OCR B GCSE Chemistry

Topic 4: Material choices

How do bonding and structure affect properties of materials?

Notes

1. Explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties

- Covalent bonds
  - Strong bonds
  - High melting & boiling points (macromolecules)
  - Low melting & boiling points (simple molecules) because it is the intermolecular forces of attraction that are broken
  - Do not conduct electricity (besides graphite – due to a delocalised electron per carbon atom)
- Ionic bonds
  - Strong bonds
  - High melting & boiling points
  - Conduct electricity when molten or dissolved/in aqueous solution, since the ions are free to move. Can't conduct electricity when solid as ions are fixed in place
- Metallic bonds
  - Strong bonds
  - High melting & boiling points
  - Conducts electricity in any state – sea of delocalised electrons
  - Flexible (layers of metal ions can slide over each other)
  - Very hard
  - Able to reshape because of metal ions that are the same size that form layers
- Individual atoms do not have these properties, because they do not have intermolecular forces nor electrostatic forces of attraction

2. Recall that carbon can form four covalent bonds

3. Explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings

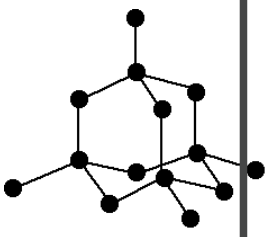
4. Describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid

- Polymers
  - have covalent bonds
  - Have very large molecules and high melting points
  - Atoms in the polymer molecules are linked to other atoms by strong covalent bonds
  - Intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature
- different polymers have different physical properties which make them suitable for different uses e.g. poly(ethene) is flexible so is used as plastic bags and poly(propene) is shatterproof so is used in plastic bowls and buckets.

5. Describe the nature and arrangement of chemical bonds in giant covalent structures

- Giant covalent structures
  - have covalent bonds
  - very high melting points:
    - All of the atoms in these structures are linked to other atoms by strong covalent bonds.
    - These bonds must be overcome to melt or boil these substances.

6. Explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action



- Diamond
  - In diamond (right), each carbon is joined to 4 other carbons covalently.
    - It's very hard, has a very high melting point and does not conduct electricity.

- Graphite
  - In graphite, each carbon is covalently bonded to 3 other carbons, forming layers of hexagonal rings which have no covalent bonds between the layers.
    - The layers can slide over each other due to no covalent bonds between the layers, but weak intermolecular forces. Meaning that graphite is soft and slippery.

- One electron from each carbon atom is delocalised.
  - This makes graphite similar to metals, because of its delocalised electrons.
  - It can conduct electricity – unlike Diamond.

7. Represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon

8. Describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals

- ionic bonds: electrostatic attraction between oppositely charged ions, formed by the transfer of electrons
- covalent bonds: electrostatic attraction between a shared pair of electrons
  - giant covalent structures have covalent bonds between all atoms in a large 3D structure
  - simple molecules have these between atoms but have weak intermolecular forces between molecules
  - polymers are held together in long chains by covalent bonds
- metallic bonds: electrostatic attraction between positive metal ions and the sea of delocalised electrons