



# SeaHawk Tutors

## AQA Chemistry GCSE Topic 4.2 - Bonding, Structure and Properties

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### Topic 4.2 only

1. This question comprises 10 multiple choice questions.

- a. In the structure of diamond, each Carbon atom is bonded to how many other atoms?

A	B	C	D
2	3	4	5

- b. Which of these does NOT have an electron configuration of 2,8?

An atom of Neon	An atom of Fluorine	An ion of Sodium	An ion of Aluminium
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- c. Which of these statements is NOT correct?

Most covalent substances have molecular structures	All substances with metallic bonding have giant lattice structures	Graphite has a structure with similar qualities to the structure of a metal	Metals can form covalent bonds
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- d. Which of these substances does NOT have a giant lattice structure?

Silicon dioxide	Buckminster Fullerene	Sodium oxide	Gold
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- e. In a diagram showing the arrangement of particles in a solid, which of these is NOT a limitation of the simple model?

All particles are shown as spheres	The diagram is much bigger than actual particles	The particles are shown as solid objects	No forces are shown
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- f. In the structure of graphite, each Carbon atom is covalently bonded to how many other atoms?

2	3	4	5
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- g. A chemist takes a sample of solid sodium chloride and dissolves it in water at 40°C for use in an experiment. What state symbol would be shown beside the NaCl in the equation?

(s)	(l)	(aq)	(g)
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- h. Which of the following would you predict will conduct electricity?

Molten Aluminium Sulfide	Solid Iodine	Gaseous Hydrogen	Liquid Oxygen
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- i. Which of the following would you predict will have the highest melting point?

Poly(ethene)	Iodine	Silicon dioxide	Sodium
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- j. A nanometer is:

$1 \times 10^{-3} \text{ m}$	$1 \times 10^{-6} \text{ m}$	$1 \times 10^9 \text{ m}$	$1 \times 10^{-9} \text{ m}$
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Total Marks - 10

2. This question is about the states of matter.

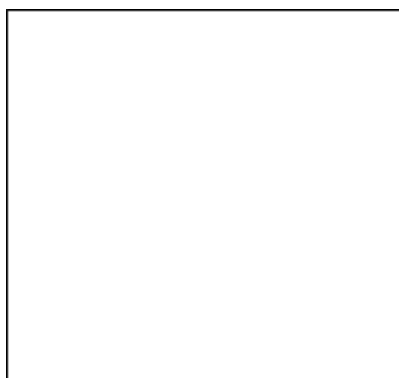
- a. Complete the following paragraph using words from the table below. You may use words once, more than once or not at all. [6]

Matter is made up of \_\_\_\_\_ which can be atoms, ions or \_\_\_\_\_. In solid state the particles are arranged in a \_\_\_\_\_ pattern and are \_\_\_\_\_ packed. They do not move in relation to each other but they can \_\_\_\_\_ about a fixed position.

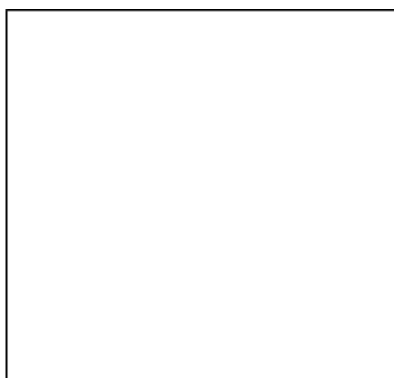
The process of changing state from solid to \_\_\_\_\_ is called melting, and from solid to \_\_\_\_\_ is called sublimation. For either of these changes of state to happen, the bonds or forces that hold the \_\_\_\_\_ together have to be overcome. The \_\_\_\_\_ those bonds or forces, the more \_\_\_\_\_ is required to break them, and therefore the \_\_\_\_\_ the melting and boiling point of that substance.

energy	weaker	loosely	gas	solid
stronger	power	temperature	liquid	vibrate
particles	higher	tightly	molecules	random
slide	randomly	lower	kinetic	thermal

