Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

STEM | Exam Builder

Chemical bonding

Time allowed: 1 hour 25 minutes

Subject code **0620**

Chemistry

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 90

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 90 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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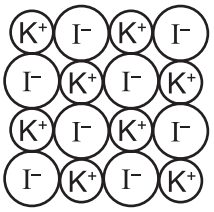
Print at 100% (Actual size) so diagrams keep their real measurements.

1 The list describes five types of chemical structures.

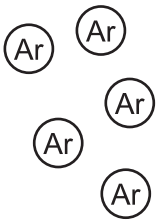
giant covalent
giant ionic
metallic
simple atomic
simple molecular

(a) The diagrams below show four types of chemical structures.

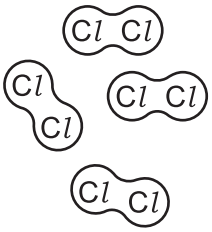
A



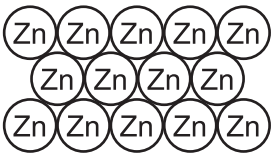
B



C



D



(i) Use the list to match these structures with the diagrams.

structure **A** is ..... [1]

structure **B** is ..... [1]

structure **C** is ..... [1]

structure **D** is ..... [1]

(ii) Which **two** of the structures **A**, **B**, **C** or **D** have low melting points?

..... and ..... [1]

(b) Sodium chloride is an ionic solid.
Complete the following sentences using words from the list.

electrons **ionic** **molecular** **molten** **solid**

Sodium chloride does not conduct electricity when it is a ..... because the ions cannot move. When it is ..... sodium chloride does conduct electricity because the ions are free to move. [2]

[Total: 7]

Ionic bonding Click for more variations

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2 Nitrogen molecules are diatomic.

(a) (i) State the meaning of the term diatomic.

..... [1]

(ii) State the percentage of nitrogen in clean, dry air.

..... [1]

(b) Ammonia has a simple molecular structure.

Complete Fig. 2.1 to show the dot-and-cross diagram for a molecule of ammonia.
Show outer shell electrons only.

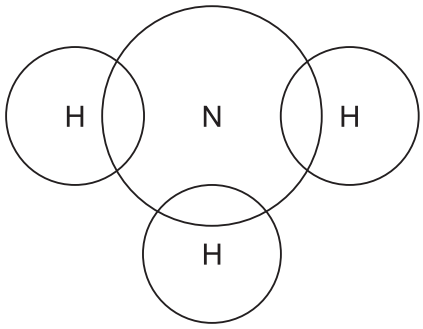


Fig. 2.1

[2]

(c) Sodium chloride has a giant ionic structure of positive and negative ions.

(i) State the general name given to any positive ion.

..... [1]

(ii) State **one** physical property of an ionic compound.

..... [1]

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(d) Graphite is used as an electrode.

(i) State one **other** use of graphite.

..... [1]

(ii) Choose the correct statement that describes the structure and bonding in graphite.

Tick (✓) **one** box.

simple covalent molecule	☐
giant ionic	☐
simple ionic	☐
giant covalent	☐

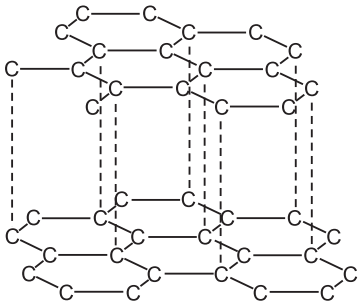
[1]

[Total: 8]

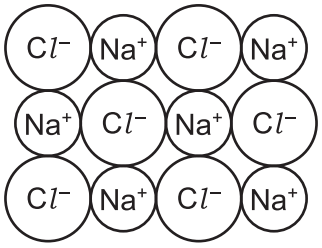
Covalent bonding and simple molecules Click for more variations

STEM | Exam Builder

3 The structures of graphite and sodium chloride are shown below.



graphite



sodium chloride

(a) Describe the similarity and differences in these structures.

.....

.....

.....

.....

.....

..... [4]

(b) Graphite is a form of carbon.
Carbon is an element.

(i) What is meant by the term *element*?

.....

..... [1]

(ii) Write a symbol equation for the complete combustion of carbon.

