

# Covalent Substances

## Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Double Award (Paper 1C)
Topic	Principles of Chemistry
Sub-Topic	Covalent Substances
Booklet	Question Paper

**Time Allowed:** 97 minutes

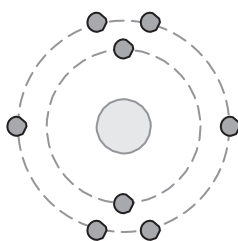
**Score:** /81

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

1 The diagram shows how the electrons are arranged in an atom of oxygen.



Oxygen atoms form both covalent and ionic bonds.

(a) Water is formed when two atoms of hydrogen combine with one atom of oxygen.

(i) Draw a dot and cross diagram of a molecule of water. You need only show the electrons in the outer shells.

(2)

(ii) Explain how the covalent bonds in the water molecule hold the hydrogen and oxygen atoms together.

(2)

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(b) The electronic configuration of a sodium atom is 2.8.1

Sodium oxide, Na<sub>2</sub>O, is an ionic compound formed when sodium reacts with oxygen.

(i) Describe, in terms of electrons, what happens when sodium oxide is formed in this reaction. (3)

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(ii) The reaction of sodium to form sodium oxide can be described as oxidation because it involves the addition of oxygen.

State one other reason why this reaction can be described as oxidation. (1)

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(c) Explain why water has a much lower melting point than sodium oxide. (2)

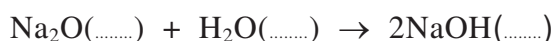
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(d) A teacher added sodium oxide to water in a beaker.  
The equation shows the reaction that occurred.



(i) Insert the appropriate state symbols in this equation. (2)

(ii) Some universal indicator was then added to the beaker. A colour change occurred. State the final colour of the universal indicator and identify the ion responsible for the colour change. (2)

Final colour .....

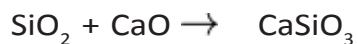
Ion responsible for colour change .....

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**(Total for Question 1 = 14 marks)**

- 2 When water is added to a mixture of sand and cement, a reaction takes place between silicon dioxide in the sand and calcium oxide in the cement. The reaction produces a salt called calcium silicate.

The equation for the reaction is:



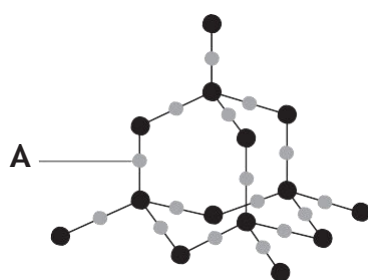
- (a) Explain why silicon dioxide reacts with calcium oxide.

(2)

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- (b) Part of the structure of silicon dioxide is shown in the diagram.



- (i) What does particle **A** represent? Give a reason for your answer.

(2)

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- (ii) Explain, in terms of its bonding and structure, why silicon dioxide has a very high melting point.

(4)

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(Total for Question 2 = 8 marks)

3 This question is about bromine and some of its compounds.

(a) Atoms of bromine can be represented as  $^{79}\text{Br}$  and  $^{81}\text{Br}$

(i) State the number of protons, neutrons and electrons in an atom of  $^{79}\text{Br}$  (2)

Protons .....

Neutrons .....

Electrons .....

(ii) What name is used for atoms of bromine that have different numbers of neutrons? (1)

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(iii) Why do all atoms of bromine have the same chemical properties? (1)

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(iv) The relative atomic mass of bromine is given in the Periodic Table as 80, but a more accurate value is 79.9

Suggest, with a reason, which of the atoms  $^{79}\text{Br}$  and  $^{81}\text{Br}$  exists in greater numbers in a sample of bromine. (2)

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(b) Hydrogen bromide (HBr) and sodium bromide (NaBr) are compounds of bromine.

(i) Draw a dot and cross diagram to represent a hydrogen bromide molecule.

Show only the outer electrons in each atom.

(2)

(ii) Explain how the atoms are held together in a hydrogen bromide molecule.

(2)

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(iii) Explain why sodium bromide has a higher melting point than hydrogen bromide.

(3)

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(c) A compound has the percentage composition 13.8% sodium, 47.9% bromine and 38.3% oxygen by mass.

Calculate its empirical formula.