- b. Draw a diagram showing the particles in a gas and in a liquid. [4]



Liquid



Gas

Total Marks – 10

3. This question is about bonding and structure.

- a. Draw lines from the boxes on the left to the boxes on the right to show the correct elements in each type of bonding. [1]

Ionic bonding

Covalent bonding

Metal and metal

Metal and non-metal

Non-metal and non-metal

- b. Draw dot-cross diagrams to show the **outer shell electrons** only:  
 i. when an atom of Calcium bonds with an atom of Oxygen; [2]

ii. in a molecule of Carbon Dioxide. [2]

c. Ring the correct words in **bold type** to make the sentences correct. [2]

i.

**mostly**                                   **giant lattice**  
Ionic compounds                                   have                                   structures

**always**                                   **simple molecular**

ii.

**mostly**                                   **giant lattice**  
Covalent substances                                   have                                   structures

**always**                                   **simple molecular**

d. Give one example of an **element** that exists in the form of covalently-bonded molecules. [1]

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e. Give one example of a substance that exists in the form of a covalently-bonded giant lattice structure. [1]

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Total Marks – 9

4. Chlorine and Lithium combine via ionic bonding to form a compound, X.

a. Write the word equation of the reaction that creates compound X. [2]

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- b. Put a ring around the most likely melting point of compound X from the options below.

-75°C

12°C

105°C

615°C

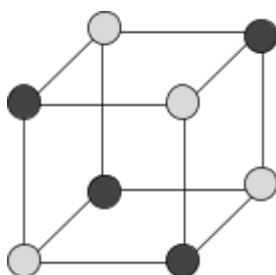
[1]

- c. Use the words below to complete the following description of the process by which these two elements combine to form compound X. [4]

Each Lithium atom \_\_\_\_\_ an electron. That electron is \_\_\_\_\_ by a Chlorine atom. As a result of this process, the atoms gain \_\_\_\_\_ and are now ions. The \_\_\_\_\_ ions are positive and the \_\_\_\_\_ ions are negative. Being \_\_\_\_\_ charged causes the ions to be bonded together by forces of \_\_\_\_\_ attraction.

loses	lost	gains	gained
creates	destroys	magnetic	electrostatic
Lithium	Chlorine	mass	charge
oppositely	similarly	positively	negatively

- d. The diagram shows the structural arrangement of a specific substance which is one of the four named below. Identify by putting a ring around it which of the substances below it could possibly be. [1]



Carbon dioxide

Diamond

Sodium Fluoride

Magnesium Fluoride

- e. The diagram above is called a 'ball and stick' diagram. State one limitation with this type of diagram. [1]

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Total Marks - 9

5. A metal is defined as an element that forms positive ions.

- a. Describe the bonding and structure that occurs in a pure metal. Draw a labelled diagram to make your explanations clear. [3]

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- b. Two physical properties of metals are that they are good conductors of electricity and they can be formed into shapes such as sheets and wires.

Use the bonding and structure described in (a) to explain these properties.

- i. Electrical conductivity: [2]

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- ii. Ductility/malleability: [2]

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- c. State two other physical properties of metals. [2]

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Steel is an alloy of Iron.

- d. Define the term 'alloy.' [2]

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e. Name one specific type of steel. [1]

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f. Explain why steel is more useful in many industrial circumstances than iron and how the alloying process causes the change in properties that improves its usefulness. [3]

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Total Marks – 15

6. Chlorine, Bromine and poly(propene) are all molecular substances. At room temperature Chlorine is a gas, Bromine is a liquid and poly(propene) is a solid.

a. Suggest what you can infer about the intermolecular forces in the three substances from their melting points. [1]

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b. Many non-metallic elements form diatomic molecules.

i. Name one such element. [1]

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ii. Explain the term 'diatomic molecule.' [1]

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c. Carbon exists in various allotropes, some of them natural and some man-made.

i. Define the term 'allotrope.' [1]

