Bonding & Structure 3

Name: _____

Class: _____

Date: _____

Time: **77 minutes**

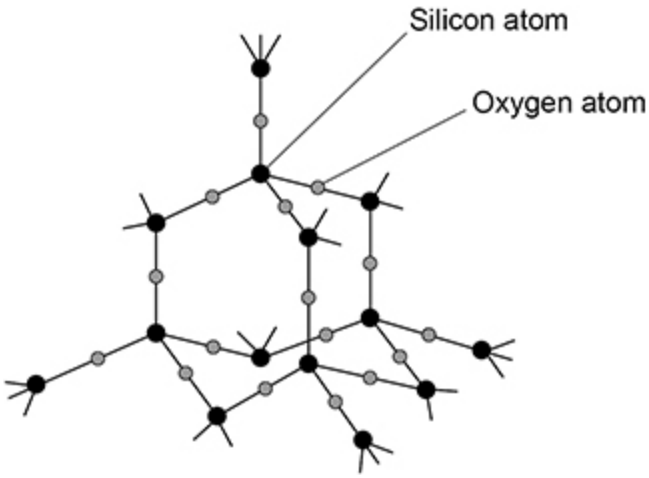
Marks: **72 marks**

Comments:

1. This question is about structure and bonding.

Figure 1 represents part of the structure of silicon dioxide.

Figure 1



(a) What type of structure is silicon dioxide?

Tick (✓) **one** box.

Giant covalent ☐

Ionic lattice ☐

Simple molecular ☐

(1)

(b) Each oxygen atom forms two bonds.

What is the number of bonds formed by each silicon atom?

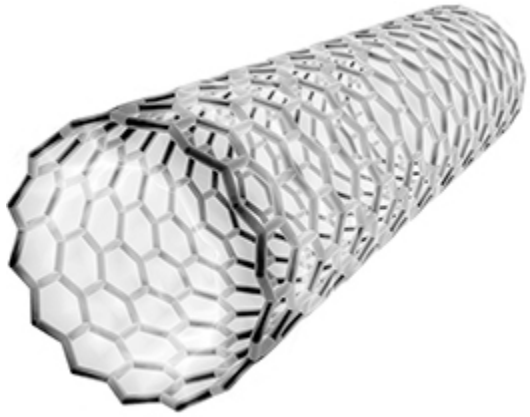
Use **Figure 1**.

_____

(1)

Figure 2 represents part of a fullerene.

Figure 2



(c) Complete the sentence.

Choose the answer from the box.

hexagons	**octagons**	**squares**	**triangles**

The structure of fullerenes is based on _____.

(1)

(d) Complete the sentence.

Choose the answer from the box.

carbon	**hydrogen**	**oxygen**

The fullerene molecule shown in **Figure 2** is made from

atoms of _____.

(1)

(e) What is the fullerene molecule shown in **Figure 2** used for?

Tick (✓) **one** box.

Electronics ☐

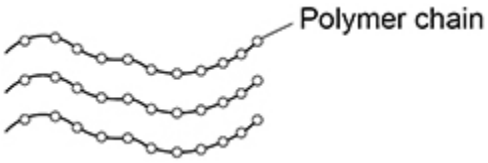
Hand warmers ☐

Sports injury packs ☐

(1)

Figure 3 represents part of the structure of a polymer.

Figure 3



(f) What holds the atoms together in a polymer chain?

Tick (✓) **one** box.

Covalent bonds ☐

Ionic bonds ☐

Metallic bonds ☐

(1)

(g) Complete the sentence.

Choose the answer from the box.

atomic	**intermolecular**	**macromolecular**

In **Figure 3** the polymer chains are held together by

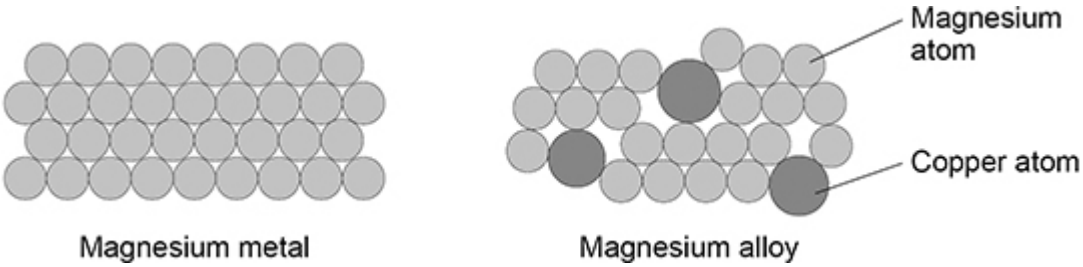
_____ forces.