(3)

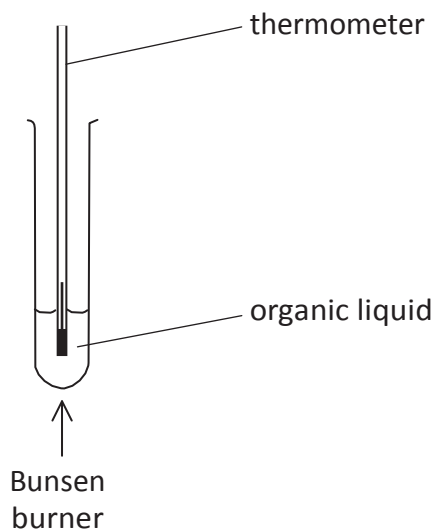
Empirical formula = .....

**(Total for Question 3 = 16 marks)**

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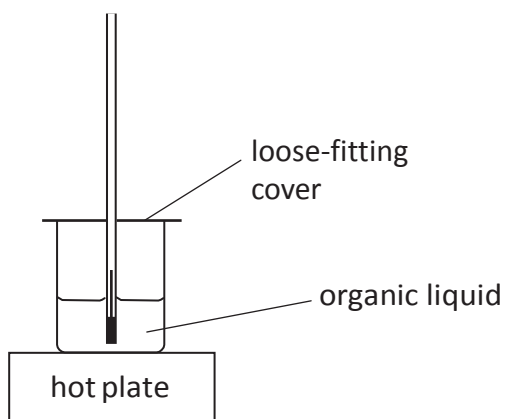
- 4 A teacher discussed with her students whether the boiling points of organic compounds are related to the size of their molecules.

The students suggested measuring the boiling points of some organic compounds using this apparatus.



- (a) The teacher said that their suggested method was too dangerous.

She recommended using the apparatus shown below instead.



Suggest **one** reason why this apparatus is better than the students' suggestion.

(1)

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(b) The students used the apparatus recommended by the teacher to measure the boiling points of five alcohols.

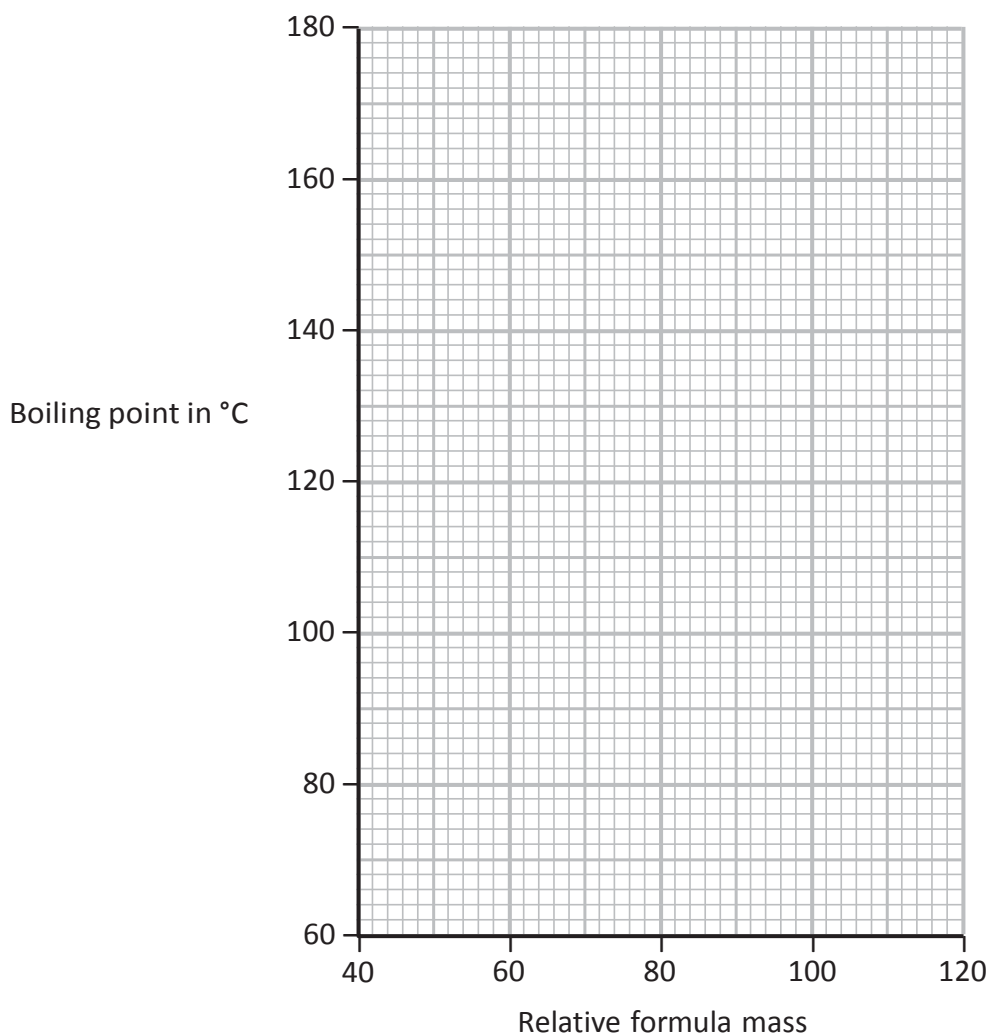
Their results are shown in the table.

