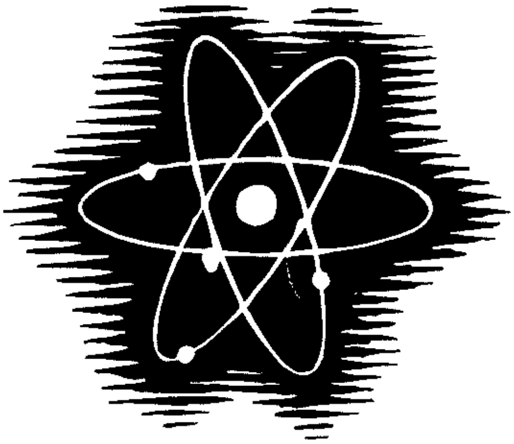
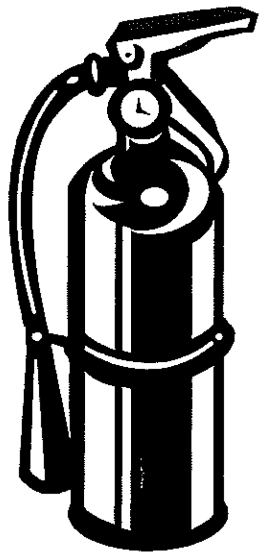
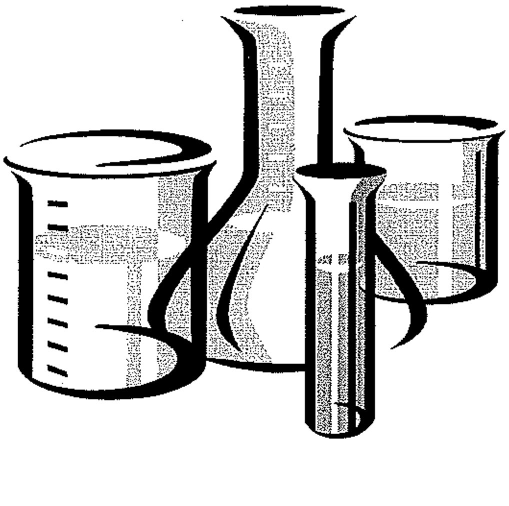



Chemical Changes and Structure
National 4/5

Pupil Summary Notes




Elements

There are about 100 elements, grouped together in the Periodic Table.

Each element has a **Name** and a **Symbol**.
For example,

carbon	**C**
aluminium	**Al**
helium	**He**
oxygen	**O_2**

Elements can be classified as:

- Metals and non metals
- Solids, liquids and gases
- Naturally occurring and made by scientists

Families of Elements

A Group is a **column** of elements in the Periodic Table

Group 1 are the **alkali metals** which are a family of very reactive metals.

Group 7 are the **halogens** which are a family of very reactive non metals

Group 0 are the **noble gases** which are a family of very unreactive elements.

The transition metals are a block of metals found between Groups 2 and 3 in the Periodic Table. Many of the transition metals are used as catalysts in chemical reactions.

Atoms

Atoms contain protons which have a mass of 1 and are positively charged, neutrons which have a mass of 1 and are neutral and electrons which have no mass but are negatively charged.

An **Isotope** has the same number of protons but different numbers of neutrons.

Compounds

Compounds are formed when two or more elements **react** together.

When a compound is formed, energy is given out eg burning magnesium.

magnesium + oxygen ⟶ magnesium oxide

When a compound is broken up, energy is required, for example in the electrolysis of copper chloride solution.

copper chloride ⟶ copper + chlorine

Naming Compounds

If a compound contains two elements, the name of the compound ends in – **ide**.
If one of the elements is a metal, the metal name comes first.

For example, aluminium ox**ide** contains the elements aluminium and oxygen.

One exception, sodium hydroxide contains three elements - sodium, hydrogen and oxygen.

If the name of the compound ends in – **ite** or – **ate,** then it contains three elements, one of which is oxygen.

For example, calcium carbon**ate** contains calcium, carbon and oxygen.

Mixtures

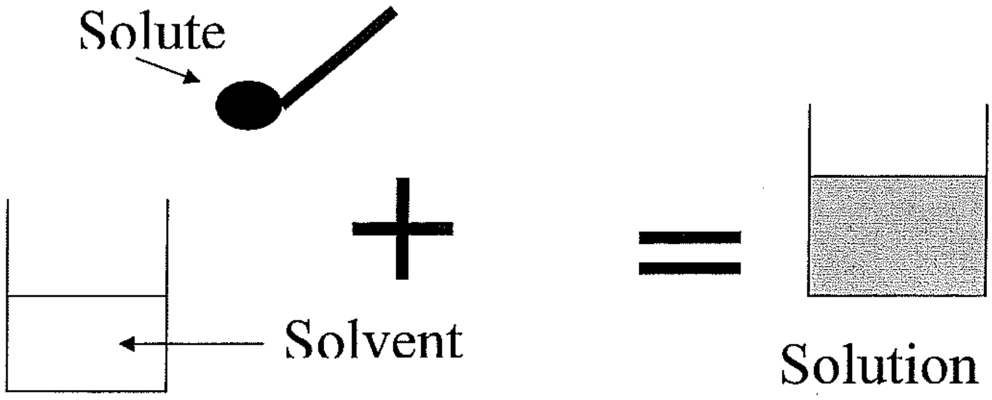
Mixtures occur when substances come together without reacting.