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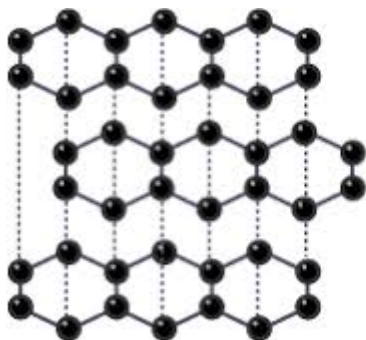
ii. Name one natural allotrope of Carbon. [1]

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iii. Name one man-made allotrope of Carbon. [1]

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d. The diagram shows the structure of one particular allotrope of Carbon. Name this substance.



\_\_\_\_\_ [1]

This allotrope can conduct electricity and is used as a lubricant.

e. Explain how these properties derive from the substance's structure.

i. Electrical conductivity: [3]

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ii. Usability as a lubricant: [2]

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Total Marks - 12



7. Innovations and discoveries in chemistry over recent decades have often involved very small particles. The diagram below shows the structure of one such substance.



- a. Identify this substance and state its chemical formula. [2]

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Another such substance is often described as ‘a single layer of graphite.’

- b. Name this substance. [1]

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- c. Mark which of the following are properties of this substance. [2]

☐

It can be magnetised

☐

It dissolves in water

☐

It has a very high strength-to-weight ratio

☐

It conducts electricity

Nanoscience is the study of particles that are of the order of 10 to 1000 times the size of an atom. Nanoparticles have useful properties that derive from their high surface area to volume ratios.

- d. Write 1 nanometer in terms of meters in standard form. [1]

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A Zinc atom has a diameter of 0.28 nm. A nanoparticle of Zinc Oxide has a diameter of 56nm.

- e. Calculate the ratio of the diameter of the nanoparticle to the diameter of the atom. [2]

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A sample of Zinc Oxide in nanoparticle form has a mass of 3.3g and a surface area of  $49.5 \text{ m}^2$ . A 1cm cube of solid Zinc Oxide has a mass of 7.1g.

- f. Show that the surface area to mass ratio of the nanoparticle sample is 175,000 times the surface area to mass ratio of the solid sample. [4]

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Total Marks - 12

8. A chemist is examining two substances. Substance A is Potassium Oxide. Substance B is Silicon Nitride.

- a. Describe, in terms of electrons, the way that the elements in substance A are bonded. [3]

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- b. State the bonding and structure that you would expect substance B to have. [2]

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- c. Substance A has a much higher melting point than substance B. Explain why this is. [3]

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- d. Predict the ability of the two substances to conduct electricity in different states. Put a tick in the boxes where you believe that electricity would be conducted.

	Solid	Liquid
Substance A		
Substance B		

[2]

Total Marks - 10

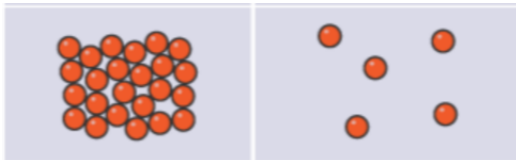
# Answers

1.

- a. C
- b. B
- c. B
- d. D
- e. B
- f. B
- g. C
- h. A
- i. C
- j. D

2.

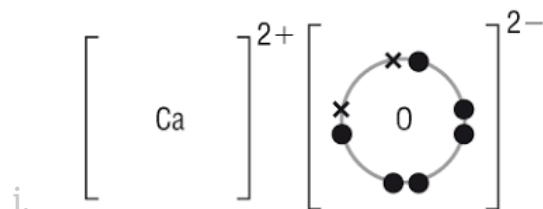
- a. Particles, molecules, regular, tightly-packed, vibrate, liquid, gas, particles, greater, energy, higher. Subtract 1 mark for each incorrect answer.



