

## Carbon allotropes: Johnstone's triangle

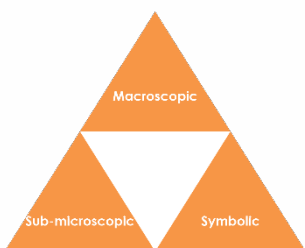
This resource is from the **Johnstone's triangle series** which can be viewed at: [rsc.li/3WUOFVK](https://rsc.li/3WUOFVK). It will help learners understand the different ways you need to think in chemistry, building their mental models and understanding.

### Learning objectives

- 1 Describe two different carbon allotropes based on observations.
- 2 Use symbolic models to represent carbon allotropes.
- 3 Explain how the different bonding in carbon allotropes relates to their properties.

### How to use Johnstone's triangle

Use Johnstone's triangle to develop learners' thinking about scientific concepts at three different conceptual levels:



- Macroscopic – what we can see. Think about the properties we can observe, measure and record.
- Symbolic – representations. Think about how we represent chemical ideas including symbols and diagrams.
- Sub-microscopic – smaller than we can see. Think about the particle or atomic level.

For learners to gain a deeper awareness of a topic, they need to understand it at all three levels.

When introducing a topic, do not try to introduce all of the levels of thinking at once. This will overload working memory. Instead complete the triangle over a series of lessons, beginning with the macroscopic level and introducing other levels, in turn, once secure.

All of the levels are interrelated, for example, learners need visual representation of the sub-microscopic in order to develop mental models of the particle or atomic level.

Find further reading about Johnstone's triangle and how to use it in your teaching at [rsc.li/3X08N96](https://rsc.li/3X08N96).

### Scaffolding

It is important to share the structure of the triangle with learners prior to use. Tell them why you want them to use the triangle and how it will help them to develop their understanding. Use an 'I try, we try, you try' approach when you are introducing Johnstone's triangle for the first time.

### More resources

To further develop learner's thinking in all areas of Johnstone's triangle, try our **Developing understanding** worksheets ([rsc.li/3YaxFKB](https://rsc.li/3YaxFKB)). These include icons in the margin referring to the conceptual level of thinking needed to answer the question.

**Macroscopic – what we can see**

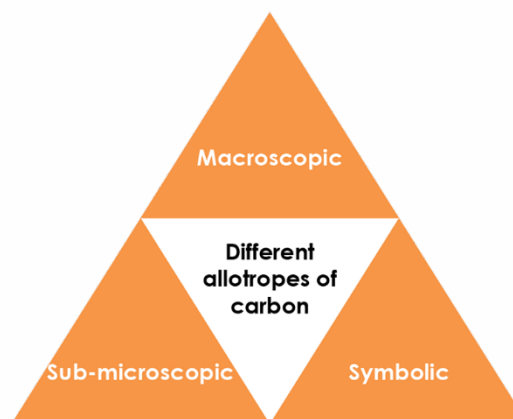
Describe the following allotropes, their properties and uses:

- Diamond *Transparent crystal, highly reflective, very hard, electrical insulator. Used for decoration and industrial cutting.*
- Graphite *Black/grey solid with a metallic lustre. Soft, conducts electricity. Used for pencils, lubricants and electrodes.*

**Sub-microscopic – smaller than we can see**

Complete the table below by writing 'diamond', 'graphite', or 'both' in the final column:

Made of only one type of atom.	Both
Has a giant covalent structure.	Both
Contains delocalised electrons.	Graphite
Each carbon atom is bonded to three other carbon atoms.	Graphite
Each carbon atom is bonded to four other carbon atoms.	Diamond
Formed of flat sheets of linking hexagons.	Graphite
Formed of a 3D lattice of repeating tetrahedrons.	Diamond

**Symbolic – representations**

Label the following on the diagrams below:

- Carbon atom
- Covalent bond
- Intermolecular force