	Alcohol				
	A	B	C	D	E
Boiling point in °C	78	96	138	157	176
Relative formula mass	46	60	88	102	116

(i) Plot a graph of the data in the table on the grid.

Draw a straight line of best fit through the points.

(3)





(ii) Describe the relationship shown by your graph.

(1)

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(iii) Use your graph to predict the boiling point of the alcohol that has a relative formula mass of 74.

(1)

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(iv) Which of the alcohols **A**, **B**, **C**, **D** or **E** is the least volatile?

(1)

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**(Total for Question 4 = 7 marks)**

5 Ethene can be converted into many useful substances.

(a) Draw a dot and cross diagram to show the covalent bonding in a molecule of ethene.  
Only the outer electrons in each atom need to be shown.

(2)

(b) Compound X is made from ethene and is used in cars to prevent the engine coolant from freezing in cold weather.

(i) Compound X contains 38.7% carbon, 9.7% hydrogen and 51.6% oxygen by mass.

Calculate the empirical formula of X.

(3)

Empirical formula .....

(ii) The relative formula mass ( $M_r$ ) of X is 62

What is the molecular formula of X?

(1)

Molecular formula .....

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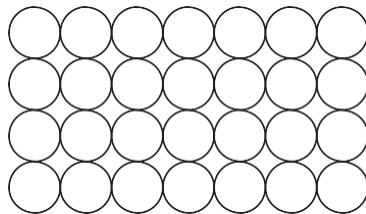
**(Total for Question 5= 6 marks)**

6 The properties of substances can be explained in terms of their bonding and structure.

Electricity can be transmitted by overhead power lines. This method of transmission requires electrical conductors and insulators.

- (a) Aluminium is used for the overhead lines because it is a good conductor of electricity and is ductile (can be pulled into a wire).

This diagram can be used to represent the structure of aluminium.



○ aluminium atom

- (i) Explain why aluminium is a good conductor of electricity.

(2)

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- (ii) Suggest why aluminium is ductile.

(2)

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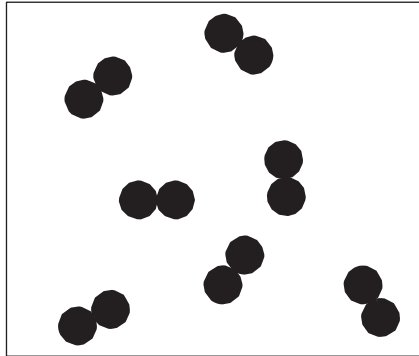
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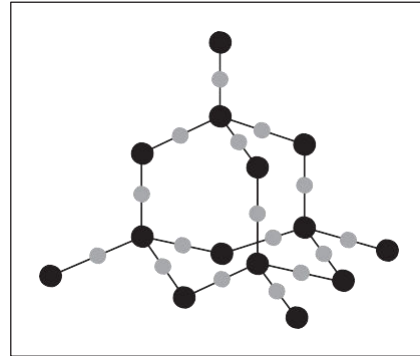
(b) The main substance that acts as an insulator in this method of transmission of electricity is air, which is mostly nitrogen.

The power lines are supported by solid insulators. Most solid insulators are manufactured using silica.

The diagram shows the structures of nitrogen and silica.



Nitrogen



Silica

Explain, in terms of bonding and structure, why nitrogen is a gas at room temperature but silica is a solid with a high melting point.

(5)

Nitrogen

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Silica

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**(Total for Question 6 = 9 marks)**

7 The table shows some properties of four substances A, B, C and D.

Substance	Melting point in °C	Boiling point in °C	Conducts electricity when solid?	Conducts electricity when molten?
A	-101	-35	no	no
B	1063	2970	yes	yes
C	801	1413	no	yes
D	3550	4830	no	no

(a) Use the information in the table to identify the substance that

(i) is a metal

(1)

A         C     D

(ii) could be diamond

(1)

A     B     C     D

(iii) is a gas at 20°C

(1)

A     B     C     D

(iv) contains oppositely charged ions

(1)

A     B     C     D

(b) Some of the substances in the table are compounds.

