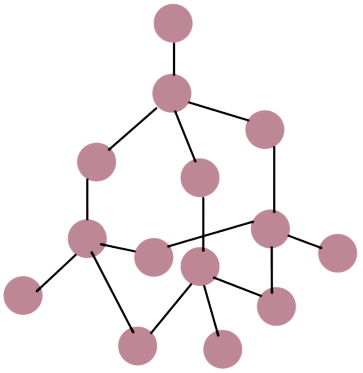
CAIE IGCSE Chemistry

2.6 Giant covalent structures

Notes

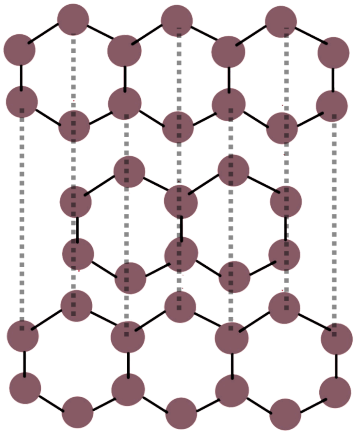
Describe the giant covalent structures of graphite and diamond

Diamond



- In diamond, each carbon atom is covalently bonded to 4 other carbon atoms
- Its structure is a tetrahedral 3D shape
- Diamond is very hard due to many strong covalent bonds
- Cannot conduct electricity as there are no delocalised electrons

Graphite



- In graphite, each carbon atom is covalently bonded to 3 other carbons
- Its structure consists of layers of hexagonal rings with no covalent bonds between the layers
- The layers are connected by weak intermolecular forces, meaning the layers can slide over each other resulting in graphite being soft
- One electron from each carbon atom is delocalised, meaning graphite can conduct electricity since the delocalised electrons carry charge

Relate the structures and bonding of graphite and diamond to their uses

Graphite

- Lubricant – layers slide over each other due to weak intermolecular forces
- Conductor (e.g. electrodes in batteries) – can conduct electricity due to delocalised electrons

Diamond

- Cutting tools – very hard due to rigid structure held together by strong covalent bonds

(Extended only) Describe the giant covalent structure of silicon(IV) oxide (silicon dioxide), SiO_2

- Silicon dioxide, also known as silica, is the main component of sand
- Each silicon atom is covalently bonded to 4 oxygen atoms
- Each oxygen atom is covalently bonded to 2 silicon atoms
- Therefore, the formula is SiO_2 (since Si_2O_4 simplified is SiO_2)

(Extended only) Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures

- In silicon (IV) oxide, each silicon atom is covalently bonded to 4 oxygen atoms and in diamond, each carbon atom is covalently bonded to 4 carbon atoms
- Both have strong covalent bonds which require a lot of energy to break so both diamond and silicon (IV) oxide have high melting and boiling points
- Both diamond and silicon (IV) oxide have their atoms bonded in a tetrahedral arrangement which means both structures are very hard and rigid