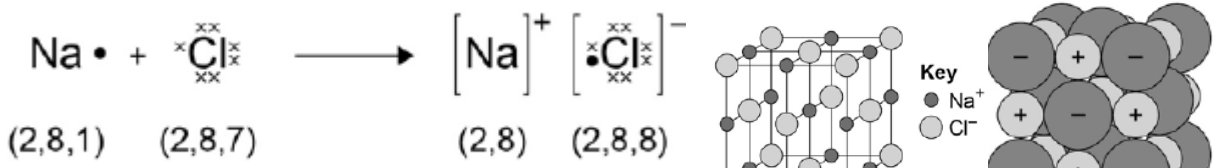
# Chemistry 2: Bonding, Structure and the Properties of Matter

## Section 1: Bonding Key Terms

| | |
|---|---|
| 1 Ion | An atom that is **charged** because of **gain** or **loss** of **electrons**. |
| 2 Ionic bond | The **bond** between two **oppositely charged ions** (**metal** and **non-metal**). Occurs because of electrostatic attraction. |
| 3 Electrostatic attraction | The **force** that **holds two oppositely charged ions** together. A **strong** force. |
| 4 Metals | In ionic bonding, **metals lose electrons** to become **positively-charged** ions. |
| 5 Non-metals | In ionic bonding, **non-metals gain electrons** to become **negatively-charged** ions. |
| 6 Giant lattice | A **large 3D structure** that contains a **lot of bonds**. |
| 7 Covalent bond | A bond formed when **non-metals share electrons**. A **strong** bond. |
| 8 Molecule | A **small group of atoms** held together with **covalent bonds**. **Not charged**. |
| 9 Polymer | **Very large covalent compounds** with **many repeating units**. |
| 10 Metallic bonding | The **electrons** in the **outer shell** of metal atoms are **delocalised** and so are **free to move** through the whole structure. The **sharing of delocalised electrons** gives rise to **strong metallic bonds**. |
| 11 Alloy | A mixture of **two or more elements**, **at least one of which is a metal**. E.g. steel |

## Section 2: Ionic Bonding



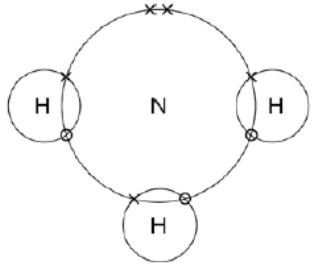

In ionic bonding, metals lose electrons to become positively-charged ions. Non-metals gain electrons to become negatively-charged ions.

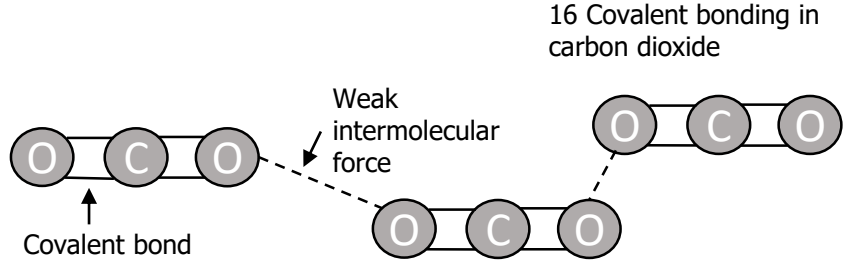



12 Two representations of a **giant ionic lattice**. The lines represent ionic bonds.

| Property | Reason |
|---|---|
| 13 High melting point | There is a **strong electrostatic force** between the **positive and negative ions** in the **giant lattice**. A **large amount of energy** is **needed to overcome this force**. |
| 14 Conduct electricity when liquid/ molten | **Ions are able to move** so there is a **flow of charged ions** (current). |
| 15 Do not conduct electricity when solid | **Ions are in fixed positions** so cannot flow**.** |

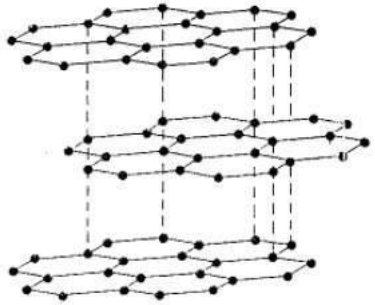
## Section 3: Simple Covalent Molecules




| Property | Reason |
|---|---|
| 17 Low melting and boiling points (usually gases or liquids) | There are only **weak intermolecular forces between the molecules**. **Not much energy** is needed to overcome these forces. |
| 18 Do not conduct electricity | Covalent molecules are **not charged**. |

## Section 4: Giant Covalent Structures Made of Carbon

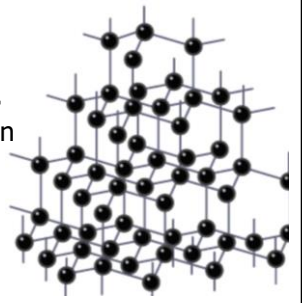


19 Graphite

Each **carbon** forms **3 bonds** to other carbon atoms. Arranged in **layers** with **weak intermolecular forces between layers**.

20 Diamond

Each **carbon** forms **4 bonds** to other carbon atoms.



