GCSE Chemistry (9 – 1)

Structure and Bonding

Name: .....

Group: .....

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.

For markers use	
Question	**Mark**
1	/4
2	/11
3	/6
4	/7
5	/8
6	/10
7	/7
8	/8
Total	/61
%	
Grade	

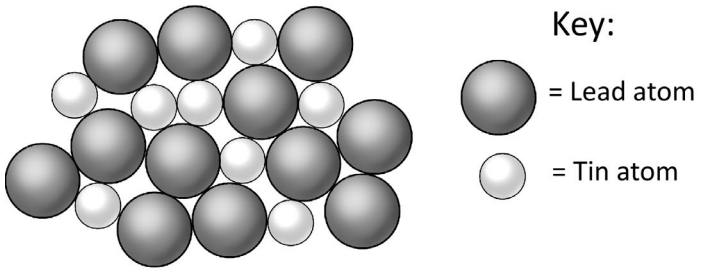
Information

- The maximum mark for this paper is 61 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.

1. At the core of all chemical reactions is the drive for atoms to achieve a stable, full outer shell of electrons, which they do by forming ionic, covalent, or metallic bonds.

   Circle the letter of the correct answer for each of the following questions.

a) A chemist was examining the structure of an alloy. The figure below shows the image of the alloy.



What is the simplest ratio of lead atoms to tin atoms in the alloy?

A	B	C	D
12 : 8	8 : 12	2 : 3	3 : 2

(1 mark)

b) Graphite is an allotrope of carbon with a giant covalent structure.
Which statement gives a **correct** description of graphite?

A It has a strong, rigid three-dimensional structure.

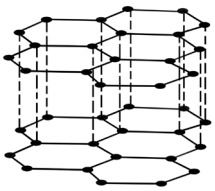
B It has four strong covalent bonds between each carbon atom.

C It has layers, which can slide over each other.

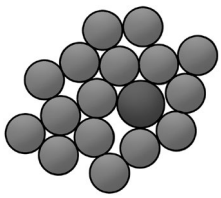
D It has no free electrons, so does not conduct electricity. **(1 mark)**

c) Which of the following figures shows the structure of an alloy?

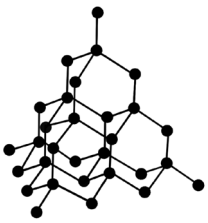
A



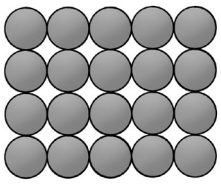
B



C



D



(1 mark)

d) A student is given an unknown substance, **Q**. They record the following properties:

- It is a shiny, silver-coloured solid.
- It is a good conductor of heat and electricity.

Which of the following statements about substance **Q** is correct?

A Q is a metallic element or a non-metallic element.

B Q is an ionic compound or a metallic element.

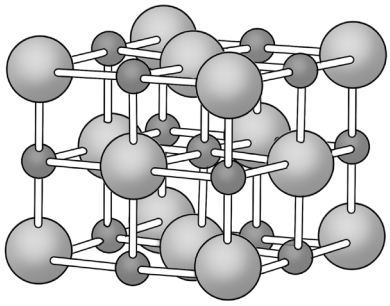
C Q is an alloy or a non-metallic element.

D Q is an alloy or a metallic element.

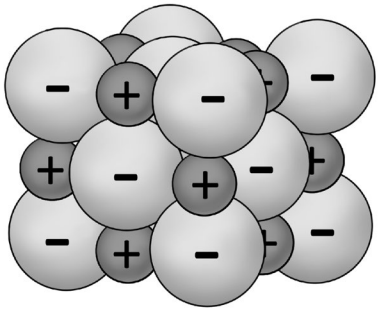
(1 mark)

(Total for Question 1 is 4 marks)

2. The figures below show **two** different models that can be used to represent the giant ionic lattice of sodium chloride, NaCl.



Ball and stick model



Space filling model

a) A student is using the ball-and-stick model to represent an ionic compound.

Describe **two** limitations of this model for showing the structure of an ionic compound.

