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AS Chemistry

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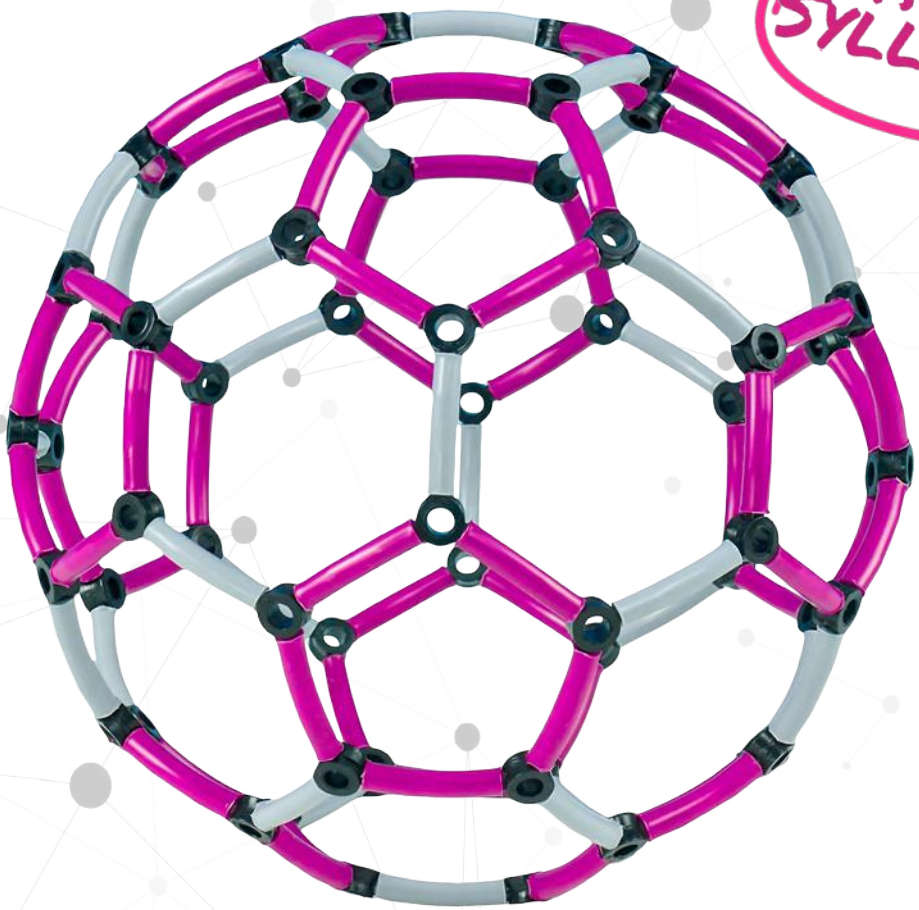

Complete Notes

SCAN ME

How to use this book?

