KNOWLEDGE

Chemistry Topic C2
Structure and bonding

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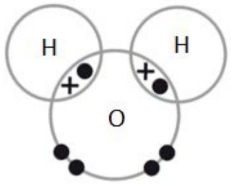
Section 1: Bonding Key Terms

Ion	A **charged particle** formed when atoms lose or gain **electrons**.
Ionic bond	An electrostatic attraction between two **oppositely charged ions** (**metal** and **non-metal**).
Electrostatic attraction	The attraction between a negatively charged particle and a positively charged particle.
Metals	In ionic bonding, **metals lose electrons** to become **positively-charged** ions.
Non-metals	In ionic bonding, **non-metals gain electrons** to become **negatively-charged** ions. Located on the right hand side of the periodic table.
Giant lattice	A **large regular 3D structure** that contains millions **of bonds**.
Covalent bond	A bond formed when **non-metals share electrons.** An electrostatic attraction between the positively charged nuclei of the bonded atoms and the electrons shared between them.
Molecule	A **small group of atoms** held together with **covalent bonds**. **Not charged.**
Polymer	**Very large covalently bonded** molecules with **many repeating units.**
Metallic bonding	The bonding of a metal consists of a lattice of **positive ions** surrounded by a **sea of delocalised electrons**. The metallic bond is the Electrostatic attraction between the positive ions and the delocalised electrons.
Alloy	A mixture of **two or more elements, at least one of which is a metal**. E.g. steel is a mixture of iron and carbon

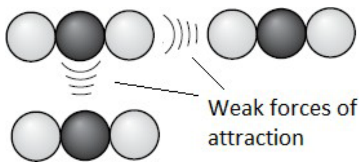
Section 2: Simple Covalent Molecules

Property	Reason
Low melting and boiling points (usually gases or liquids)	There are only **weak intermolecular forces between the molecules** which **don't need much energy** to overcome these forces.
Do not conduct electricity	Covalent molecules are **not charged** & have no free moving electrons.



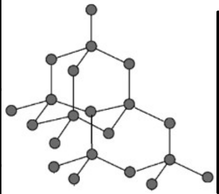
Water

Covalent dot and cross diagrams show which atoms the electrons have come from but don't show relative size of atoms or their arrangement in space.

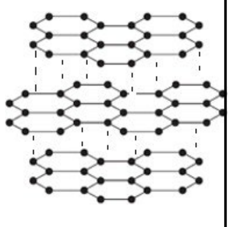


Section 3: Giant Covalent Structures Made of Carbon

In Giant covalent compounds, all the atoms are bonded via strong covalent bonds in a giant lattice structure.


Diamond

In Diamond, each **C is bonded to 4 other carbons** in a tetrahedral arrangement.


Graphite

Graphite contains layers of hexagons with each carbon having 3 bonds. The extra electrons become delocalised between the layers.

Properties of Diamond

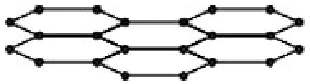
Property	Reason
Doesn't conduct electricity	Diamond **doesn't contain delocalised electrons or ions.**
Very hard	Each carbon bonds to **4 other carbon atoms** with **strong covalent bonds** to form a **lattice.**
High melting point	A **large amount of energy** is needed to overcome all the strong covalent bonds in the lattice.

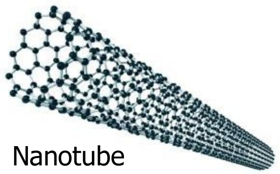
Properties of Graphite

Property	Reason
Conducts electricity	The delocalised electrons are **free to move** and **carry charge** through the structure.
Soft and slippery	Only **weak intermolecular forces** exist **between layers**, so layers can slide..

Section 4: Small Carbon-Based Structures


Fullerene


Graphene


Nanotube

	Structure	Properties	Uses
Fullerene	**Hollow-shaped**, cage like structures and tubes which also contain hexagonal rings. E.g. Buckminsterfullerene (C_{60})	Very **strong**. Hollow so can contain other chemicals within it.	Drug delivery, lubricants, catalysts (large surface to volume ratio) and in electronics
Graphene	A **single layer of graphite** (one atom thick)	Very **strong & light**. **Has delocalised electrons** so it is able to **conduct electricity**.	Electronics, composites.
Carbon nanotube	**Cylindrical tubes** of carbon atoms that are **very long** compared to their diameter.	Very **strong, light** and **flexible.** Has **delocalised electrons** so it is able to **conduct electricity**.	Nanotechnology, electronics, reinforcing (e.g. tennis rackets).

