

Diamond

4.2.3.1 · Bonding, structure and the properties of matter · revision notes

Diamond is a form of carbon with a giant covalent structure in which each carbon atom is bonded to four others. You must explain why it is very hard, has a very high melting point and does not conduct electricity. It often appears alongside graphite in comparison questions.

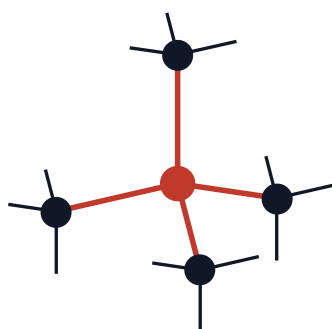
Key facts

- Diamond: carbon atoms, each forming 4 covalent bonds
- Very hard: strong covalent bonds hold every atom rigidly
- Does not conduct: no delocalised electrons (all 4 outer electrons used in bonds)
- Giant covalent structure: a rigid 3D network
- Very high melting point: many strong covalent bonds to break

Notes

Structure and bonding

- Diamond is made of **carbon atoms only**.
- Each carbon atom forms **four covalent bonds** with four other carbon atoms.
- This makes a **giant covalent structure**: a rigid 3D network that continues in all directions, with no separate molecules.



each carbon atom forms
4 covalent bonds (red)

the network continues
in all directions

Diamond: every carbon atom is bonded to four others in a rigid 3D network.

- A carbon atom has four outer electrons, and in diamond **all four** are used in covalent bonds.

Properties explained

- **Very hard:** every atom is held in place by strong covalent bonds in a rigid 3D network, so the atoms cannot easily be moved out of position.
- **Very high melting point:** to melt diamond, a huge number of strong covalent bonds must be broken, which needs a very large amount of energy.
- **Does not conduct electricity:** all the outer electrons are used in bonds, so there are **no delocalised electrons** (and no ions) free to move and carry charge.

Uses and comparison

- Its hardness makes diamond useful for cutting tools, such as the tips of drills and saws used to cut rock, glass and metal.
- Graphite is also carbon with a giant covalent structure, but each atom forms only three bonds. This one difference explains why graphite is soft and conducts electricity.

How to answer each type of question

Explain why diamond has a very high melting point (or is very hard)

3 marks

Grade 5

1. Describe the structure: giant covalent, each carbon atom bonded to four others.
2. Say there are many strong covalent bonds.
3. Melting point: a lot of energy is needed to break them. Hardness: the atoms are held rigidly in place.

Example. Explain why diamond has a very high melting point.

Model answer. Diamond has a giant covalent structure in which each carbon atom is bonded to four others (1). There are many strong covalent bonds (1). A lot of energy is needed to break these bonds (1).

Don't lose marks

- ✗ Saying diamond is made of molecules or has intermolecular forces.
- ✗ Saying diamond is hard because of ionic bonds, or because of 'strong forces' without saying covalent bonds.
- ✗ Saying diamond doesn't conduct because it has no free ions. The key point is that it has no delocalised electrons.
- ✗ Writing that each carbon atom in diamond forms three bonds. That is graphite.

More tips

Memory tricks

- Diamond: 4 bonds per carbon = 0 spare electrons = no conduction.
- Hard, high, no flow: diamond is very hard, has a very high melting point, and lets no charge flow.
- Diamond vs graphite: 4 bonds vs 3 bonds. Almost every difference in properties comes from this.

Exam technique

- Start every diamond answer with the structure: giant covalent, each carbon atom bonded to four others. Then link each property to it.
- Use 'many strong covalent bonds' for hardness and melting point, and 'no delocalised electrons' for conductivity.
- In comparisons with graphite, write about both substances, point by point.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State that diamond is a form of carbon

Diamond is made only of carbon atoms, in a giant covalent structure.

Grade 4

Describe the bonding in diamond

Each carbon atom forms four covalent bonds with other carbon atoms.

Grade 5

Explain why diamond is very hard

Many strong covalent bonds hold the atoms rigidly in a 3D network.

Grade 5

Explain diamond's very high melting point

A lot of energy is needed to break the many strong covalent bonds.

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