Use the syllabus **checklist** at the end of the book 

Build your answers around the **key terms** 

Learn the **Practical details** for every unit 

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SCAN ME

Part of syllabus

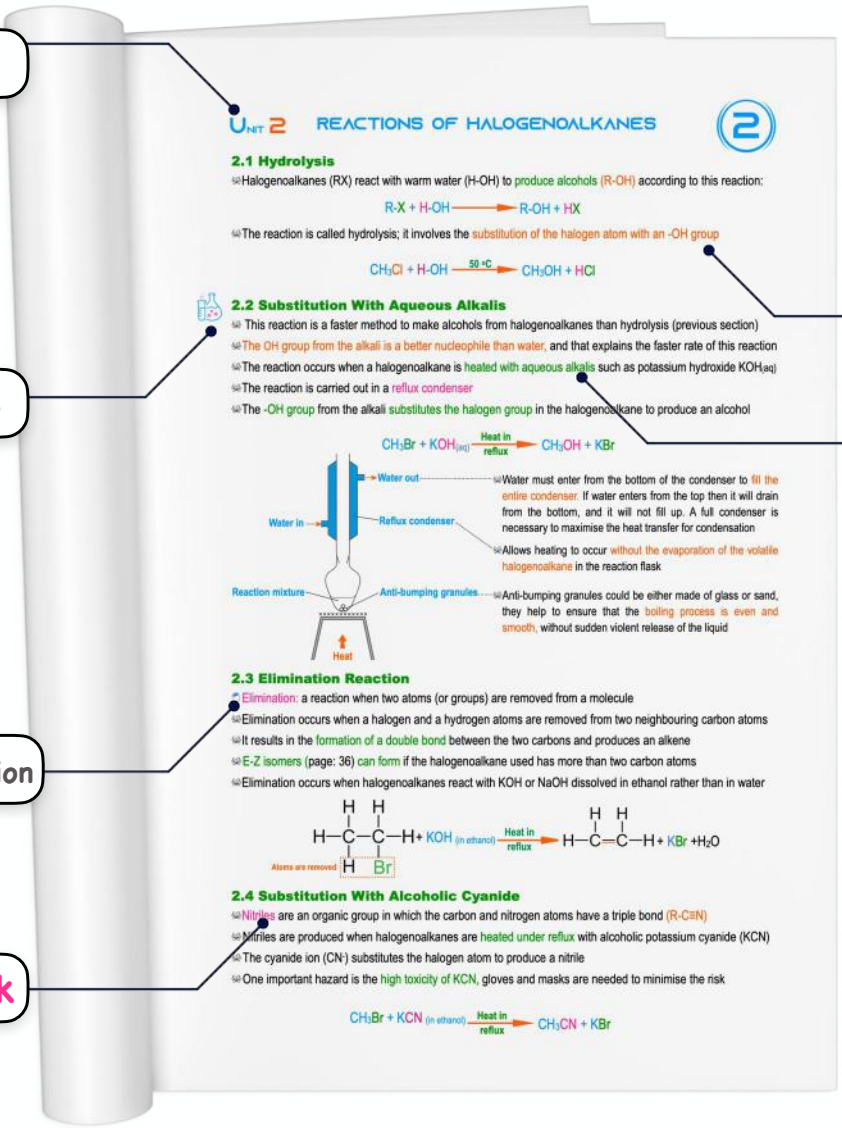
Practical details

Important Definition

Key terms in pink

Mark scheme points

Key facts in green



UNIT 2 REACTIONS OF HALOGENOALKANES

2.1 Hydrolysis

- Halogenoalkanes (RX) react with warm water (H-OH) to produce alcohols (R-OH) according to this reaction:

$$R\text{-}X + H\text{-}OH \longrightarrow R\text{-}OH + HX$$

- The reaction is called hydrolysis; it involves the substitution of the halogen atom with an -OH group

$$CH_3Cl + H\text{-}OH \xrightarrow{50\,^\circ C} CH_3OH + HCl$$

2.2 Substitution With Aqueous Alkalis

- This reaction is a faster method to make alcohols from halogenoalkanes than hydrolysis (previous section)
- The OH group from the alkali is a better nucleophile than water, and that explains the faster rate of this reaction
- The reaction occurs when a halogenoalkane is heated with aqueous alkalis such as potassium hydroxide $KOH_{(aq)}$
- The reaction is carried out in a reflux condenser
- The -OH group from the alkali substitutes the halogen group in the halogenoalkane to produce an alcohol

$$CH_3Br + KOH_{(aq)} \xrightarrow[\text{reflux}]{\text{Heat in}} CH_3OH + KBr$$

- Water must enter from the bottom of the condenser to fill the entire condenser. If water enters from the top then it will drain from the bottom, and it will not fill up. A full condenser is necessary to maximise the heat transfer for condensation
- Allows heating to occur without the evaporation of the volatile halogenoalkane in the reaction flask
- Anti-bumping granules could be either made of glass or sand, they help to ensure that the boiling process is even and smooth, without sudden violent release of the liquid

2.3 Elimination Reaction

- Elimination: a reaction when two atoms (or groups) are removed from a molecule
- Elimination occurs when a halogen and a hydrogen atoms are removed from two neighbouring carbon atoms
- It results in the formation of a double bond between the two carbons and produces an alkene
- E-Z isomers (page: 36) can form if the halogenoalkane used has more than two carbon atoms
- Elimination occurs when halogenoalkanes react with KOH or NaOH dissolved in ethanol rather than in water

2.4 Substitution With Alcoholic Cyanide

- Nitriles are an organic group in which the carbon and nitrogen atoms have a triple bond (R-C≡N)
- Nitriles are produced when halogenoalkanes are heated under reflux with alcoholic potassium cyanide (KCN)
- The cyanide ion (CN^-) substitutes the halogen atom to produce a nitrile
- One important hazard is the high toxicity of KCN, gloves and masks are needed to minimise the risk

$$CH_3Br + KCN \xrightarrow[\text{(in ethanol)}]{\text{Heat in reflux}} CH_3CN + KBr$$