(1)

Figure 4 represents part of the structures of:

- magnesium metal
- a magnesium alloy.

Figure 4



(h) Calculate the percentage of copper atoms in the alloy.

Number of magnesium atoms in the alloy = _____

Number of copper atoms in the alloy = _____

Total number of atoms in the alloy = _____

_____

Percentage of copper atoms in the alloy = _____ %

(3)

(i) Explain why the magnesium alloy is harder than magnesium metal.

Use **Figure 4**.

_____

_____

_____

_____

_____

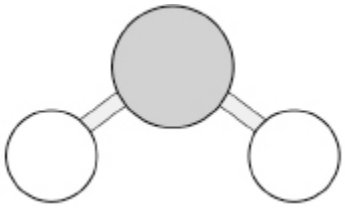
_____

(3)

(Total 13 marks)

2. This question is about substances with covalent bonding.

(a) The diagram below shows a ball and stick model of a water molecule (H_2O).



Suggest **one** limitation of using a ball and stick model for a water molecule.

_____

_____

_____

(1)

(b) Ice has a low melting point.

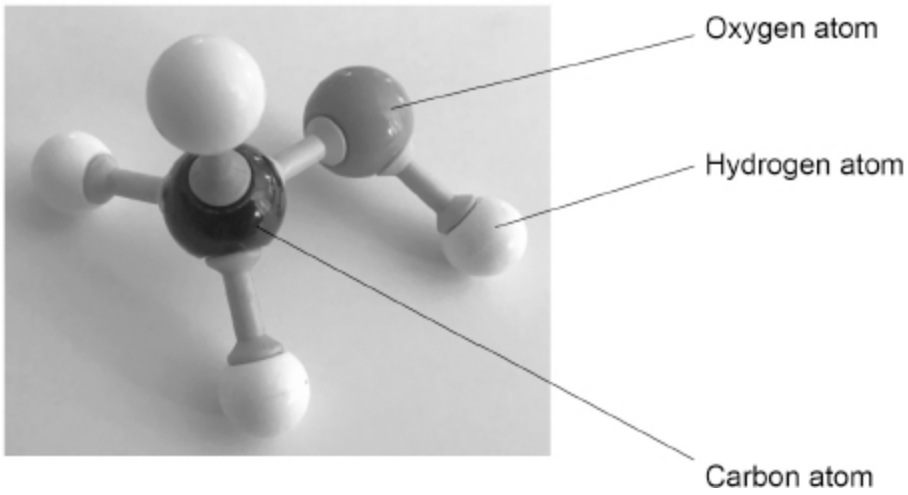
Water molecules in ice are held together by intermolecular forces.

Complete the sentence.

Ice has a low melting point because the intermolecular forces are _____.

(1)

(c) The image below shows the structure of a molecule.



What is the molecular formula of the molecule in the above image?

_____

_____

(1)

Diamond has a giant covalent structure.

(d) What is the number of bonds formed by each carbon atom in diamond?

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 8 ☐

(1)

(e) Give **two** physical properties of diamond.

1. _____

2. _____

(2)

(f) Name **two** other substances with giant covalent structures.

1. _____

2. _____

(2)

(Total 8 marks)

3. This question is about oxygen and compounds of oxygen.

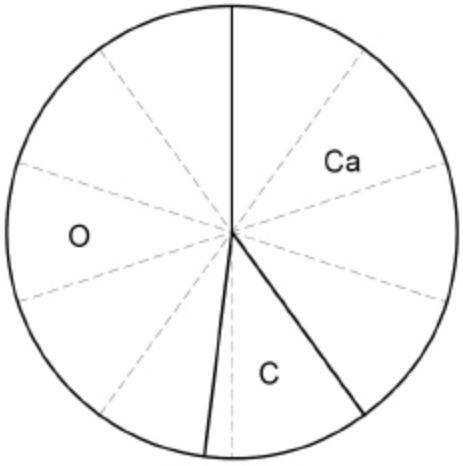
(a) What is the state symbol of oxygen at room temperature?