### Section 4a: Properties of Graphite

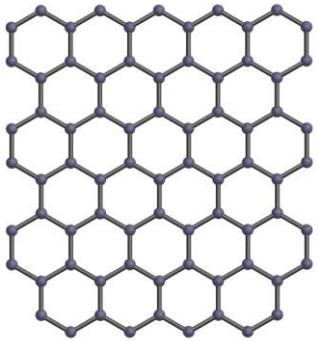
| Property | Reason |
|---|---|
| 21 Conducts electricity | Each carbon only **forms 3 bonds** so **one electron is delocalised**. These electrons are **free to move** and **carry charge** through the structure. |
| 22 Soft and slippery | Only **weak intermolecular forces** exist **between layers**, so layers can easily be rubbed off. |

### Section 4b: Properties of Diamond

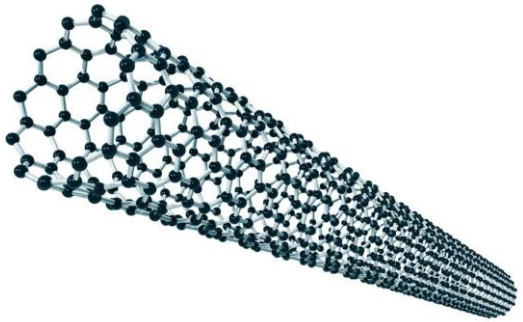
| Property | Reason |
|---|---|
| 23 Doesn't conduct electricity | Diamond **doesn't contain delocalised electrons or ions**. |
| 24 Very hard | Each carbon bonds to **4 other carbon atoms** with **strong covalent bonds** to form a **lattice**. |
| 25 High melting point | Each carbon bonds to 4 other carbon atoms with strong covalent bonds to form a lattice. A **large amount of energy** is needed to overcome all these bonds. |

## Section 5: Small Carbon-Based Structures

26 Fullerene



27 Graphene



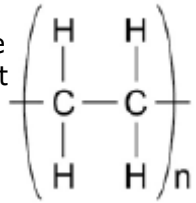
28 Carbon nanotube

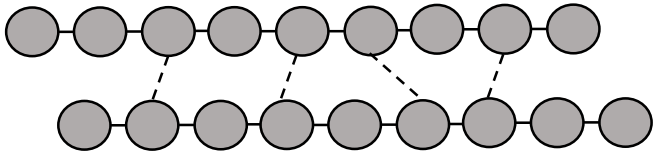
## Section 1: Properties of Metals

| | Structure | Properties | Uses |
|---|---|---|---|
| 29 Fullerene | **Hollow-shaped**. Usually **hexagonal rings of carbon** atoms. E.g. Buckminsterfullerene ($C_{60}$) | Very **strong**. Hollow so can contain other chemicals within it. | **Drug delivery, lubricants**. |
| 30 Graphene | A **single layer of graphite**. | Very **strong**. **Has delocalised electrons** so it is able to **conduct electricity**. | **Electronics, composites.** |
| 31 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).** |

## Section 6: Polymers

32 A polymer. The lines show covalent bonds. 'n' is a large number.

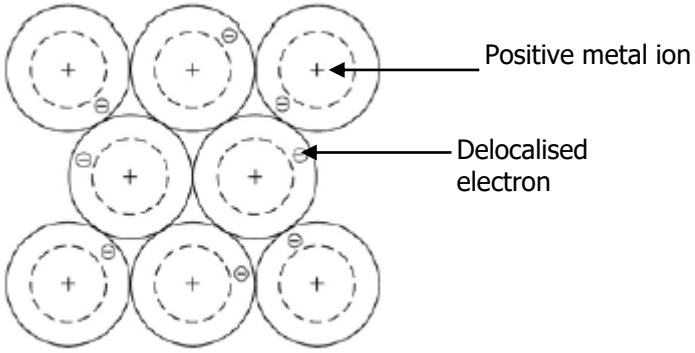


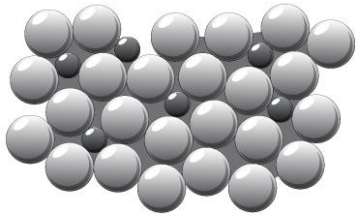
33 Polymer molecules are held together by intermolecular forces (dashed lines)

| Property | Reason |
|---|---|
| 34 Solid | Usually solid because the **intermolecular forces between polymer molecules** are **relatively strong**. |

## Section 7: Metallic Bonding




35 A pure metal. It consists of metal ions in layers with delocalised electrons.



36 An alloy. The layers have been distorted by the presence of other elements

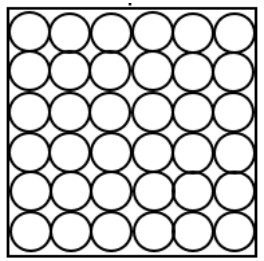
### 7a Properties of Pure Metals

| Property | Reason |
|---|---|
| 37 High melting points | **Strong electrostatic forces** between the **positive ions** and **delocalised electrons**. Requires a **large amount of energy** to overcome. |
| 38 Conduct electricity | Metals have **delocalised electrons**. These electrons are **able to move** through the structure and carry charge. |
| 39 Conduct heat | The **delocalised electrons** are able to **move and transfer thermal energy** through the structure. |
| 40 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. |

### 7b Properties of Alloys

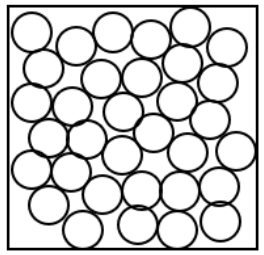
| Property | Reason |
|---|---|
| 41 Harder than metals | The **layers are distorted** by the presence of other elements. This **prevents the layers from being able to slide over each other**. |

## Section 8: States of Matter



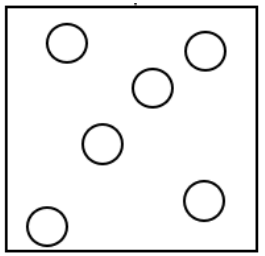
42 Solid

State symbol – (s)



43 Liquid

State symbol – (l)



44 Gas

State symbol – (g)