UNIT 1

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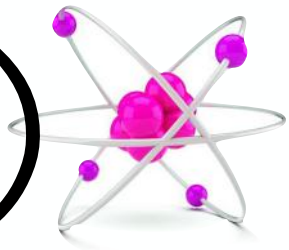

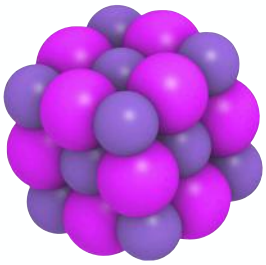

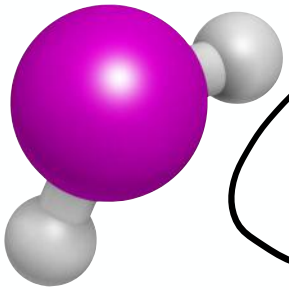

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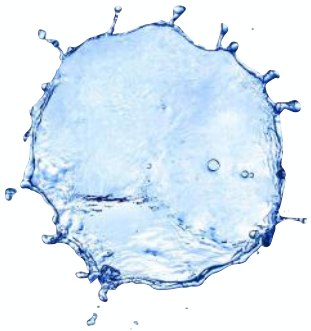

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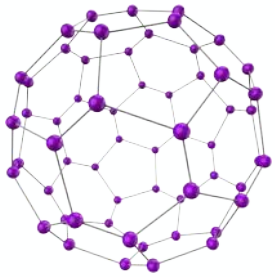

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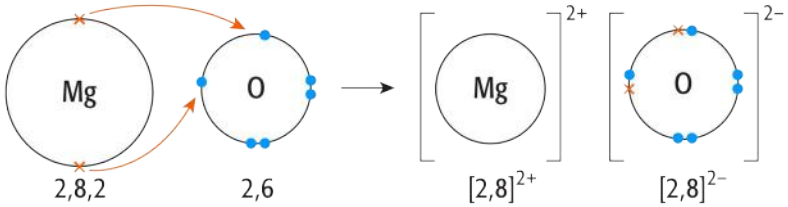
Unit 1 Ionic Bonding

7.1 Ionic Bonds

- Ionic bonds involve the transfer of electrons between two atoms to form oppositely charged ions
- Ionic bond: a strong electrostatic attraction between oppositely charged ions
- Ionic crystal: a giant lattice of ions arranged in an alternative manner



Dot-cross diagram for the formation of the ionic compound magnesium oxide (MgO)

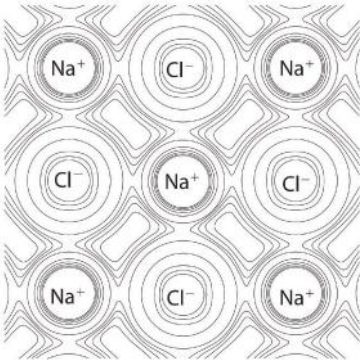
7.2 Strength Of Ionic Bonding

- The stronger the electrostatic attraction between the ions, the stronger the ionic bond
- Stronger ionic bonds lead to higher melting points in the ionic compounds
- Three factors affect the strength of an ionic bond:
  1. Charges of ions: the greater the charge on an ion, the stronger the ionic bond
  2. Ionic radii: electrostatic forces are stronger at a shorter distance, and ionic bonds are stronger with smaller radii of ions
  3. Charge density is higher when the charge of an ion is greater, and the radius is smaller
- An Ionic bond is stronger when the charge density of its constituent ions is higher
- Stronger ionic bonds require more heat to break, this is reflected by the high melting points of ionic compounds
- Example: the melting point of MgO is around 2850 °C, while the melting point of NaCl is 800 °C
- This shows that the ionic bond is stronger in MgO than in NaCl; this can be explained by the following reasons:

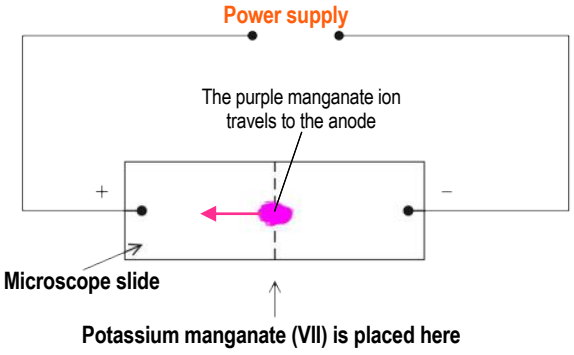
Compound	MgO	NaCl
Radius of cation	Smaller	Larger
Charge of cation	2+	1
Charge density	Higher	Lower
Radius of anion	Smaller	Larger
Charge of anion	2-	1-
Charge density	Higher	Lower
Ionic bonding	Stronger	Weaker
Melting point	Higher	Lower
Reason	✵Stronger electrostatic forces of attraction in MgO because of the higher charge density of its ions ✵ Stronger ionic bonds require more heat energy to melt, and thus the higher melting point	