[2]

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(c) The table shows some properties of four substances, **A**, **B**, **C** and **D**.

substance	melting point / °C	boiling point / °C	electrical conductivity
A	–7	+59	does not conduct
B	–157	–152	does not conduct
C	+769	+1930	conducts when molten but not when solid
D	+1410	+2355	does not conduct

Which **one** of these substances, **A**, **B**, **C** or **D**,

(i) is a liquid at room temperature, ... [1]

(ii) is a giant ionic structure, ... [1]

(iii) is a noble gas, ... [1]

(iv) is a giant covalent structure? ..... [1]

[Total: 11]

Giant covalent structures: diamond, graphite and silicon dioxide Click for more variations

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4 The diagrams below show the electron arrangement in two compounds.



(a) In a water molecule, each hydrogen atom is bonded to the oxygen atom by sharing a pair of electrons.
Why does an oxygen atom share two pairs of electrons rather than just one pair?

.....

..... [1]

(b) Describe how a potassium atom becomes a potassium ion.

..... [1]

(c) Why is there a bond between the ions in potassium chloride?

.....

..... [1]

(d) Solid potassium chloride is a poor conductor of electricity. When dissolved in water it is a good conductor. Explain.

.....

..... [2]

[Total: 5]

Ionic bonding Click for more variations

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5 Table 2.1 shows the melting points, boiling points and electrical conductivities of seven substances, **A**, **B**, **C**, **D**, **E**, **F** and **G**.

Table 2.1

substance	melting point / °C	boiling point / °C	electrical conductivity when solid	electrical conductivity when molten
A	1600	2230	poor	poor
B	–219	–183	poor	poor
C	770	1420	poor	good
D	–39	357	good	good
E	–7	58	poor	poor
F	44	280	poor	poor
G	1085	2562	good	good

(a) Identify which substance, **A**, **B**, **C**, **D**, **E**, **F** or **G**, is:

(i) a gas at 25 °C

..... [1]

(ii) a solid consisting of simple molecules at 25 °C

..... [1]

(iii) a metal which is liquid at 25 °C.

..... [1]

(b) (i) Identify which substance, **A**, **B**, **C**, **D**, **E**, **F** or **G**, has a giant covalent structure.

Use the information in Table 2.1 to give **two** reasons for your choice.

substance .....

reason 1 .....

reason 2 .....

[3]

(ii) Identify which substance, **A**, **B**, **C**, **D**, **E**, **F** or **G**, is an ionic compound.

Use the information in Table 2.1 to give **one** reason for your choice.

substance .....

reason .....

[2]

[Total: 8]

Ionic bonding Click for more variations

STEM Exam Builder

6 Diamond and graphite are different forms of the same element, carbon.
Explain the following in terms of their structure.

(a) Graphite is a soft material which is used as a lubricant.

.....

..... [2]

(b) Diamond is a very hard material which is used for drilling and cutting.

.....

..... [2]

(c) Graphite is a good conductor of electricity and diamond is a poor conductor.

.....

.....

..... [2]

[Total: 6]

Giant covalent structures: diamond, graphite and silicon dioxide Click for more variations

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7 The table below includes information about some of the elements in Period 2.

element	carbon	nitrogen	fluorine	neon
symbol	C	N	F	Ne
structure	macromolecular	simple molecules N_2	simple molecules F_2	single atoms Ne
boiling point / °C	4200	–196	–188	–246

(a) Why does neon exist as single atoms but fluorine exists as molecules?

.....

..... [2]

(b) What determines the order of the elements in a period?

..... [1]

(c) When liquid nitrogen boils the following change occurs.

$$N_2(l) \rightarrow N_2(g)$$

The boiling point of nitrogen is very low even though the bond between the atoms in a nitrogen molecule is very strong. Suggest an explanation.

.....

..... [2]

(d) Draw a diagram showing the arrangement of the outer shell (valency) electrons in a molecule of nitrogen.

[2]

[Total: 7]

Noble gases Click for more variations

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8 Magnesium forms ionic compounds.

(a) Magnesium reacts with fluorine to form the ionic compound magnesium fluoride.
The electronic configurations of an atom of magnesium and an atom of fluorine are shown in Fig. 3.1.

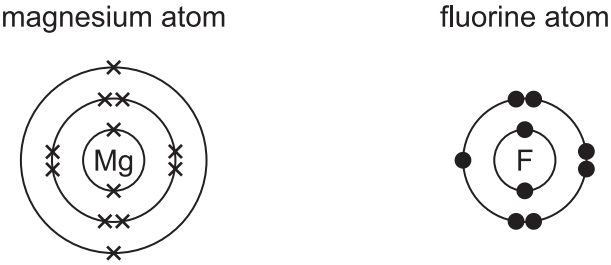


Fig. 3.1

(i) Ions are formed by the transfer of electrons from magnesium atoms to fluorine atoms.