What is meant by the term **compound**?

(2)

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(c) (i) The electronic configurations of atoms of sodium and chlorine are

Na 2.8.1

Cl 2.8.7

Describe the changes in the electronic configurations of sodium and chlorine when these atoms form sodium chloride.

(3)

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(ii) Calculate the relative formula mass of sodium chloride (NaCl).

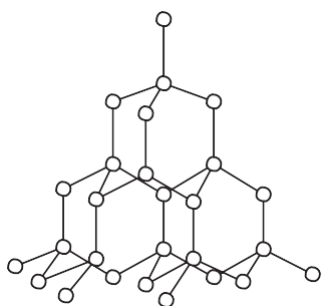
Use the Periodic Table on page 2 to help you.

(2)

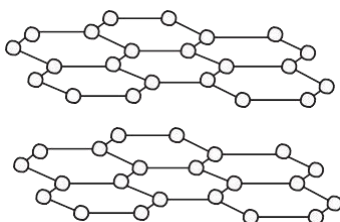
relative formula mass = .....

**(Total for Question = 11 marks)**

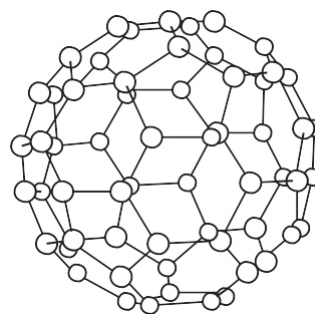
8 The diagram shows three different forms of carbon.



diamond structure



graphite structure



fullerene molecule

(a) Name the type of bond that exists between the carbon atoms in all three structures.

(1)

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(b) (i) Explain why diamond has a very high melting point.

(4)

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(ii) Fullerene has a simple molecular structure.

Explain why it has a low melting point.

(2)

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(c) There are two theories used to explain why graphite can act as a solid lubricant.

Theory A      The forces of attraction between the layers are weak, allowing the layers to slide over one another.

Theory B      Gas molecules are trapped between the layers allowing the layers to slide over one another.

The table shows the ability of graphite to act as a lubricant in different locations.

Location	Ability to act as a lubricant
Earth's surface	good
high altitude	average
outer space	very poor

Suggest which theory is supported by the evidence in the table.

Give a reason for your choice.

(1)

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(d) Graphite and diamond can be changed from one form to the other according to the equation



Would a low or a high temperature favour the conversion of graphite into diamond?

Give a reason for your choice.

(1)

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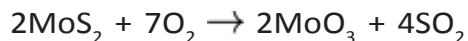
(Total for Question 7 = 9 marks)



9 Molybdenum (Mo) is a metal. It is often used to make an alloy with iron.

Like iron, it is extracted from its oxide. Unlike iron, it occurs mainly as its sulfide.

(a) Molybdenum sulfide is converted into molybdenum oxide by heating in air.  
The equation for this reaction is



(i) Why is molybdenum said to be oxidised in this reaction?

(1)

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(ii) The sulfur dioxide formed in the reaction could form acid rain if it escaped into the atmosphere.

Write a chemical equation for the formation of an acid from sulfur dioxide.

(1)

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(b) The table shows the melting points of molybdenum oxide and sulfur dioxide.

	Melting point in °C
molybdenum oxide	800
sulfur dioxide	-75

The melting point indicates the type of bonding and structure in a compound.

(i) What is the type of bonding in a molecule of sulfur dioxide?

(1)

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(ii) Explain why the melting point of sulfur dioxide is low.

(2)

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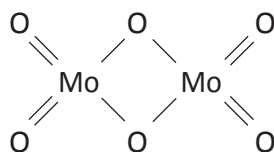
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- (iii) The melting point of molybdenum oxide suggests that it has ionic bonding. However, it is often represented as a molecular structure.

Deduce the molecular formula of molybdenum oxide as shown in this structure.



(1)

- (c) The metallic structure of molybdenum gives it some typical properties.

- (i) Describe the metallic structure of molybdenum.

(2)

- (ii) Explain why molybdenum is a good conductor of electricity.

(2)

- (iii) Explain why molybdenum is malleable.

(2)

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**(Total for Question 8 = 12 marks)**