

4-2 / 5-2 Bonding, structure and the properties of matter – Trilogy

1.0 This question is about bonding and atomic structure.

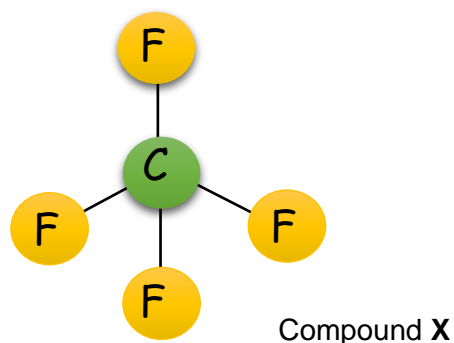
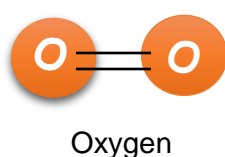
1.1 Draw one line from each type of bonding to the description of bonding.

[2 marks]

Type of bonding	Description of bonding
Covalent bonding	Positive ions surrounded by delocalised electrons
Metallic bonding	Strong electrostatic forces of attraction
Ionic bonding	Sharing of electrons

Figure 1 shows the structure of two small molecules, oxygen and compound X.

Figure 1



1.2 Oxygen (O<sub>2</sub>) is described as a diatomic element.

Suggest what is meant by the term “*diatomic element*”.

[1 mark]

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1.3 Give the molecular formula of compound X

[1 mark]

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1.4 Complete the sentence by putting a ring around the correct word.

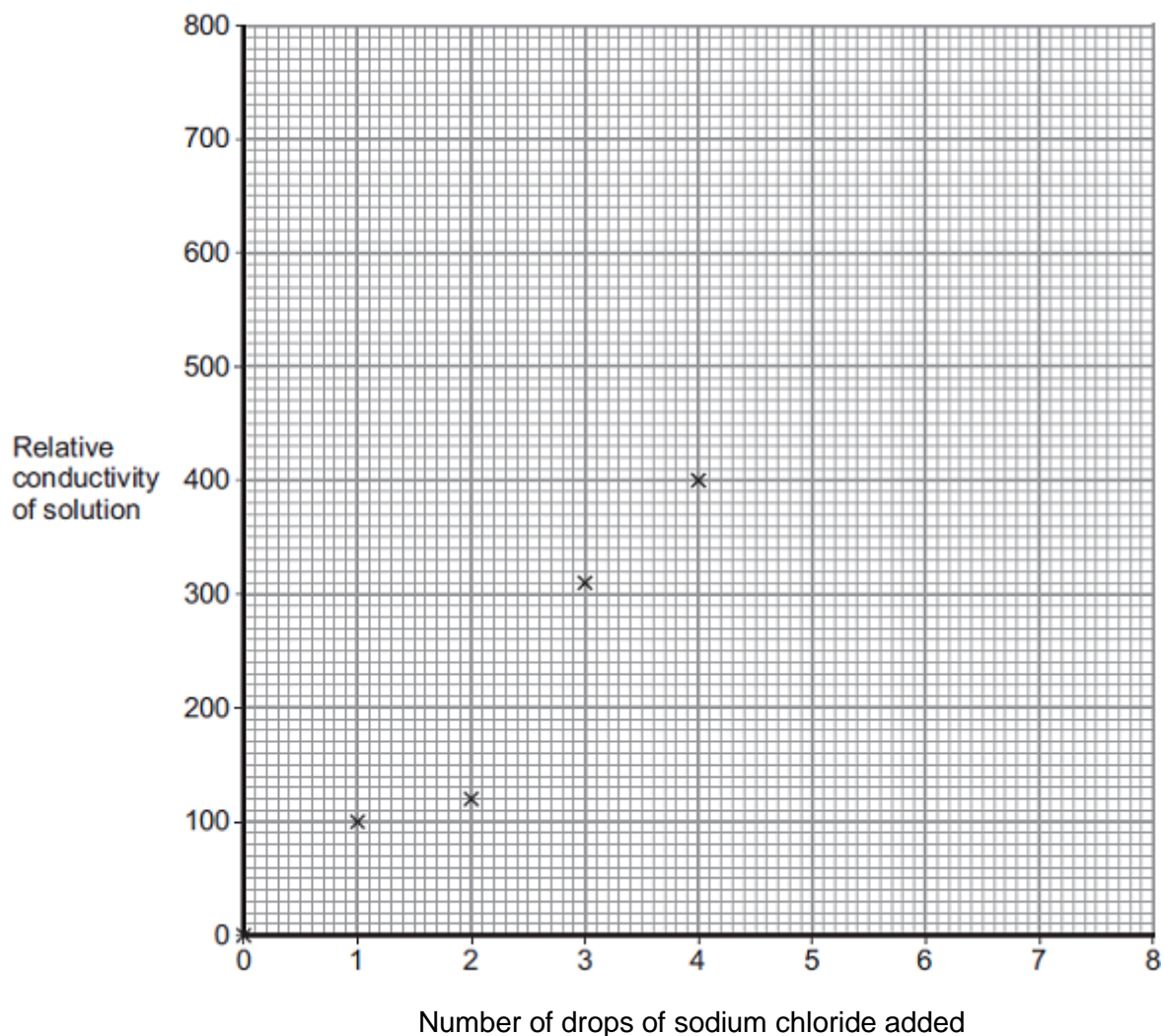
[1 mark]

Chemicals with small molecules usually have a **low / medium / high** melting point

**2.0** A student investigated the conductivity of different concentrations of sodium chloride solution. The student's results are shown below.