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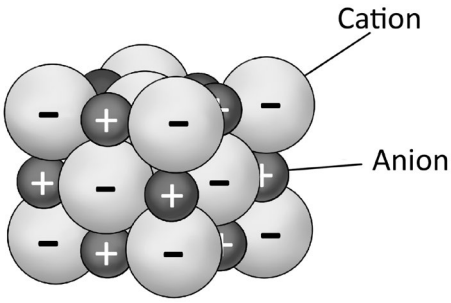
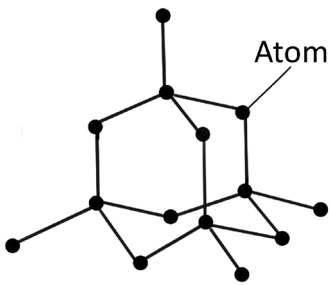
(2 marks)

The figures below show two different arrangements of particles in the solid state.
Structure **A** is formed from charged ions, while structure **B** is formed from neutral atoms



A



B

b) Describe the bonding shown in structure A.
Your answer should identify the type of bonding and a reason for your choice.

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(2 marks)

c) Explain, in terms of its **structure and bonding**, why substance B has a high melting point.

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(3 marks)

d) Explain why substance B cannot conduct electricity.
Your answer should refer to the electrons in its structure.

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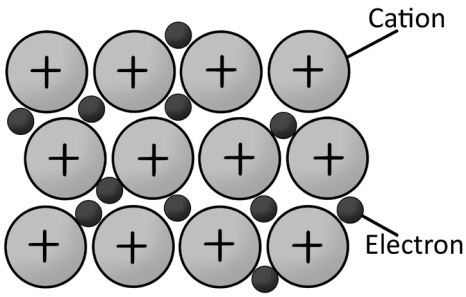
(2 marks)

e) Use the figure of the model below to explain why metals are **malleable**.



Your answer should describe:

- The particles in a metal.
- How these particles are arranged.

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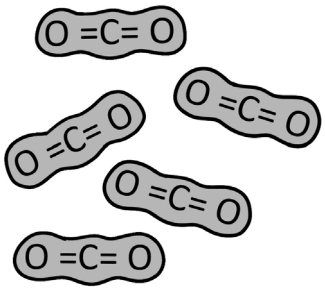
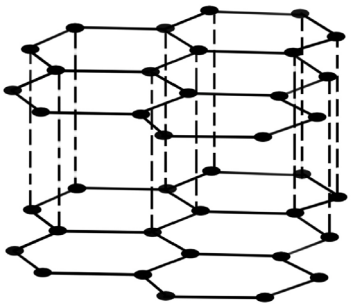
(2 marks)

(Total for Question 2 is 11 marks)

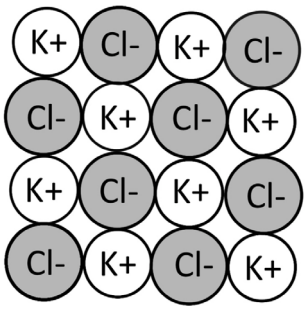
3. The figure below shows models of three different substances, P, Q, and R.
Compare the structure and bonding of substances P, Q, and R.



P



Q



R

In your answer, you should describe for each substance:

- The type of chemical bonding.
- The arrangement of its particles.
- The movement of its particles at room temperature.

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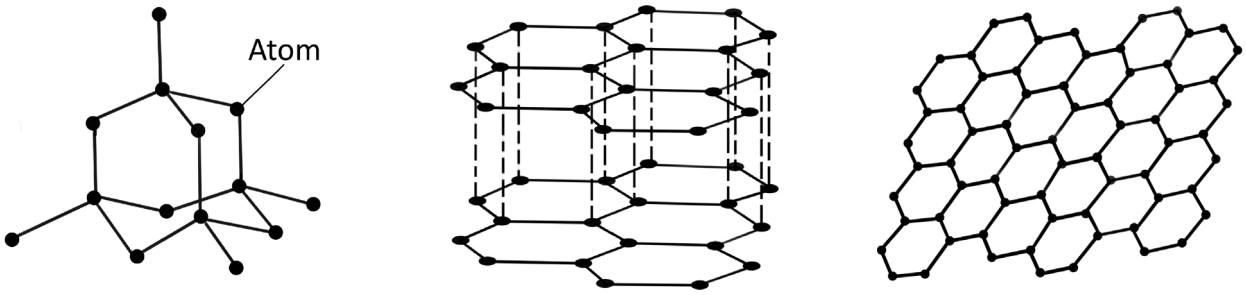
(6 marks)

(Total for Question 3 is 6 marks)

4. Carbon can exist in different forms called allotropes.

The figure below shows three different allotropes of carbon.

a) Complete the missing values in the table below.