Air is a mixture of gases.

Test for oxygen :
Oxygen relights a glowing splint.

Note that there is not enough oxygen in air for the oxygen test to be positive.

Solutions



A **solution** is a mixture formed when a **solute** dissolves in a **solvent.**

A **saturated solution** is one in which no more substance can be dissolved.

If a substance dissolves in a liquid, then it is **soluble**.
If it does not, it is **insoluble**.

A **dilute solution** has a lower concentration of dissolved substances than a **concentrated solution.**

A solution can be diluted by adding more solvent.

State Symbols

There are **four** chemical states – solid, liquid, gas and in solution.

solid	(s)
liquid	(l)
gas	(g)
In solution	(aq)

For example,

iron (s)	- solid iron
water (l)	- liquid water
O_2 (g)	- oxygen gas
sodium chloride (aq)	- salt solution

Chemical Reactions

All chemical reactions involve the formation of one or more new substances.

Chemical reactions can be identified by signs :

- Colour change
- Gas given off
- Energy change
- Precipitate formed

Exothermic reactions give out energy to the surroundings. As a result, the products have less energy than the reactants.

Endothermic reactions take in energy from the surroundings and the products have more energy than the reactants.

Activation Energy

Most chemical reactions need energy to get them going.

For example you strike a match to light it or you put magnesium in a Bunsen flame to get it to react with oxygen.

This energy is sometimes referred to as **activation energy**.

Collision Theory of Reaction Rate

Reaction rate is affected by changes in concentration, particle size and temperature. **Collision Theory** can be used to explain the effect of concentration and surface area on reaction rate.

Temperature – as temperature increases, particles move faster and collide more often. Therefore, reaction rate increases.

Concentration – the more particles present, the more likely they are to collide. The more collisions, the faster the reaction rate.

Particle Size – As the particle size gets smaller, the surface area gets larger. Therefore there will be more collisions between reactants and so a faster reaction rate.

Catalysts - A catalyst is used to speed up a chemical reaction but it is not used up during the reaction. Homogeneous means the catalyst is in same state as the reactants. Heterogeneous means the catalyst is in a different state than the reactants.

Rate of Reaction

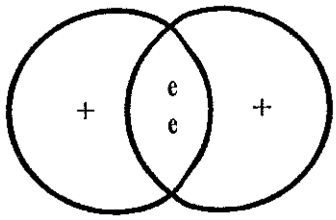
Rate = $\frac{\text{change in volume or mass}}{\text{Change in time}}$

Ions –Atoms are neutral because they have an equal number of positive protons and negative electrons but if the numbers are unequal there is an imbalance of electrons to protons an **ion** is formed .

The Covalent Bond

When two atoms collide, we would expect the negatively charged electron clouds to repel each other. However, if the collision has enough energy, the positive nucleus of one atom will 'pull' on the electron cloud of the other and vice versa. This allows a very strong attraction to develop between the two atoms which is called a **COVALENT BOND.**

- Positive nuclei of each atom is attracted to negatively charged shared pair of electrons



When a **metal and a non metal element** combine the outer electrons are TRANSFERRED and **charged particles** called IONS are formed. These particles are attracted to each other and form an IONIC BOND.

Valency

Group Number	1	2	3	4	5	6	7	0
Valency	1	2	3	4	3	2	1	0

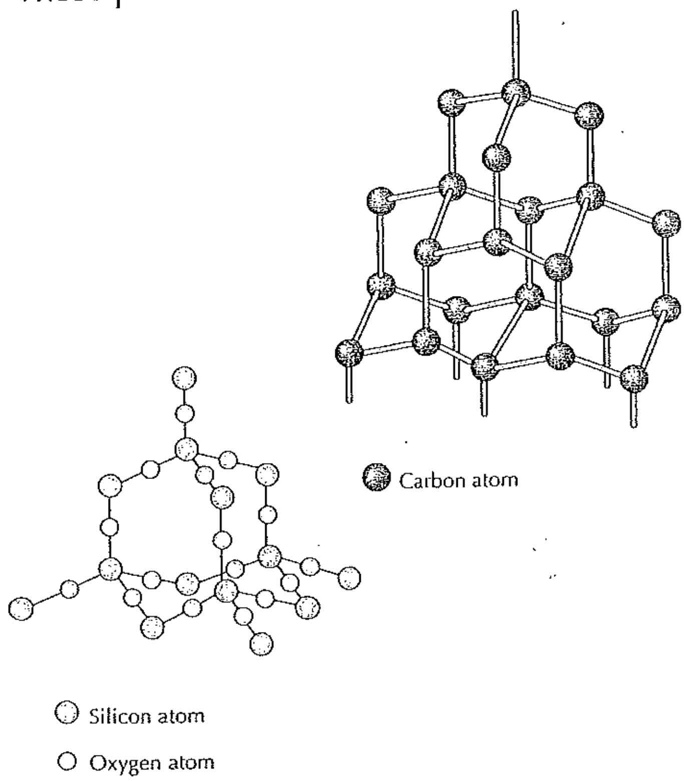


Figure 1.2.28: *Diamond and silicon dioxide are covalent network structures*

The MOLE and Titration calculations

1. For a given **Mass**, **1 mole = formula mass in grams**

$$\text{No. moles} = \frac{\text{mass}}{\text{gram formula mass}} = \frac{m}{gfm}$$

