OCR A GCSE Chemistry

Topic 2: Elements, compounds and mixtures

Properties of materials

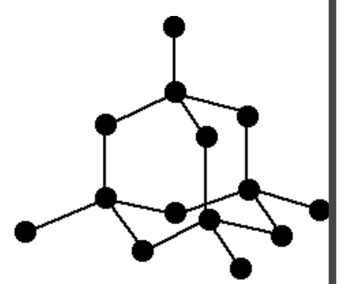
Notes

C2.3a recall that carbon can form four covalent bonds

C2.3b explain that the vast array of natural and synthetic organic compounds occur due to the ability of carbon to form families of similar compounds, chains and rings

- There is such a large number of natural and synthetic organic compounds due to carbon forming families of similar compounds, chains and rings – dependent on its ability to form different numbers of bonds as well

C2.3c explain the properties of diamond, graphite, fullerenes and graphene in terms of their structures and bonding



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.

- Fullerenes
  - Carbon can also form fullerenes with different numbers of carbon atoms.
    - Molecules of carbon atoms with hollow shapes
    - They are based on hexagonal rings of carbon atoms, but they may also contain rings with five or seven carbon atoms
    - The first fullerene to be discovered was Buckminsterfullerene (C60), which has a spherical shape
  - Carbon nanotubes
    - Cylindrical fullerenes with very high length to diameter ratios
    - Their properties make them useful for nanotechnology, electronics and materials

- Graphene
    - Graphene
        - Single layer of graphite
        - Has properties that make it useful in electronics and composites

C2.3d use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur

- Energy transfer
    - Energy transferred TO a compound – melting, boiling
    - Energy transferred FROM a compound – condensing, freezing
- Relative strength of chemical bonds
    - Covalent bonds are VERY strong
    - Ionic bonds are VERY strong – electrostatic forces of attraction
- Intermolecular forces
    - Simple molecules are melted / boiled easily, because the weak intermolecular forces are overcome and NOT the covalent bonds
    - Ionic compounds have higher melting and boiling points, because the electrostatic forces of attraction are harder to overcome
    - Macromolecular substances do not have intermolecular forces and therefore, are very hard to break down, because the covalent bonds must be overcome to boil or melt these substances
- All of these factors result in different temperatures at which substances change state

C2.3e use data to predict states of substances under given conditions

- temperature below melting point: solid
- temperature between melting and boiling point: liquid
- temperature above boiling point: gas

C2.3f explain how the bulk properties of materials (ionic compounds; simple molecules; giant covalent structures; polymers and metals) 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

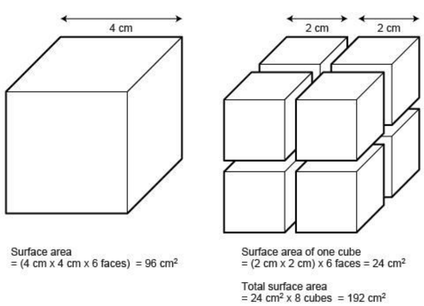
- A material has different properties to the 'bulk' chemical it's made from, because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes. e.g fullerenes have different properties to big lumps of carbon.

C2.3g compare 'nano' dimensions to typical dimensions of atoms and molecules

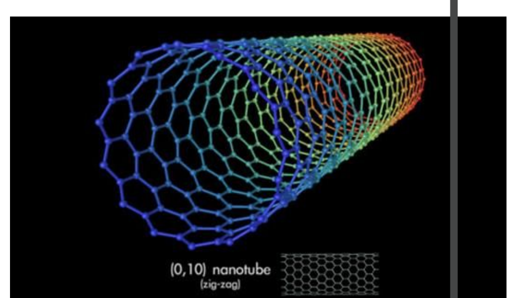
- Nanoparticles are 1-100 nanometers across.
- They contain a few hundred atoms.
- Nanoparticles, are smaller than fine particles (PM2.5), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m).
  - Coarse particles (PM10) have diameters between 1×10^{-5} m and 2.5×10^{-6} m.
  - Coarse particles are often referred to as dust.
- As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10

C2.3h describe the surface area to volume relationship for different-sized particles and describe how this affects properties

- In nanoparticles – surface area to volume ratio is very large
- Atoms on the surface of a material are often more reactive than those in the centre, so a larger surface area means the material is more reactive



C2.3i describe how the properties of nanoparticulate materials are related to their uses



- They have a high surface area to volume ratio, and therefore would make good catalysts.
- They can also be used to produce highly selective sensors.
- Nanotubes could make stronger, lighter building materials.
- New cosmetics, e.g sun tan cream and deodorant. They make no white marks.
- Lubricant coatings, as they reduce friction. These can be used for artificial joints and gears.
- Nanotubes conduct electricity, so can be used in small electrical circuits for computers.

C2.3j explain the possible risks associated with some nanoparticulate materials

- Don't know the risks fully yet as nanoparticulate materials are still being created and tested
- Medically there could be problems with how nanoparticulate materials interact with our cells