Diamond **Graphite** **Graphene**

Allotrope	Covalent bonds
Diamond	.....
Graphite	3
Graphene	.....

(2 marks)

b) Diamond can be used as a cutting tool because it is so hard.

Explain, in terms of its **structure and bonding**, why diamond is a very hard substance.

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(3 marks)

c) The layers in graphite can slide over each other easily, making it useful as a lubricant.

Explain why these layers can slide, with reference to the forces involved.

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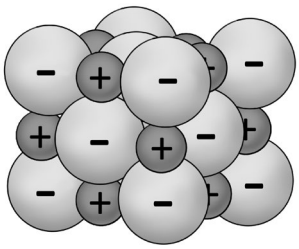
(2 marks)

(Total for Question 4 is 7 marks)

5. This question is about the ionic compound, sodium chloride, NaCl.
The figure below shows the structure on sodium chloride.



a) Describe, in terms of electrons, how a sodium atom and a chlorine atom react to form a sodium ion ,Na^+ and a chloride ion, Cl^-.

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(2 marks)

b) The structure of solid sodium chloride is a giant ionic lattice.

i. What are the forces that hold the ions together in the lattice?

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(1 mark)

ii. Explain why sodium chloride has a high melting point.

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(2 marks)

c) Explain why solid sodium chloride **does not conduct electricity**, but **molten** sodium chloride **does**.

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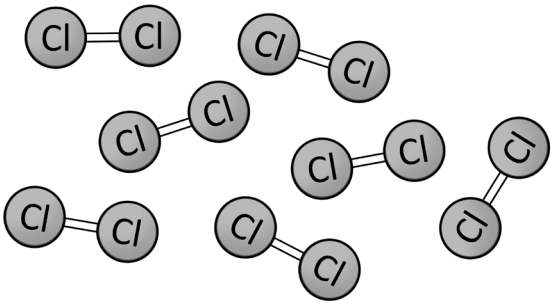
(3 marks)

(Total for Question 5 is 8 marks)

6. Chlorine exists as diatomic molecules. The figure below shows some molecules of chlorine gas.



In a molecule, two chlorine atoms are joined by a covalent bond.

a) Describe what is meant by a **covalent bond**.

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(2 marks)

b) Explain why chlorine is a gas, rather than a liquid, at room temperature.

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(2 marks)

c) This question is about four substances:

Chlorine: a simple molecular substance

Diamond: a giant covalent substance

Sodium chloride: a giant ionic substance

Zinc: a giant metallic substance

Explain the differences in the properties of these substances.

In your answer you should refer to structure and bonding to explain:

- Why chlorine has a very low melting point, while the other three have high melting points.
- Why sodium chloride dissolves in water but diamond does not."

(6 marks)

(Total for Question 6 is 10 marks)

7. Bromine is a liquid at room temperature and it vaporises easily.
Bromine has a simple molecular structure that has a low boiling point.

a) Explain, in terms of structure and bonding, why bromine has a low boiling point.

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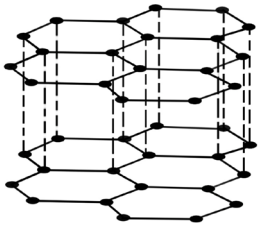
(2 marks)

b) The figure below shows part of the structure of graphite.



Explain, in terms of bonding and electrons, why graphite will be a good conductor of an electric current.

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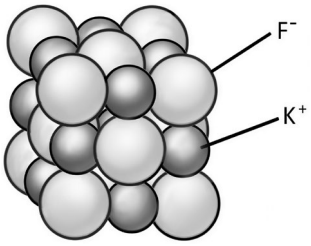
(3 marks)

c) The figure below shows the structure of potassium fluoride.



Potassium fluoride has a melting point of 858 °C. Explain why potassium chloride has a high melting point.

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(2 marks)

(Total for Question 7 is 7 marks)

8. Metals, such as sodium and magnesium, have a giant metallic lattice structure.

a) In the space below, draw a **labelled** diagram to show the arrangement of particles in a metal.

(3 marks)

b) Describe the bonding in a metal.

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(3 marks)

c) Use the metallic bonding model to explain why metals are good conductors of electricity.

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(2 marks)

(Total for Question 8 is 8 marks)