So mass = No. moles x gfm

1a. Changing Mass to Moles

Example : Calculate the mass of 4 moles of carbon tetrachloride, CCl_4

C	1 x 12	=	12
Cl	4 x 35.5	=	142
So,	1 mole	=	154g

Therefore, 4 moles = 4 x 154 = 616g

1b. Changing Moles to Mass

Example : How many moles are contained in 150g of calcium carbonate $CaCO_3$?

Ca	1 x 40	=	40
C	1 x 12	=	12
O	4 x 16	=	64
So, 1 mole		=	100g

$$\text{No. moles} = \frac{\text{mass}}{gfm} = \frac{150}{100} = 1.5 \text{ mol}$$

2. In Solution,

Number of moles = Concentration (mol l^{-1}) x Volume (litres)

ie n = CV or by changing the subject of the equation,

$$C = \frac{n}{V} \quad \text{or} \quad V = \frac{n}{C}$$

(Remember 1 litre = 1000 cm^3)

Example 1 How many moles of sodium chloride are dissolved to form 500 cm^3 of 2 mol l^{-1} solution

n = CV

n = 2 x 0.5 [Remember – volume in litres]

= 1 mol.

Example 2 What concentration of solution is formed when 2 mol of solute is dissolved and the solution made up to 250 cm^3 ?

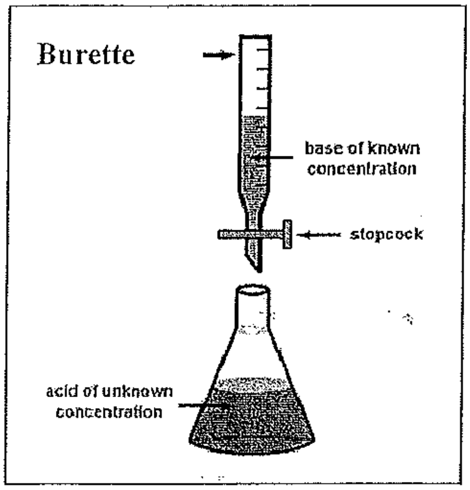
n = C x V So, $C = \frac{n}{V} = \frac{2}{0.25} = 8$ mol l^{-1}

3. Calculations based on Equations.

Best shown by example : What mass of water is produced when 4 g of methane is completely burned .

Steps			
1 The equation	CH_4 + $2O_2$	→	CO_2 + $2H_2O$
2 Mol equation	**1 mol**	→	**2 mol**
3 Put in masses, then work out answer by proportion	**16g**	→	**36 g**
So	1 g CH_4	→	36/16 g H_2O
and so	4 g	→	4 x 36/16
			= 9g

Acid/ Alkali Titrations



Example:

Sodium hydroxide and nitric acid react as follows :

$NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

In a titration, 30 cm^3 of nitric acid neutralised 20 cm^3 of 0.2 mol l-1 sodium hydroxide.

Calculate the concentration of the nitric acid.

Steps

1. Write equation $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

2. Mole equation 1 mol 1 mol

0.004mol

3. Look at info given, the reactant for which there is both concentration and volume data then that is the place to start by calculating the number of moles present.

For NaOH, $n = CV$ $n = 0.2 \times 0.02$ $n = 0.004$ mol

4. From the mole equation above, one mole of alkali reacts with one mole of acid so the number of moles of HNO_3 which react exactly with the alkali is 0.004 mol.

5. From the number of moles calculated above and the volume of acid given in the question, the required concentration can be calculated.

So. For the acid $n = CV$, therefore $C = \frac{n}{V} = \frac{0.004}{0.03}$

$= 0.133 \text{ mol } l^{-1}$

Acids and bases.

The pH scale measures if a solution is acidic , alkaline or neutral. If the pH is below 7 the solution is acidic if its above 7 then it is alkaline if the pH is 7 the solution is neutral. Acids contain H+ ions and alkalis contain 0H- ions when they react together they cancel each other out in a **neutralization** reaction.
Non metal oxides when dissolved in water make acids. Metal oxides when dissolved in water make alkalis.

ACIDS		ALKALIS	
HCl	Hydrochloric acid	NAOH	Sodium Hydroxide
H_2SO_4	Sulphuric acid	K0H	Potassium Hydroxide
HNO_3	Nitric acid	Li0H	Lithium Hydroxide

Acid + Alkali → Salt + Water
Acid + Metal Carbonate → Salt + Water + Carbon dioxide
Acid + (reactive) Metals → Salt + Hydrogen.

Spectator ions are ions that are present during the reaction, but are unchanged by the reaction.