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C6. Quantitative Chemistry

C6.01 Chemical analysis and formulae

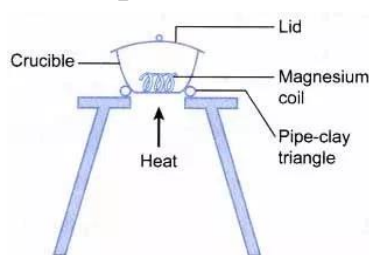
using mass spectrometer to weigh atoms

1. Terminology

stand atom - carbon-12 isotope, mass=12

- **relative atomic mass** - average mass of naturally occurring atoms of the element on a scale where the carbon-12 atom has a mass of exactly 12 units
- **relative molecular mass** - covalent substance, the sum of the relative atomic masses of the elements present in a molecule of the substance
- **relative formula mass** - when the substance is an ionic compound, same meaning

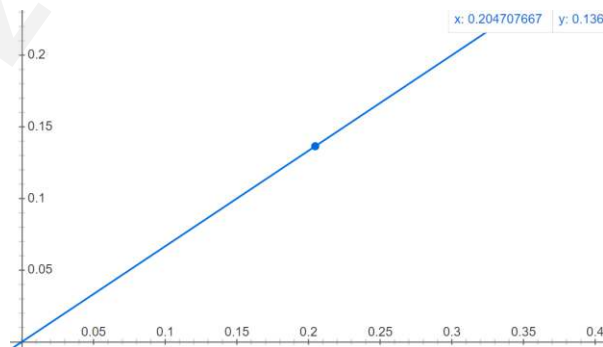
2. Compound formation and chemical formulae



1. prepare magnesium and heat a coil of it in a crucible
2. crucible - heated strongly, open crucible to allow to cool
3. mass - increased
4. do experiment several times by differing mass of Mg
5. draw a graph

what can we know

- A particular compound always contain same elements
- elements are always present in the same proportion by mass
- doesn't matter where the compound is found or how it is made
- These proportions cannot be changed

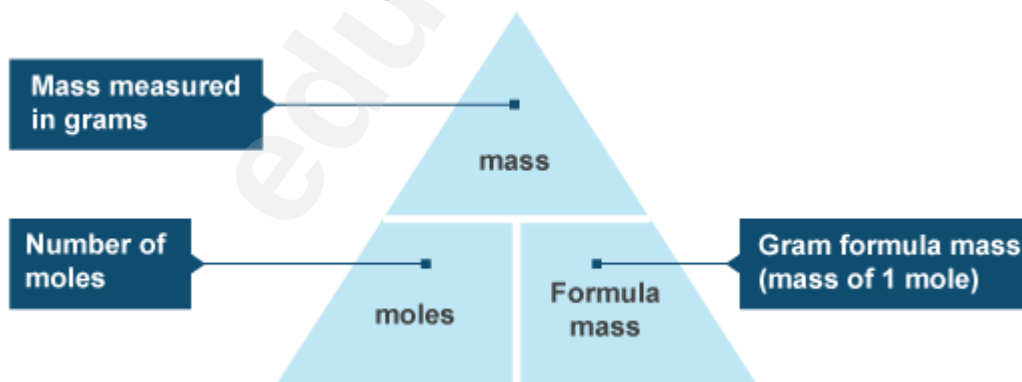


C6.02 The mole and chemical formulae

1. The mole - the chemical counting unit

- one mole - has a mass equal to its relative formula mass in grams
- contains 6.02×10^{23} (avogadro constant) atoms

2. Calculations involving the mole



3. Working out chemical formulae

1. Find the number of grams of the element that combine
2. Find the number of moles of each element that combine

3. Find the simplest whole-number ratio, find using number of mole

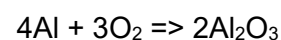
	Si	O
Mass in 10g	4.7g	5.3g
Molar mass	28g/mol	18g/mol
Number of moles	0.168 mol	0.331 mol
simplest ratio	1	2
Formula	SiO ₂	

C6.03 The mole and chemical equations

Law of **conservation mass** (질량 보존의 법칙) => mass of the product = total mass of the reactants

Question

What mass of aluminium oxide is produced when 9.2g of aluminium metal reacts completely with oxygen gas?



ration: 4 mol : 2 mol

number of moles in 4Al = $9.2/27 = 0.34$ mol

number of moles in $2\text{Al}_2\text{O}_3 \Rightarrow 0.17$ mol

$0.17 \times (27 \times 2 + 16 \times 3)$

= 17.3g

C6.04 Calculations involving gases

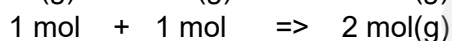
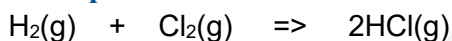
1. The volume of one mole of a gas

avogadro's law = Equal volumes of gases are found to contain the same number of particles

- One mole of any gas occupies a volume of approximately 24dm³ (24 litres) at r.t.p
- The molar volume of any gas therefore has the value 24 dm³/mol at r.t.p
- 1 dm³ (1litre) = 1000cm³

$$\text{volume(dm}^3\text{)} = \text{number of mole} \times 24\text{dm}^3/\text{mol}$$

Example



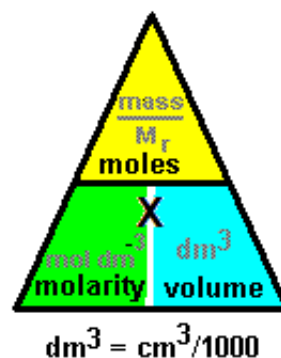
C6.05 Moles and solution chemistry

1. The concentration of solutions

- solute : chemical substance dissolved
- solvent
- two way to calculate mass in grams
 - Mass concentration:** solution measured in g/dm³
 - Molar concentration:** solution is measured in mol/dm³

2. Calculations using solution concentration

number of moles in solution = molar concentration x volume of solution(in dm³)



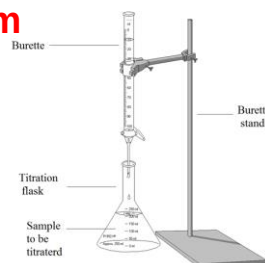
3. Acid-base titrations

concentration of an unknown acid solution can be found if it is reacted with a standard solution of alkali

Example

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A solution of hydrochloric acid is titrated against a standard sodium hydroxide solution. It's found that 20cm^3 of acid neutralises 25cm^3 of 0.1mol/dm^3 of NaOH solution. What is the concentration of the hydrochloric acid solution?



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