7.3 Electron Density Maps

- These are maps that show the probability of finding electrons in a specific region
- The electron density map for an ionic compound shows a regular pattern of cations and anions
- The lines on the map show the likelihood of finding electrons in a region
- They also show the relative size of the ions (the map on the next page shows that chloride is larger than sodium)
- The density of electrons falls to zero between the ions with no single line that surrounds both ions
- This shows that ions are actually separate with no sharing of electrons between them
- This is not the case for the density maps of covalent molecules (page: 20) which shows an overlap



The electron density map of NaCl



Migration of ions on a slide

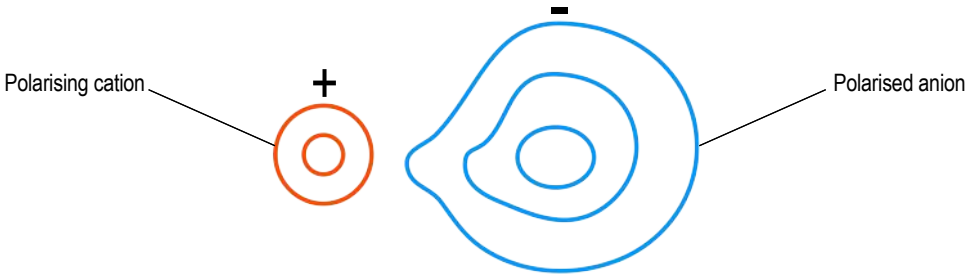
UNIT 3

7.4 Electrolysis Is Evidence Of Ions

- Electrolysis is the breaking of ionic compounds using an electric current
- Ionic compounds only conduct electricity when molten or dissolved
- For example, solid lead bromide does not conduct electricity, while molten lead bromide can be electrolysed
- Lead metal forms at the cathode while brown bromine gas forms at the anode
- Another evidence of moving ions can be demonstrated using aqueous potassium manganate ($KMnO_4$)
- A drop of this solution is placed on a moist filter paper on a microscope slide connected to a power supply
- After ten minutes, the purple colour of the manganate ion ($MnO4^-$) appears on the positive end of the slide
- This is evidence that the anion has migrated to the anode
- The same experiment can be done with a drop of green copper(II) chromate(VI)
- The filter paper turns blue at the cathode due to the copper ions, while the yellow chromate ion forms at the anode

7.5 Polarisation Of Anions

- Ionic compounds always have a small degree of electron sharing within the ionic bonding
- When two oppositely charged ions approach each other, the cation attracts the outer electrons in the anion
- This results in a distortion (bending) of the electron cloud of the anion and the anion will no longer be spherical
- Polarisation: the distortion of the electron cloud around an anion by a cation in an ionic lattice
- Polarising power of a cation: the ability of a cation to attract electrons and distort an anion
- The tendency of the anion to become polarised by the cation is known as its polarisability
- Several factors increase the polarisability of an anion and decrease its ionic character:
  1. Cations with higher charge density: smaller cations with higher charge have stronger polarising power
  2. Larger anions: the outermost electrons are well shielded in larger anions and easily distorted by cations
- Polarisation causes a degree of electron sharing also known as a covalent character within the ionic lattice
- There is always some degree of covalent character and the bonding in the lattice is never 100% ionic
- This small degree of covalent character affects the melting point of ionic compounds
- Ionic compounds have high melting points due to the strong electrostatic forces of attraction between the ions
- The covalent character weakens the ionic bonds and reduces the amount of heat needed for the melting
- We can determine the degree of covalent character by comparing the melting point of ionic compounds
- Lower melting points than expected reflect more degree of covalent character within the ionic lattice

