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:

$MgCl_2$

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

$24 + (35.5 \times 2) = 95$

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

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

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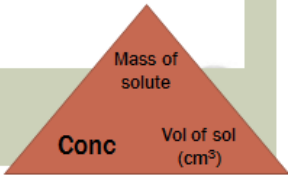
As an example, imagine that you make a solution of sodium hydroxide in water. You dissolve exactly 40.0 g of sodium hydroxide in enough water to make exactly 3.00 dm^3 of solution. You can calculate the concentration of the solution in g/dm^3:

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



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.

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)

=(2xH) + (1xO)

= (2x1) + (1x16)

=18

Law of conservation of mass

During chemical reactions, mass is never lost or gained.

calcium carbonate → calcium oxide + carbon dioxide

50g 28g 22g

HT Trilogy Chemistry Quantitative chemistry

A "MOLE"

Definition

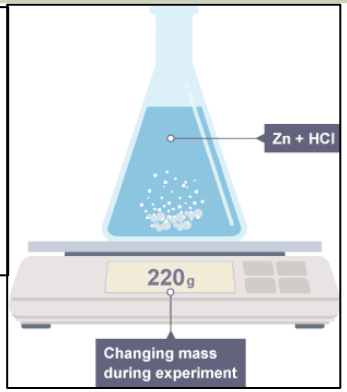
A mole of a substance is the relative formula mass of that substance in grams

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'.

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



Reacting masses

Worked Example

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

$2Al_2O_3 \longrightarrow 4Al + 3O_2$

Equation	$2Al_2O_3$ ——>	$4Al +$	$3O_2$
Mass (g)	1020g	?	
RAM	2x(2x27 + 3x16) = 204	4 x 27 = 108	
Moles	1020/204 = 5moles		

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.

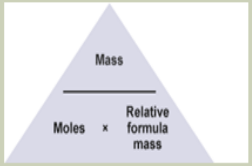
The Mass (g) of 4Al is moles x RAM

Mass = 5 x 108

Mass = 540g

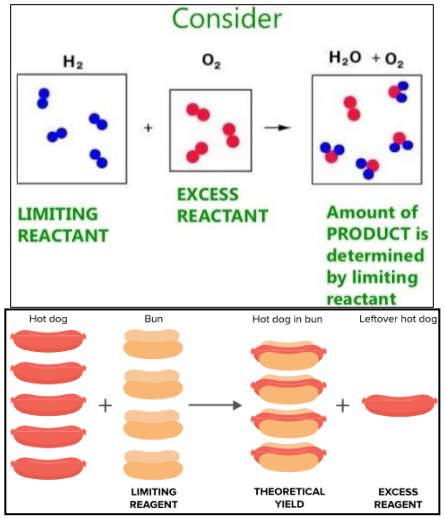
WORKING OUT MOLES

- Chemists can work out number of moles using this equation
- Moles = mass/A_r (or M_r)



- Task – Rearrange the formula to make:
- Moles =
- Mass =
- M_r/A_r =

Limiting reactant- In chemical reactions involving two reactants it is common to use one of them in excess to ensure the other one is completely used up.The one that is completely used up is the limiting reactant.



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_4	

C2 REVISION – CHAPTER 3 – HOW MUCH?

Conservation of mass and balanced equations
What is the **las 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:

H_2 + O_2 → H_2O

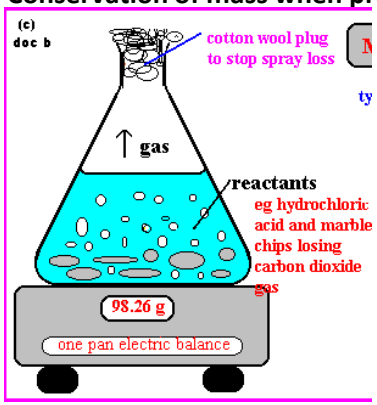
Write the balanced symbol equation of this:
Methane + water → Carbon dioxide + water

Relative formula mass
What is the RFM of a molecule/compound?

Work out the RFM of the following

1. F_2
2. Fe
3. H_2SO_4
4. Al_2O_3
5. $Mg(OH)_2$
6. $Al(NO_3)_3$
7. $(NH_4)_2SO_4$

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

HT – Moles.
Draw the equation triangle for moles, mass and Mr.

Complete the equations
n=
Mr=
Mg=

What is avagadro's constant?

What does it mean?

Reacting masses

Worked Example

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

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REACTING MASS CALCULATIONS 1

1) Aluminium is extracted from aluminium oxide as shown. Calculate the mass of aluminium that can be formed from 1020 g of aluminium oxide. $2Al_2O_3 \rightarrow 4Al + 3O_2$

2) Calculate the mass of oxygen needed to react 10.0 g of calcium to form calcium oxide. $2Ca + O_2 \rightarrow 2CaO$

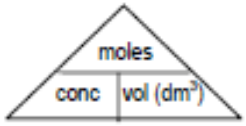
3) What mass of propane could burn in 48.0 g of oxygen? $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

CONCENTRATION OF SOLUTIONS

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

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

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



1) Calculate the concentration of the following solutions in mol/dm^3.

a) 0.10 moles of NaCl in 200 cm^3 .....

.....

b) 0.20 moles of H_2SO_4 in 100 cm^3 .....

.....

c) 0.020 moles of NaOH in 25 cm^3 .....

.....

2) Calculate the number of moles in the following solutions.

a) 100 cm^3 of 0.20 mol/dm^3 HNO_3 .....

.....

b) 25 cm^3 of 1.50 mol/dm^3 KOH .....

.....

c) 50 cm^3 of 0.10 mol/dm^3 H_2SO_4 .....

.....

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

1 dm^3

2 moles of H_2SO_4
196 g of H_2SO_4

Concentration = 2 mol/dm^3

M_r of H_2SO_4 = 98

Concentration = 2 x 98 = 196 g/dm^3

A simple conversion is: **conc (g/dm^3) = conc (mol/dm^3) x M_r**

3) Calculate the concentration of the following solutions in g/dm^3.

a) 0.100 mol/dm^3 NaOH .....

.....

b) 0.250 mol/dm^3 CH_3COOH .....

.....

c) 1.50 mol/dm^3 HNO_3 .....

.....

4) 0.20 moles of NaOH is dissolved in 250 cm^3 of water.

a) Calculate the concentration in mol/dm^3. .....

b) Calculate the concentration in g/dm^3. .....

.....

5) 5.0 g of KNO_3 is dissolved in 100 cm^3 of water.

a) Calculate the concentration in g/dm^3. .....

b) Calculate the concentration in mol/dm^3. .....