

Exploding questions: structure and bonding

This resource accompanies the article **Improve literacy in science students** in *Education in Chemistry* which can be viewed at: rsc.li/3QIBxyc

Learning objectives

- 1 Recall your prior learning on bonding, structure, the properties of matter and changes of state.
- 2 Develop a technique to tackle extended-response exam questions and improve your answers.

Introduction

If learners do not understand the language used in questions, they may struggle to present their answers clearly, lose marks for contradictions, use the wrong key words or miss key information.

In the exploding question technique, learners annotate the question, or associated diagrams, with important facts relevant to the topic. Using this technique, learners essentially create a plan for answering extended-response exam questions.

Modelling the technique for learners will enable them to use it independently and by using good example questions they can benefit from their peers' knowledge too.

How to use the resource

Use the PowerPoint slides to introduce example one, a real past-paper question. Slide four shows how to annotate the question; command words/key instructions are boxed and key words within the question are underlined.

Slide five explodes the question, identifying key information. The blue text describes the bonding and structure and the red text provides the explanation prompted by the question.

Then, ask your learners to write their answers independently. By ticking or highlighting when a point is included they can ensure they have covered all necessary information, hopefully maximising their marks. Share the marking guidance (slide seven) with learners so they can check how successful they have been.

Example two provides another, similar question to give learners the opportunity to practice the technique. Ask them to work on their own first, then discuss their exploded question in pairs or small groups before writing an answer.

Common misconceptions

Be aware of common misconceptions surrounding bonding. Learners often struggle with the difference between breaking the bonds between atoms and breaking the forces between molecules, eg suggesting 'the low boiling point in carbon dioxide is due to the weak covalent bonds between atoms breaking.' **How to teach covalent bonding** rsc.li/40SodvT will support you to pre-empt or address misconceptions.

Differentiation and support

You can use the questions below to help explode the question in the first example or to support those learners who need it with the second example.

Alternatively, you can support learners with writing answers to extended-response questions using structure strips (see rsc.li/2POJDIW for information and template). This may be useful for learners who need more support with the writing part of the task.

Give learners who have confidently grasped the technique another extended-response question to try independently.

To introduce an opportunity for higher order thinking on this topic, ask learners to choose one substance they have been taught about with a low melting and boiling point and one with a high melting and boiling point. Then ask them to design a question similar to these examples. The learners then asks a peer to answer and the question writer marks the answer.

Example one support questions

Chlorine

- Is chlorine a metal or a non-metal?
- What type of bonding does chlorine have?
- Is the structure simple (molecular) or giant?
- Are the forces between the chlorine molecules strong or weak?
- Is a little or a lot of energy needed to overcome these forces?
- So, does chlorine have a low or high melting point and boiling point?

Sodium chloride

- Is chlorine a metal or a non-metal?
- Is sodium a metal or a non-metal?
- What type of bonding does sodium chloride have?
- What is the structure of sodium chloride (simple or giant)?
- Are the bonds between the positive sodium and negative chloride ions strong or weak?

- Is a little or a lot of energy needed to overcome these forces?
- So, does sodium chloride have a low or high melting point and boiling point?

Example two support questions

Carbon dioxide

- Is carbon a metal or a non-metal?
- Is oxygen a metal or a non-metal?
- What type of bonding does carbon dioxide have?
- Is the structure simple (molecular) or giant?
- Are the forces between the molecules strong or weak?
- Does this mean a little or a lot of energy is needed to overcome the forces?
- So, does carbon dioxide have a low or high melting point and boiling point?

Diamond

- Name the element diamond consists of?
- Is this element a metal or a non-metal?
- What type of bonding does diamond have?
- Is the structure simple (molecular) or giant?
- Are the bonds between the atoms strong or weak?
- Is a little or a lot of energy needed to overcome them?
- So, does diamond have a low or high melting point and boiling point?

Marking guidance

In questions like these the key idea is about relating structure to melting and boiling points and the amount of energy needed to break bonds or intermolecular forces.

The examples of chemistry points made offered in the slides will help learners develop their language and understanding but represent more than may be needed in an examination answer. Refer to the mark scheme below for guidance.

Those following the AQA course should note that the past-paper question used in the example was taken from a legacy AQA exam paper and AQA now has a different approach to the marking of these types of questions linked to the GCSE level descriptors. Extended response questions are marked using a levels of response (LoR) mark scheme.

Example 1

Level	Definition
0 marks	No relevant content.
Level 1 (1–2 marks)	Up to two marks can be given for any of the description statements given below.
Level 2 (3–4 marks)	There must be either a description statement and an explanation about one substance or description statements about both substances.
Level 3 (5–6 marks)	Descriptions and explanations of both substances must be included. Please note that not all points must be included to be awarded full marks. Key points can be found in bold.

Chlorine

- **structure: simple** (allow molecular) (1)
- bonding: covalent (1)

Explanation of why it is a gas

- **weak** (1)
- intermolecular **forces** (1)
- **take little energy to overcome** (1)
- low (melting point) boiling point (1)

Sodium Chloride

- structure: giant (1)
- **bonding: ionic** (1)

Explanation of why it is a solid

- **strong** (1)
- **ionic bonds** (electrostatic attraction between + and – ions) (1)
- **takes lots of energy to break** (1)
- high melting point (boiling point) (1)

Example two

Level	Definition
0 marks	No relevant content.
Level 1 (1–2 marks)	Up to two marks can be given for any of the description statements given below.
Level 2 (3–4 marks)	There must be either a description statement and an explanation about one substance or description statements about both substances.
Level 3 (5–6 marks)	Descriptions and explanations of both substances must be included. Please note that not all points must be included to be awarded full marks. Key points can be found in bold.

Carbon dioxide

- **structure: simple** (allow molecular) (1)
- bonding: covalent (1)

Explanation of why it is a gas

- **weak** (1)
- intermolecular **forces** (1)
- **take little energy to overcome** (1)
- low (melting point) boiling point (1)

Diamond

- **structure: giant** (1)
- bonding: covalent (1)

Explanation of why it is a solid

- **strong** (1)
- **covalent bonds** (between carbon atoms) (1)
- **take lots of energy to break** (1)
- high melting point (boiling point) (1)