Number of drops of sodium chloride solution added	Relative conductivity of solution
0	0
1	100
2	120
3	310
4	400
5	510
6	590
7	710
8	800

The student plotted some of the results on the graph shown in **Figure 2** below.



**2.1** On the graph:

- Plot the remaining results
- Draw a line of best fit.

**[2 marks]**

**2.2** Draw a ring around the anomalous point.

[1 mark]

**2.3** The student compared the conductivity of sodium chloride solution with the conductivity of potassium chloride solution.

State **one** variable the student should keep constant when measuring the conductivity of the two solutions.

[1 mark]

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**2.4** Explain why sodium chloride solution conducts electricity.

[3 marks]

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**3.0** Some students were discussing whether to make wires for a phone charger from copper metal or graphite.

**3.1** Compare the properties of copper and graphite to decide which material would be better for making the wire.

**[6 marks]**

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**3.2** The surface of some metals, such as iron, corrode when exposed to the air. Explain how this affects the electrical conductivity of the metal.

**[3 marks]**

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**4.0** Sodium chloride is an ionic compound.

**4.1** Explain why ionic compounds are usually solid at room temperature.

**[2 marks]**

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**4.2** Recent research has developed a new type of substance, ionic liquids. Ionic liquids have melting points at close to or below room temperature. Ionic liquids are used in batteries as they conduct electricity.

Explain why ionic liquids are used in batteries but solid ionic compounds are not.

**[3 marks]**

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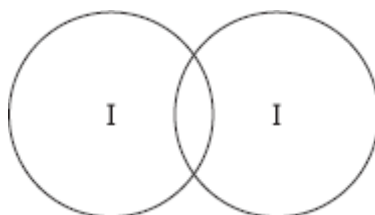
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**5.0** Iodine is in Group 7.

**5.1** Complete the diagram below to show the bonding in iodine, I<sub>2</sub>.  
Show the outer electrons only.

**[2 marks]**



**5.2** Explain, in terms of particles, why liquid iodine does not conduct electricity.

**[3 marks]**

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**5.3** Many people do not have enough iodine in their diet.

Some scientists recommend that salt should have a compound of iodine added.

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

**[1 mark]**

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**6.0** A student was investigating a compound, **X**.

The student decided that compound X was an ionic compound.

Give **three** properties of ionic compounds that the student may have found.

**[3 marks]**

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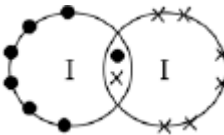
**MARK SCHEME**

Qu No.			Extra Information	Marks
1.1	Covalent bonding	Positive ions surrounded by delocalised electrons	Do <b>not</b> allow 2 lines from one type of bonding.  Allow <b>1</b> mark for 1/2 correct	2
	Metallic bonding	Strong electrostatic forces of attraction		
	Ionic bonding	Sharing of electrons		
1.2	Molecule containing two atoms		Allow 2 atoms bonded together	1
1.3	CF <sub>4</sub>			1
1.4	low			1

Qu No.		Extra Information	Marks
2.1	Points correctly plotted	Allow tolerance of $\pm \frac{1}{2}$ small square	1
	Line of best fit		1
2.2	2 drops, 120 relative conductivity		1
2.3	Any <b>one</b> from: <ul style="list-style-type: none"> <li>• concentration (of solution)</li> <li>• volume (of drops) of solution added</li> </ul>	Allow reasonable alternatives	1
2.4	Ions in sodium chloride solution	Allow Na <sup>+</sup> and Cl <sup>-</sup>	1
	can move		1
	and carry the charge / current		1
Qu No.		Extra Information	Marks
3.1			
<b>Level 3:</b>	A detailed and coherent comparison is given, which considers a range of relevant points and demonstrates a broad understanding of the key scientific ideas. The response comes to a conclusion consistent with the reasoning.		5-6
<b>Level 2:</b>	An attempt to relate relevant points and come to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.		3-4
<b>Level 1:</b>	Simple statements are made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.		1-2
<b>Level 0</b>	No relevant content		0
<b>Indicative content</b>			
<p><b>Graphite properties</b></p> <ul style="list-style-type: none"> <li>• conducts electricity</li> <li>• soft</li> <li>• slippery</li> <li>• brittle</li> <li>• high melting point</li> </ul> <p><b>Copper properties</b></p> <ul style="list-style-type: none"> <li>• can be bent or malleable</li> <li>• ductile or can be shaped into wires</li> <li>• strong / not brittle</li> <li>• conducts electricity</li> <li>• high melting point</li> </ul> <p><b>Conclusion</b> Copper would be more suitable with a justification</p>			
3.2	Conductivity will decrease		1
	as an ionic compound formed		1
	which will not conduct electricity when solid		1



Qu No.		Extra Information	Marks
4.1	Strong electrostatic forces	allow strong forces between oppositely charged ions	1
	which require a lot of energy to overcome		1
4.2	In ionic liquids, ions are able to move		1
	(so) ions carry charge		1
	(however) in a solid, ions are unable to move		1

Qu No.		Extra Information	Marks
5.1	One bonding pair of electrons		1
	6 unbonded electrons on each atom	Accept dot, cross or e or – or any combination, eg 	1
5.2	Iodine has no delocalised / free electrons	Allow iodine molecules have no overall charge for 1 mark if MP 1 and 2 not awarded.	1
	iodine has no ions		1
	so cannot carry charge / current		1
5.3	Any one from: people should have right to choose insufficient evidence of effect on people individuals may need different amounts	Allow too much could be harmful  Ignore cost / religious reasons Ignore reference to allergies	1

Qu No.		Extra Information	Marks
6	High melting point	Any three properties that could be reasonably found from experiment	1
	Conducts electricity when molten / dissolved		1
	Does not conduct when solid		1