_____

(1)

(b) **Figure 1** shows the percentage by mass of the elements calcium, carbon and oxygen in calcium carbonate.

Figure 1



What is the percentage by mass of calcium in calcium carbonate?

_____

Percentage = _____ %

(1)

(c) At high temperature, sodium nitrate decomposes into sodium nitrite and oxygen.

A student heats three samples of sodium nitrate.

The mass of each sample was 4.50 g

The mass of solid after heating was recorded.

Table 1 shows the mass of solid after heating in each experiment.

Table 1

Experiment	Mass of solid after heating in g
1	3.76
2	3.98
3	4.09

Calculate the mean mass of solid after heating.

Give your answer to 3 significant figures.

Mean mass of solid after heating = _____ g

(3)

(d) **Table 2** shows the electronic structure of hydrogen and oxygen.

Table 2

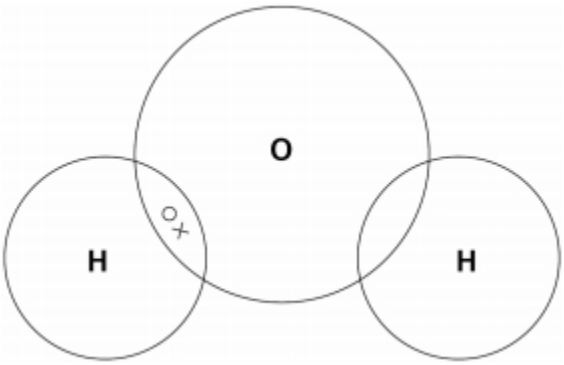
Element	Electronic structure
Hydrogen	1
Oxygen	2,6

Figure 2 shows part of a dot and cross diagram of a molecule of water (H_2O).

Complete the dot and cross diagram.

You should show only the electrons in the outer energy levels.

Figure 2



(2)

Oxygen and sulfur are examples of simple molecules.

(e) Complete the sentence.

Choose the answer from the box.