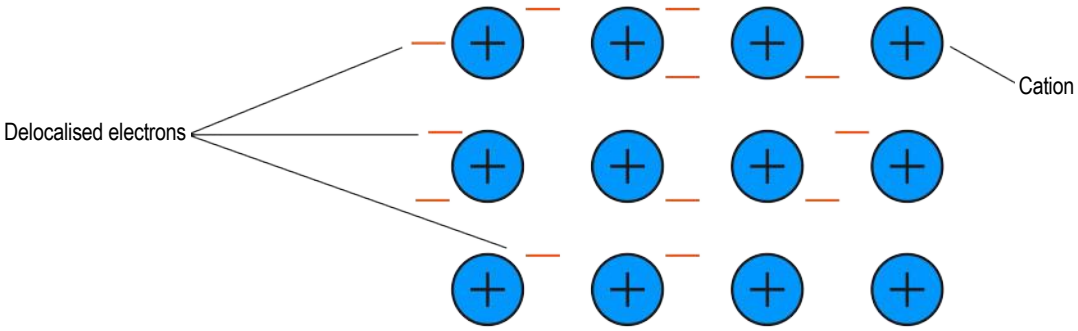


Unit 1 Metallic Bonding

8

8.1 The Metallic Lattice

- The metallic lattice is a regular arrangement of metal cations in a sea of delocalised electrons
- The delocalised are the valence electrons lost by the metal atom
- Delocalised electrons are those that are not associated with one particular metal atom
- Metallic bonding is a strong electrostatic attraction between the cations and the delocalised electrons
- Metals conduct electricity because electrons are free to move under a potential difference (voltage)
- Two factors increase the strength of metallic bonding
  1. A higher charge density of the cation, which is achieved by a smaller radius and higher charge intensity
  2. More delocalised electrons, which can be done by having more valence electrons in the metal atom
- Metals like aluminium can produce a stronger metallic lattice because of their smaller radius, higher charge and a larger number of valence electrons (see section: 6.8 on page: 15)



8.2 Comparison Between Ionic And Metallic Bonding

Property	Ionic	Metallic
Structure of the lattice	Alternating cations and anions	Cations in a sea of delocalised electrons
Electrostatic attractions	Between the cations and anions	Between cations and delocalised electrons
Strength of the bond	Stronger when the ions have a higher charge density	Stronger when cations have higher charge density and when they have more valence electrons
Electrical conductivity	Ions can only move when ionic compounds molten or dissolved	Conduct electricity when solid or molten
Malleability	Not malleable	Metals are malleable because the cations can slide past each without breaking the forces of attraction which exist in all directions (non-directional)
Melting point	High because of the strong electrostatic forces of attraction, so a lot of heat energy is needed to overcome these forces	

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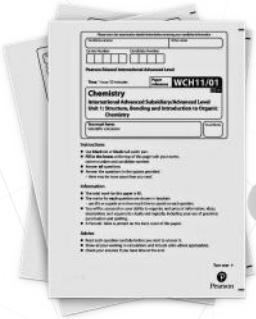

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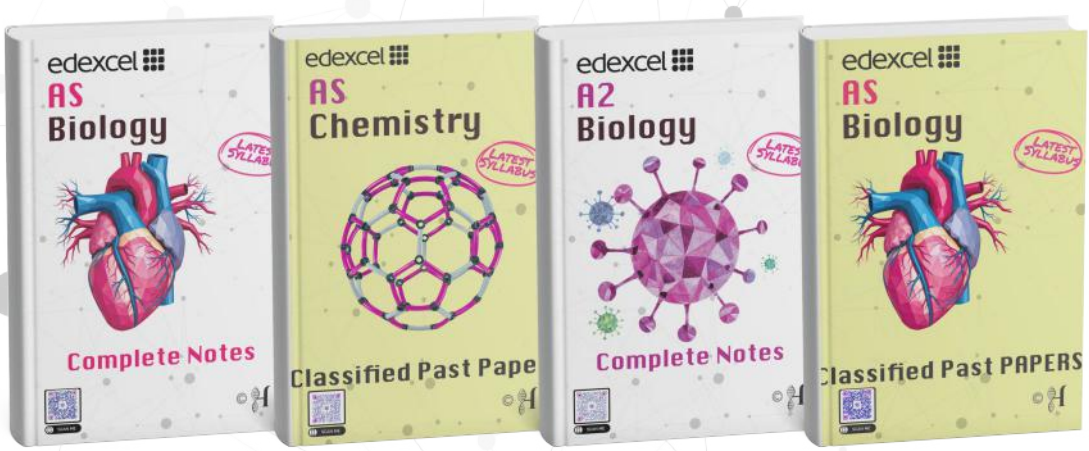

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