Complete the dot-and-cross diagrams in Fig. 3.2 to show the electronic configurations of **one** magnesium ion and **one** fluoride ion. Show the charges on the ions.

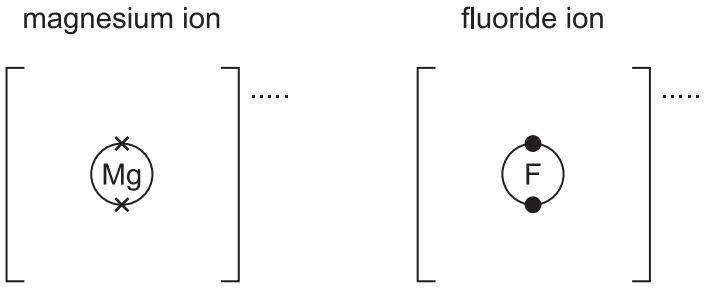


Fig. 3.2

[3]

(ii) Deduce the formula of magnesium fluoride.

..... [1]

(iii) When solid magnesium fluoride is dissolved in water it forms a solution that conducts electricity.

State one other change that can be made to solid magnesium fluoride to allow it to conduct electricity.

..... [1]

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(b) Silicon tetrachloride, $SiCl_4$, and silicon(IV) oxide, SiO_2, are covalent compounds.

Complete the dot-and-cross diagram in Fig. 3.3 to show the electronic configuration in a molecule of silicon tetrachloride. Show outer shell electrons only.

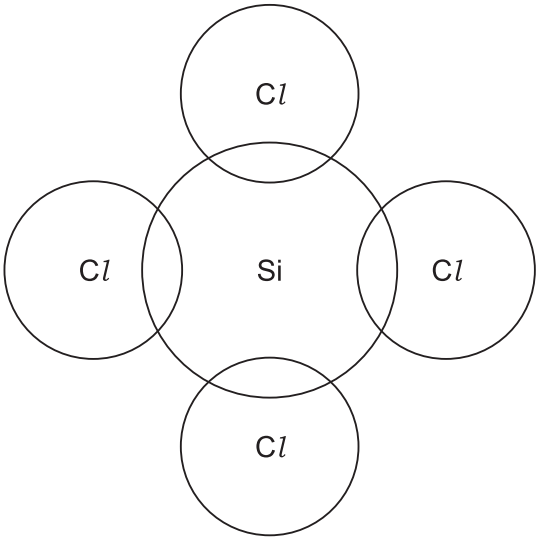


Fig. 3.3

[2]

(c) The melting points of silicon tetrachloride and silicon(IV) oxide are shown in Table 3.1.

Table 3.1

	melting point / °C
silicon tetrachloride	–69
silicon(IV) oxide	1710

(i) Silicon tetrachloride has a low melting point because it has weak forces of attraction between particles.

Name the type of particles that are held together by these weak forces of attraction.

..... [1]

(ii) Explain, in terms of structure and bonding, why silicon(IV) oxide has a high melting point.

.....

.....

.....

..... [2]

[Total: 10]

Ionic bonding Click for more variations

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9 Magnesium is a metal.

(a) Describe the structure and bonding in magnesium.

.....

.....

.....

..... [3]

(b) Why can magnesium conduct electricity when solid?

.....

.....

.....

..... [2]

(c) Why is magnesium malleable?

.....

.....

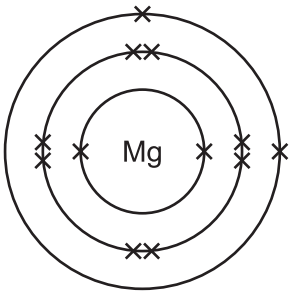
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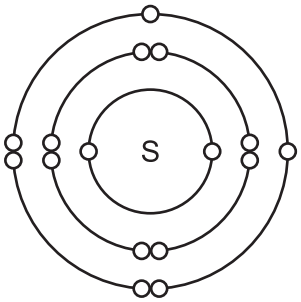
..... [2]

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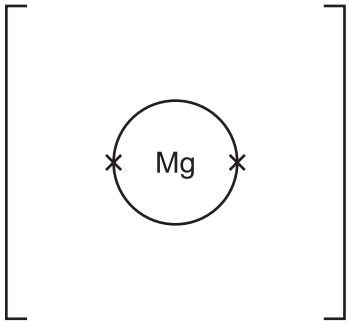
(d) Magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS.