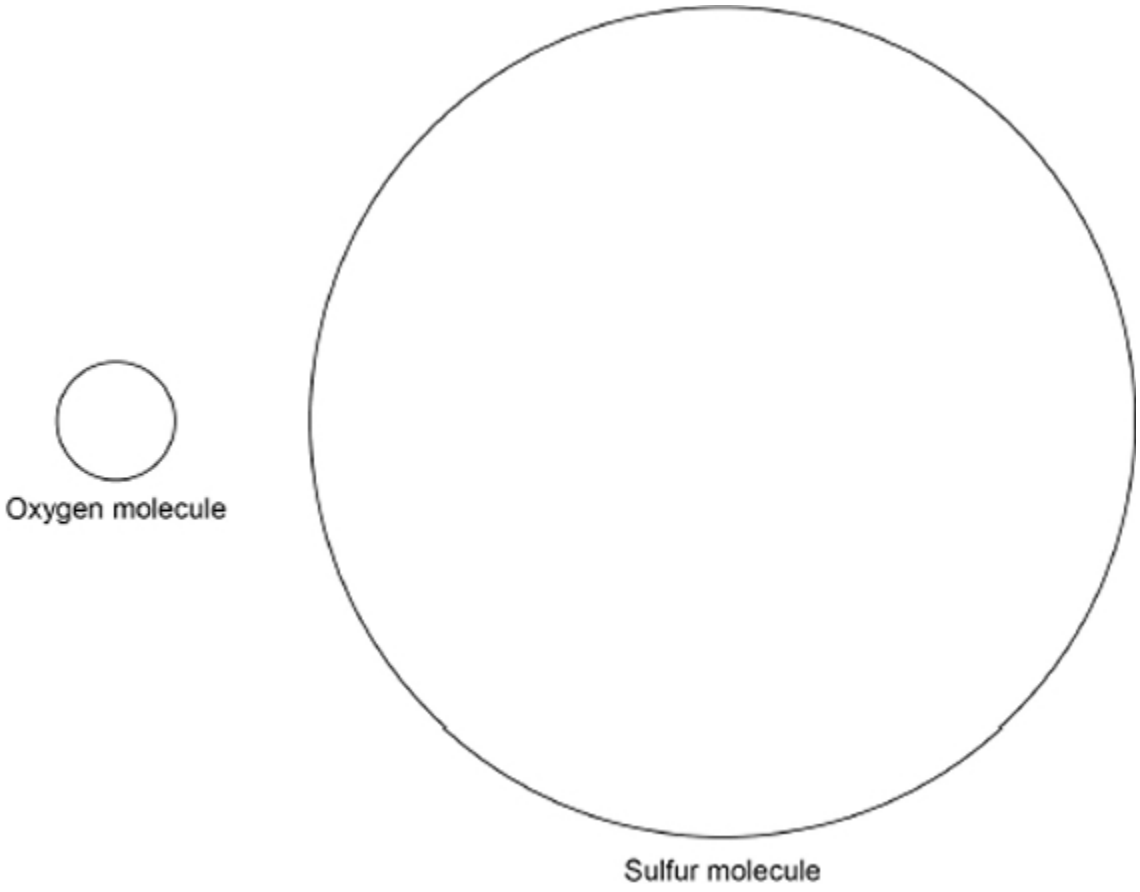
covalent	ionic	metallic

There are _____ bonds between the atoms of oxygen in an oxygen molecule.

(1)

(f) **Figure 3** shows the relative sizes of an oxygen molecule and a sulfur molecule.

Figure 3



How does the boiling point of sulfur compare with the boiling point of oxygen?

Complete the sentences.

The boiling point of sulfur is _____ the boiling point of oxygen.

This is because in sulfur the intermolecular forces are _____

than the intermolecular forces in oxygen.

(2)

(Total 10 marks)

4. This question is about sodium.

(a) Sodium reacts with chlorine.

What is the balanced equation for the reaction?

Tick (✓) **one** box.

$Na + Cl \longrightarrow NaCl$ ☐

$Na + Cl_2 \longrightarrow NaCl_2$ ☐

$2\ Na + Cl_2 \longrightarrow 2\ NaCl$ ☐

$2\ Na + Cl \longrightarrow Na_2Cl$ ☐

(1)

(b) Hot sodium is put in a gas jar of chlorine.

Describe the observations made before, during and after the reaction.

Before reaction _____

_____

During reaction _____

_____

After reaction _____

_____

(3)

(c) Explain why sodium is less reactive than potassium.

(4)

(d) Chlorine reacts with sodium and with hydrogen.

Compare the structure and bonding in sodium chloride and hydrogen chloride.

(6)

(Total 14 marks)

5. This question is about compounds of fluorine.

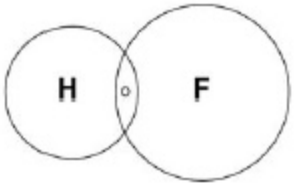
(a) A fluorine atom has 7 electrons in the outer shell.

Figure 1 shows part of a dot and cross diagram of a molecule of hydrogen fluoride (HF).

Complete the dot and cross diagram in **Figure 1**.

You should show only the electrons in the outer shells.

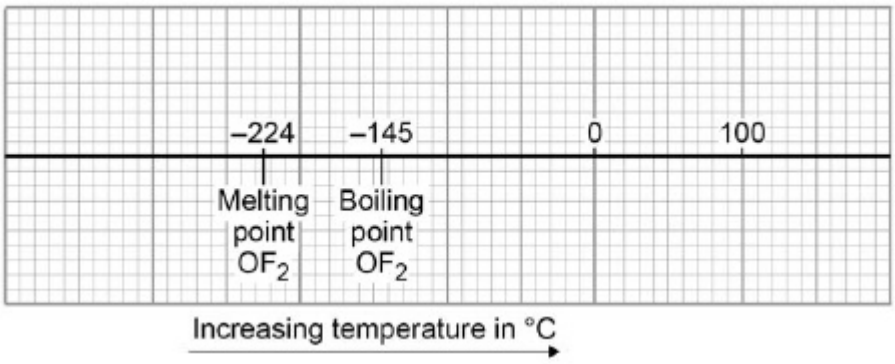
Figure 1



(1)

Figure 2 shows the boiling point and melting point of oxygen difluoride (OF_2).

Figure 2



(b) What is the state of oxygen difluoride at –200 °C?

Tick **one** box.

Aqueous (aq) ☐

Gas (g) ☐

Liquid (l) ☐

Solid (s) ☐

(1)

(c) What change of state occurs when oxygen difluoride is cooled from –220 °C to –230 °C?

