Mr Gomez for markscheme for the calcs

# Reacting masses

## Worked Example

Aluminium is extracted from aluminium oxide as shown. Calculate the mass of aluminium that can be formed from 1020 g of aluminium oxide.



Equation	$2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$
Mass (g)	1020g                      ?
RAM	$2 \times (2 \times 27 + 3 \times 16) = 204$ $4 \times 27 = 108$
Moles	$1020/204 = 5$ moles

Moles across the bottom of the table are the same. We now know that there are 5 moles of aluminium and the total RAM for the aluminium is 108.

The Mass (g) of 4Al is moles x RAM

$$\text{Mass} = 5 \times 108$$

$$\text{Mass} = 540\text{g}$$



# REACTING MASS CALCULATIONS 1

- 1) Aluminium is extracted from aluminium oxide as shown.  $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$   
Calculate the mass of aluminium that can be formed from 1020 g of aluminium oxide.

.....

.....

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- 2) Calculate the mass of oxygen needed to react 10.0 g of calcium to form calcium oxide.  $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$

.....

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.....

.....

- 3) What mass of propane could burn in 48.0 g of oxygen?  $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$

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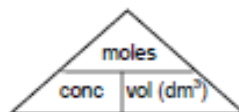


# CONCENTRATION OF SOLUTIONS

The concentration of a solution is usually measured in moles per cubic decimetre ( $\text{mol/dm}^3$ ). This is a measure of the number of moles in one cubic decimetre.

The volume must be in  $\text{dm}^3$  (there are 1000  $\text{cm}^3$  in 1  $\text{dm}^3$ ).  $\text{vol in dm}^3 = \frac{\text{vol in cm}^3}{1000}$

$$\text{concentration (mol/dm}^3) = \frac{\text{moles}}{\text{volume (dm}^3)}$$



- Calculate the concentration of the following solutions in  $\text{mol/dm}^3$ .
  - 0.10 moles of NaCl in 200  $\text{cm}^3$  .....
  - 0.20 moles of  $\text{H}_2\text{SO}_4$  in 100  $\text{cm}^3$  .....
  - 0.020 moles of NaOH in 25  $\text{cm}^3$  .....
- Calculate the number of moles in the following solutions.
  - 100  $\text{cm}^3$  of 0.20  $\text{mol/dm}^3$   $\text{HNO}_3$  .....
  - 25  $\text{cm}^3$  of 1.50  $\text{mol/dm}^3$  KOH .....
  - 50  $\text{cm}^3$  of 0.10  $\text{mol/dm}^3$   $\text{H}_2\text{SO}_4$  .....

Concentration can also be measured in grams per cubic decimetre ( $\text{g/dm}^3$ ). This is a measure of the number of grams in one cubic decimetre. [remember that  $\text{mass} = M_r \times \text{moles}$ ]

**1  $\text{dm}^3$**

**2 moles of  $\text{H}_2\text{SO}_4$**   
**196 g of  $\text{H}_2\text{SO}_4$**

Concentration = 2  $\text{mol/dm}^3$

$M_r$  of  $\text{H}_2\text{SO}_4 = 98$

Concentration = 2 x 98 = 196  $\text{g/dm}^3$

A simple conversion is:

$$\text{conc (g/dm}^3) = \text{conc (mol/dm}^3) \times M_r$$

- Calculate the concentration of the following solutions in  $\text{g/dm}^3$ .
  - 0.100  $\text{mol/dm}^3$  NaOH .....
  - 0.250  $\text{mol/dm}^3$   $\text{CH}_3\text{COOH}$  .....
  - 1.50  $\text{mol/dm}^3$   $\text{HNO}_3$  .....
- 0.20 moles of NaOH is dissolved in 250  $\text{cm}^3$  of water.
  - Calculate the concentration in  $\text{mol/dm}^3$  .....
  - Calculate the concentration in  $\text{g/dm}^3$  .....
- 5.0 g of  $\text{KNO}_3$  is dissolved in 100  $\text{cm}^3$  of water.
  - Calculate the concentration in  $\text{g/dm}^3$  .....
  - Calculate the concentration in  $\text{mol/dm}^3$  .....