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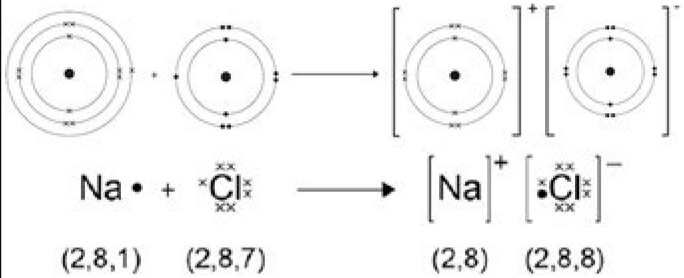
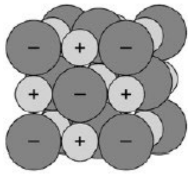
Section 5: Ionic Bonding



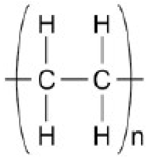


When a metal and a non-metal react together, **the metal atom loses electrons** and becomes **a positive io**n. The **non-metal atom gains electrons** and becomes a **negative ion**. The ionic bond is a **strong electrostatic force of attraction between these oppositely charged ions**.

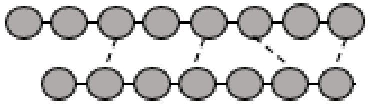
Property	Reason
High melting point and boiling points	Because it takes a lot of energy to overcome the many strong ionic bonds in the lattice. There is a **strong electrostatic force** between the **positive and negative ions** in the **giant lattice**.
Conduct electricity when liquid/ molten	**Ions are able to move** so there is a **flow of charged ions** (current).
Do not conduct electricity when solid	**Ions are in fixed positions** so cannot flow**.**

Section 6: Polymers

A polymer is a substance made from **very large molecules** made up of many repeating units called **monomers**.



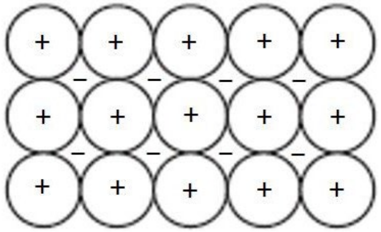
Monomer



Polymer

Polymers are usually solid because the **intermolecular forces between polymer molecules** are **relatively strong**.

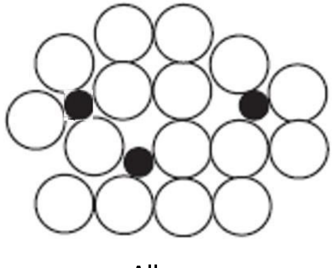
Section 7: Metallic Bonding



A **pure metal** consists of a lattice of **positive ions** surrounded by a **sea of delocalised electrons**.

Properties of Pure Metals

Property	Reason
High melting points	**Strong electrostatic forces** between the **positive ions** and **delocalised electrons**. Requires a **large amount of energy** to overcome.
Conduct electricity	the **delocalised electrons** are **free to move** and **carry a charge**.
Conduct heat	The **delocalised electrons** are free to **move and transfer thermal energy** through the structure.
Malleable	The **layers** are able to **slide over each other** so the metal can be bent and shaped. The attraction between the positive ions and delocalised electrons prevents the metal from shattering.



Alloy

Alloys are **harder** than pure metals because the **different sized atoms distort the layers** making it **harder for them to slide.**

Steel is an alloy consisting of **Iron** and **carbon**

Section 8: Nanoparticles (triple only)

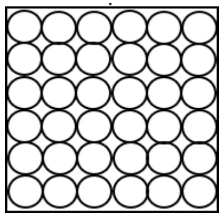
Nanoscience is the study of **small particles** that are between **1 and 100 nanometres** in size.

Nanoparticles may have properties **different** from those for the same materials in bulk because of their **high surface area to volume ratio**.

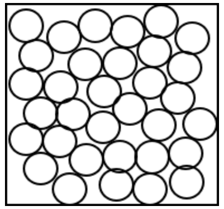
Nanoparticles may result in smaller quantities of materials e.g. catalysts being needed for industry.

Uses	Advantage	
Sun cream (Zinc oxide nanoparticles)	Nanoparticles more effective at blocking suns rays.	Nanoparticles are smaller than skin cells so can go through the skin into the bloodstream, Unpredictable effect on our cells?
Silver nanoparticles used in fridges, antimicrobial dressings.	Inhibit growth of microorganisms (protect against bacteria)	Scientists are also worried about nanoparticles entering the environment and affecting aquatic life

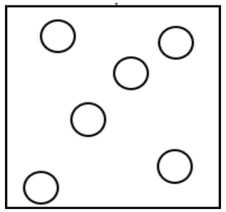
Section 9: States of matter



Solid
State symbol
(s)



Liquid
State symbol
(l)



Gas
State symbol
(g)