Tick **one** box.

Condensing ☐

Evaporating ☐

Freezing ☐

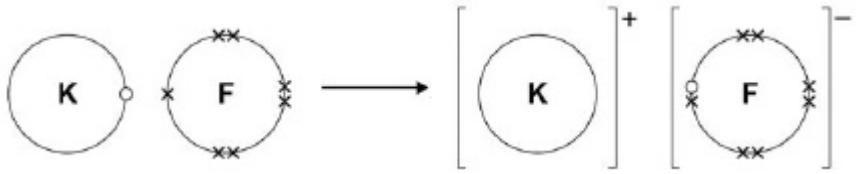
Melting ☐

(1)

Potassium reacts with fluorine to produce the ionic compound potassium fluoride (KF).

Figure 3 shows the transfer of electrons during the reaction.

Figure 3



(d) Describe what happens when potassium reacts with fluorine to produce potassium fluoride.

Write about electron transfer in your answer.

(5)

(e) Potassium fluoride is an ionic compound.

Explain why ionic compounds have high melting points.

Use the following words in your answer:

- attraction
- energy
- ions.

(4)

(Total 13 marks)

6. This question is about sodium chloride and iodine.

(a) Describe the structure and bonding in sodium chloride.

(4)

(b) When sodium chloride solution is electrolysed, one product is chlorine.

Name the **two** other products from the electrolysis of sodium chloride solution.

_____

_____

(2)

(c) Many people do not have enough iodine in their diet.

Sodium chloride is added to many types of food. Some scientists recommend that sodium chloride should have a compound of iodine added.

Give **one** ethical reason why a compound of iodine should **not** be added to sodium chloride used in food.

_____

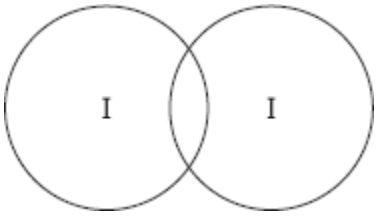
_____

(1)

(d) The bonding in iodine is similar to the bonding in chlorine.

(i) Complete the diagram below to show the bonding in iodine.

Show the outer electrons only.



(2)

(ii) Explain why iodine has a low melting point.

_____

_____

_____

_____

_____

_____

(3)

(iii) Explain, in terms of particles, why liquid iodine does not conduct electricity.

_____

_____

_____

_____

(2)

(Total 14 marks)

1. (a) giant covalent

1

(b) 4 / four

1

(c) hexagons

1

(d) carbon

1

(e) electronics

1

(f) covalent bonds

1

(g) intermolecular

1

(h) (magnesium) 22 **and** (copper) 3

1

(percentage =)
$\frac{3}{25}$ (× 100)

allow correct use of incorrectly determined value(s) for number of magnesium atoms and / or copper atoms

1

= 12 (%)

1

(i) (alloy is harder because) copper atoms are larger
or
(copper) atoms are a different size

1

(so the) layers of (magnesium) atoms are distorted

1

(and therefore the) layers cannot easily slide

allow (so) the atoms cannot slide over each other

1

[13]

2.

(a) any **one** from:

- not to scale
  allow size of atoms incorrect
- not 3 dimensional / D
- incorrect arrangement in space
  allow atoms are separated
- electrons / shells not shown
  ignore properties of water

1

(b) weak

allow weaker

1

(c) CH_4O

allow CH_3OH

1

(d) 4

1

(e) any **two** from:

- (very) hard
  allow strong
- (very) high melting point
- does not conduct electricity
  allow high thermal conductivity
  ignore shiny

2

(f) graphite

allow graphene

1

silicon dioxide

allow silica
allow silicon
allow polymer(s)
or *allow (named) polymer(s)*
allow fullerene
or *allow carbon nanotubes*
ignore buckminsterfullerene

1

[8]

3. (a) (g)

allow g

ignore formulae

1

(b) 40 (%)

1

(c) $\frac{3.76 + 3.98 + 4.09}{3}$ **or** $\frac{11.83}{3}$

*an answer of 3.94 (g) scores **3** marks*

= 3.943(333333333333333333)

1

= 3.94 (g)

allow a correctly written answer to 3 significant figures from an incorrectly calculated mean