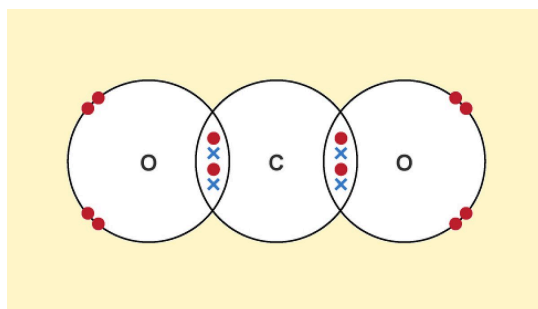
b.

3.

- a. Ionic = metal and non-metal  
Covalent = non-metal and non-metal
- b.



Calcium may show full outer shell also



ii.

- c.
  - i. Always, giant lattice
  - ii. Mostly, simple molecular
- d. Any one from Hydrogen, Oxygen, Nitrogen, any halogen, any other correct element
- e. Diamond, graphite, silicon dioxide. Do not allow Carbon.

4.

- a. Lithium + Chlorine  $\rightarrow$  Lithium Chloride
- b.  $615^{\circ}\text{C}$

- c. Loses; gained; charge; Lithium; Chlorine; oppositely; electrostatic. Subtract 1 mark for each incorrect answer.
- d. Sodium Fluoride
- e. Any one of: shows bonds as solid lines; misrepresents sizes and distances; do not show forces; struggle to show detail of complex structural shapes.

5.

- a. Metal atoms lose one or more electrons to become **ions**. Ions arrange themselves in a regular **lattice** structure. The lost electrons become **delocalised** and form a '**soup**' or '**glue**' that hold the positively charged metal ions together.
- b.
  - i. Delocalised electrons are **charged particles** which are **free to move**.
  - ii. Ions are arranged in **layers** which can **slide** across each other.
- c. Shiny; conduct heat; high melting and boiling points
- d. A **mixture of a metal and (at least) one other substance** (allow metal), All 3 bold elements for both marks. 1 mark for just one.
- e. Stainless steel, carbon steel, mild steel, tool steel,
- f. Iron is relatively **soft and/or weak** and steel is **stronger / harder** (M1). The atoms of the alloying material **break up / disrupt the layers** and **prevent layers from sliding** as easily.

6.

- a. The intermolecular forces are stronger in poly(propene) than bromine which is stronger than chlorine.
- b.
  - i. Hydrogen, Oxygen, any halogen, Nitrogen
  - ii. A molecule made up of (only) 2 atoms
- c.
  - i. A different structural form of the same element
  - ii. Diamond, graphite. Ignore graphene. Allow fullerenes.
  - iii. Graphene
- d. Graphite
- e.
  - i. Each carbon atom is **bonded to 3 others**, leaving one electron free. This electron is **delocalised**, meaning is **free to move** and/or **carry charge**.
  - ii. The atoms are arranged in **layers** which can **slide** over each other.

7.

- a. Buckminster fullerene, C<sub>60</sub>
- b. Graphene
- c. Boxes 3 & 4
- d.  $1 \times 10^{-9}$  or  $10^{-9}$
- e. Shows dividing  $56 / 0.28 = 200 : 1$ . Allow 200
- f. Conversion m<sup>2</sup> to cm<sup>2</sup> or reverse, factor of  $100 \times 100$  or  $100^2$  or 10,000 M1  
 SA of cube = 6 cm<sup>2</sup> M1  
 SA:m for nanoparticle:  $49.5 \times 10000 / 3.3 = 150,000$   
 SA:m for cube [6] / 7.1 = 0.85 M1 for one or other, with their SA of cube  
 $150,000 / 0.85 = 177,367$  A1

8.

- a. Potassium atoms **give / donate** electrons to Oxygen atoms, creating **ions** of opposite charges, which are bonded by **forces of (electrostatic) attraction**.
- b. Covalent bonding; simple molecular structure.
- c. To melt a substance requires that particles be separated. In A, the particles are ions held together with **strong ionic bonds** which take large amounts of energy to break them. In B, the particles are molecules held together by **weak intermolecular forces** which require little energy to overcome them.
- d. Only A / Liquid ticked, all others blank or X. Deduct 1 mark for each incorrect box.