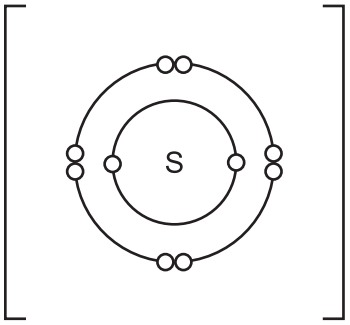
The diagrams show the electronic structures of atoms of magnesium and sulfur.





(i) Complete the diagrams to show the electronic structures of the ions in magnesium sulfide. Show the charges on the ions.





[3]

(ii) Ionic compounds, such as magnesium sulfide, do **not** conduct electricity when solid.
Magnesium sulfide does **not** dissolve in water.
Magnesium sulfide **does** conduct electricity under certain conditions.

State the conditions needed for magnesium sulfide to conduct electricity. Explain why magnesium sulfide conducts electricity under these conditions.

.....

.....

.....

..... [2]

[Total: 12]

Metallic bonding Click for more variations

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10 This question is about covalent compounds.

(a) State what is meant by a covalent bond.

.....

..... [2]

(b) Chlorine(I) oxide, Cl_2O, is a simple molecule with covalent bonds.

(i) State what is meant by (I) in the name chlorine(I) oxide.

..... [2]

(ii) Complete the dot-and-cross diagram in Fig. 2.1 of a molecule of chlorine(I) oxide.

Show outer electrons only.

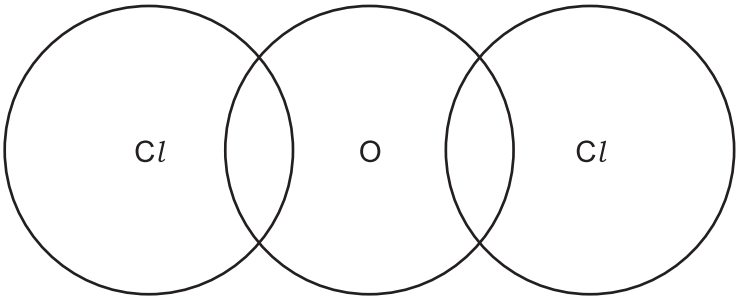


Fig. 2.1

[3]

(iii) Explain, in terms of structure and bonding, why Cl_2O boils at a low temperature and does **not** thermally decompose into its constituent elements, Cl_2 and O_2.

.....

.....

.....

..... [3]

(iv) Give **two** reasons why liquid Cl_2O is a poor conductor of electricity.

1 .....

2 .....

[2]

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(c) Carbon and silicon(IV) oxide both exist as giant covalent structures.

(i) Name a giant covalent structure of carbon which conducts electricity.

..... [1]

(ii) Identify the particles responsible for the conduction of electricity in this covalent structure of carbon.

..... [1]

(iii) Silicon(IV) oxide contains silicon atoms, Si, and oxygen atoms, O.

Fig. 2.2 shows part of the giant covalent structure of silicon(IV) oxide.

Complete the diagram in Fig. 2.2 by adding the symbol for each of the 9 atoms shown.

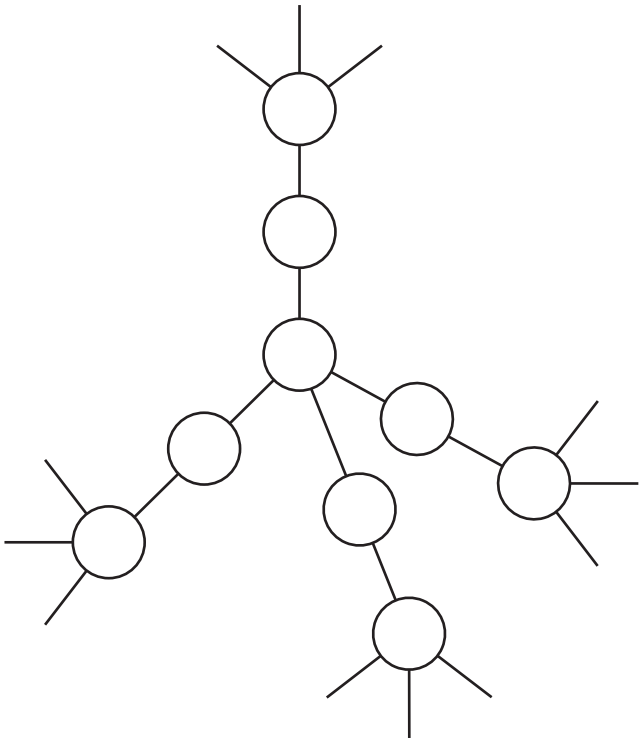


Fig. 2.2

[2]

[Total: 16]

Covalent bonding and simple molecules Click for more variations

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