1

(d) one shared pair in each overlap

allow combination of circles, dots, crosses or $e^{(-)}$

*do **not** accept extra electron(s) on outer shell of hydrogen*

1

4 non-bonding electrons in outer shell of oxygen

ignore any inner shell electrons

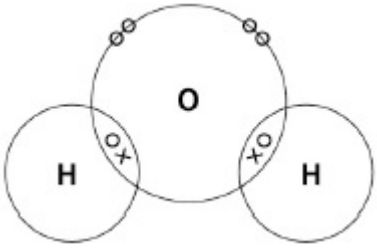


diagram scores 2 marks

1

(e) covalent

1

(f) higher (than)

1

stronger
(than between oxygen molecules)

1

[10]

4. (a) 2 Na + Cl_2 ⟶ 2 NaCl

1

(b) (before)
silver solid / liquid / metal

allow grey solid / metal

or

green (gas)

allow yellow (gas)

1

(during)
yellow flame

allow orange / white flame

or

white smoke

or

green colour fades / disappears

1

allow vigorous reaction

(after)
white solid / powder

1

(c)

allow converse for potassium

(sodium has) fewer energy levels / shells

allow diagrams of electron structure

1

outer electron / shell is closer to nucleus

or

outer electron / shell is less shielded

1

(so) greater attraction between nucleus and outer electron / shell

1

(so) outer electron is less easily lost

allow (so) loses an / one electron less easily

allow (so) more energy needed to remove an / one electron

1

(d) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.

4–6

Level 1: Relevant features are identified and differences noted.

1–3

No relevant content

0

Indicative content

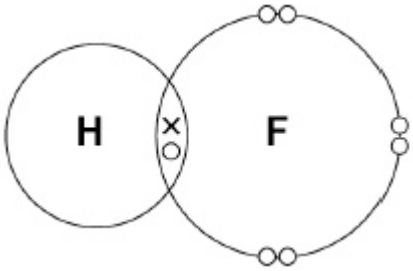
	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two **non**-metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral **or** no overall charge
differences in structure	**giant** structure or lattice	**small / simple / discrete** molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are **strong**	(intermolecular forces) are **weak**
	act in all directions	random **or** between the molecules
	regular	irregular / random
similarities in bonding	full shells **or** stability	full shells **or** stability
	(transferring) electrons	(sharing) electrons
	strong bonds	**strong** (covalent) bonds
	act in all directions	random **or** between the molecules
similarities in structure	(electrostatic) forces	(intermolecular) forces

ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride.

[14]

5. (a)



1 *mark for one shared pair of electrons*

1 *mark for six unbonded electrons on F*

2

(b) liquid (l)

1

(c) freezing

1

(d) K loses

1

one electron

1

(to) form a positive ion

1

F gains one electron

1

(to) form a negative ion

1

(e) lattice / giant structure

allow many ions

1

strong attraction

1

between K^+ and F^- ions / oppositely charged ions

1

(so) a lot of energy is needed to overcome / break

allow strong bonds

1

[13]

6.

(a) lattice / giant structure

*max **3** if incorrect structure or bonding or particles*

1

ionic **or** (contains) ions

1

Na^+ **and** Cl^-

accept in words or dot and cross diagram: must include type and magnitude of charge for each ion

1

electrostatic attraction

allow attraction between opposite charges

1

(b) hydrogen

allow H_2

1

sodium hydroxide

allow NaOH

1

(c) any **one** from, eg:

- people should have the right to choose
- insufficient evidence of effect on individuals
- individuals may need different amounts.

allow too much could be harmful

ignore religious reasons

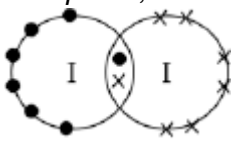
ignore cost

ignore reference to allergies

1

(d) (i) one bonding pair of electrons

accept dot, cross or e or − or any combination, eg



1

6 unbonded electrons on each atom

1

(ii) simple molecules

*max **2** if incorrect structure or bonding or particles*

accept small molecules

accept simple / small molecular structure

1

with intermolecular forces

accept forces between molecules

must be no contradictory particles

1

which are weak **or** which require little energy to overcome − must be linked to second marking point

reference to weak covalent bonds negates second and third marking points

1

(iii) iodine has no delocalised / free / mobile electrons or ions

1

so cannot carry charge

*if no mark awarded iodine molecules have no charge gains **1** mark*

1

[14]