

Giant covalent structures

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

Substances such as diamond, graphite and silicon dioxide, in which every atom is joined to others by strong covalent bonds in a huge network. You need to explain their very high melting points, recognise them from diagrams, and contrast them with substances made of small molecules.

Key facts

- Giant covalent: all atoms joined by strong covalent bonds in a network
- Melting breaks many strong covalent bonds → very high melting points
- Usually do not conduct (no charged particles free to move); graphite is the exception
- Examples: diamond, graphite, silicon dioxide (silica)
- No separate molecules
- SiO_2 : each Si bonded to 4 O, each O bonded to 2 Si

Notes

What a giant covalent structure is

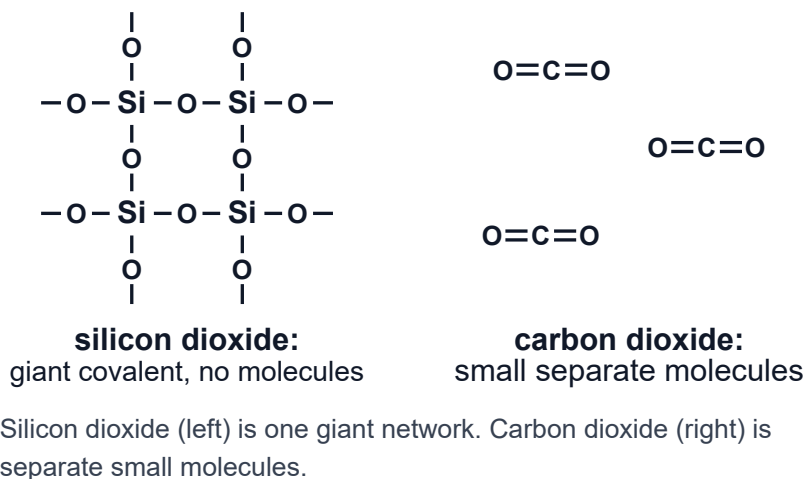
- In a **giant covalent structure**, **all** the atoms are linked to other atoms by **strong covalent bonds**, forming a huge network.
- There are no separate molecules.
- Examples: **diamond** and **graphite** (forms of carbon) and **silicon dioxide**, SiO_2 (silica, the main compound in sand).
- In silicon dioxide, each silicon atom is bonded to four oxygen atoms and each oxygen atom to two silicon atoms, which gives the 1 : 2 ratio in SiO_2 .

Properties

- To melt or boil a giant covalent substance, **covalent bonds must be broken**.
- There are a huge number of strong bonds, so a **very large amount of energy** is needed. So these substances are **solids** with **very high melting and boiling points**.
- Most do not conduct electricity, because they have no charged particles that are free to move. Graphite is the exception: it has delocalised electrons.

Recognising them from diagrams

- Look for many atoms joined by lines (bonds) in a repeating network, with bonds going off the edges of the diagram.
- Diamond: each carbon atom joined to four others in 3D. Graphite: flat layers of hexagons. Silicon dioxide: silicon and oxygen atoms alternating in a network.



- Not giant covalent: small, complete molecules; chains in brackets with n (polymers); + and - ions (ionic).

How to answer each type of question

Explain why a giant covalent substance has a very high melting point

3 marks

Grade 5

- Name the structure: giant covalent.
- Say there are many strong covalent bonds (every atom is linked).
- Say these must be broken, which needs a lot of energy.

Example. Silicon dioxide does not melt until over 1600 °C.
Explain why, in terms of its structure and bonding.

Model answer. Silicon dioxide has a giant covalent structure (1). There are many strong covalent bonds between the atoms (1). A lot of energy is needed to break these bonds (1).

Don't lose marks

- ✗ Saying diamond or silicon dioxide has intermolecular forces. They have no separate molecules.
- ✗ Saying silicon dioxide has a high melting point because of strong intermolecular forces.
- ✗ Writing 'strong bonds' without 'covalent', or saying silicon dioxide has ionic bonds.
- ✗ Confusing silicon dioxide (giant covalent) with carbon dioxide (small molecules).
- ✗ Saying that all giant covalent substances are hard and don't conduct: graphite is soft and conducts.

More tips

Memory tricks

- Giant covalent: no molecules, so melting means breaking covalent bonds.
- Sand (silica) and diamond both have very high melting points: both are giant covalent.
- Very high melting point + doesn't conduct even when molten → giant covalent. Graphite is the one that does conduct.

Exam technique

- The key phrase is 'many strong covalent bonds', which must be broken and need a lot of energy.
- In compare questions, write about both substances: explaining only one earns at most half the marks.
- Identify the structure first, from the formula, the diagram or the data, then explain the property.

What each grade needs

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

Grade 3

Name examples of giant covalent structures

Diamond and graphite (both forms of carbon) and silicon dioxide (silica).

Grade 4

State that they have very high melting points

They are solids at room temperature with very high melting and boiling points.

Grade 5

Explain their very high melting points

Many strong covalent bonds must be broken, which needs a lot of energy.

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