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

1.0 This question is about bonding and atomic structure.

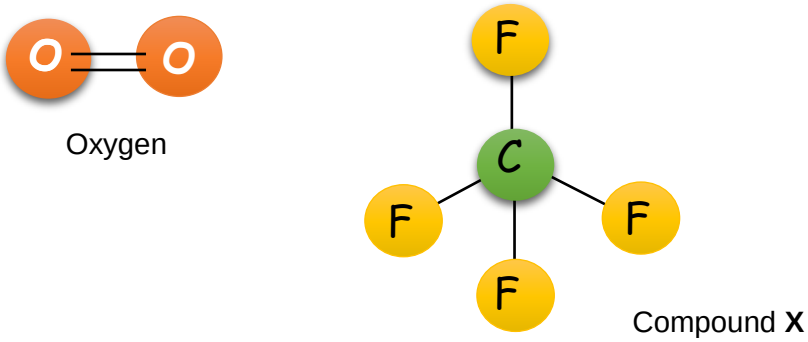
1.1 Draw one line from each type of bonding to the description of bonding.

[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_2) is described as a diatomic element.

Suggest what is meant by the term *"diatomic element".*

[1 mark]

_____

1.3 Give the molecular formula of compound **X**

[1 mark]

_____

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

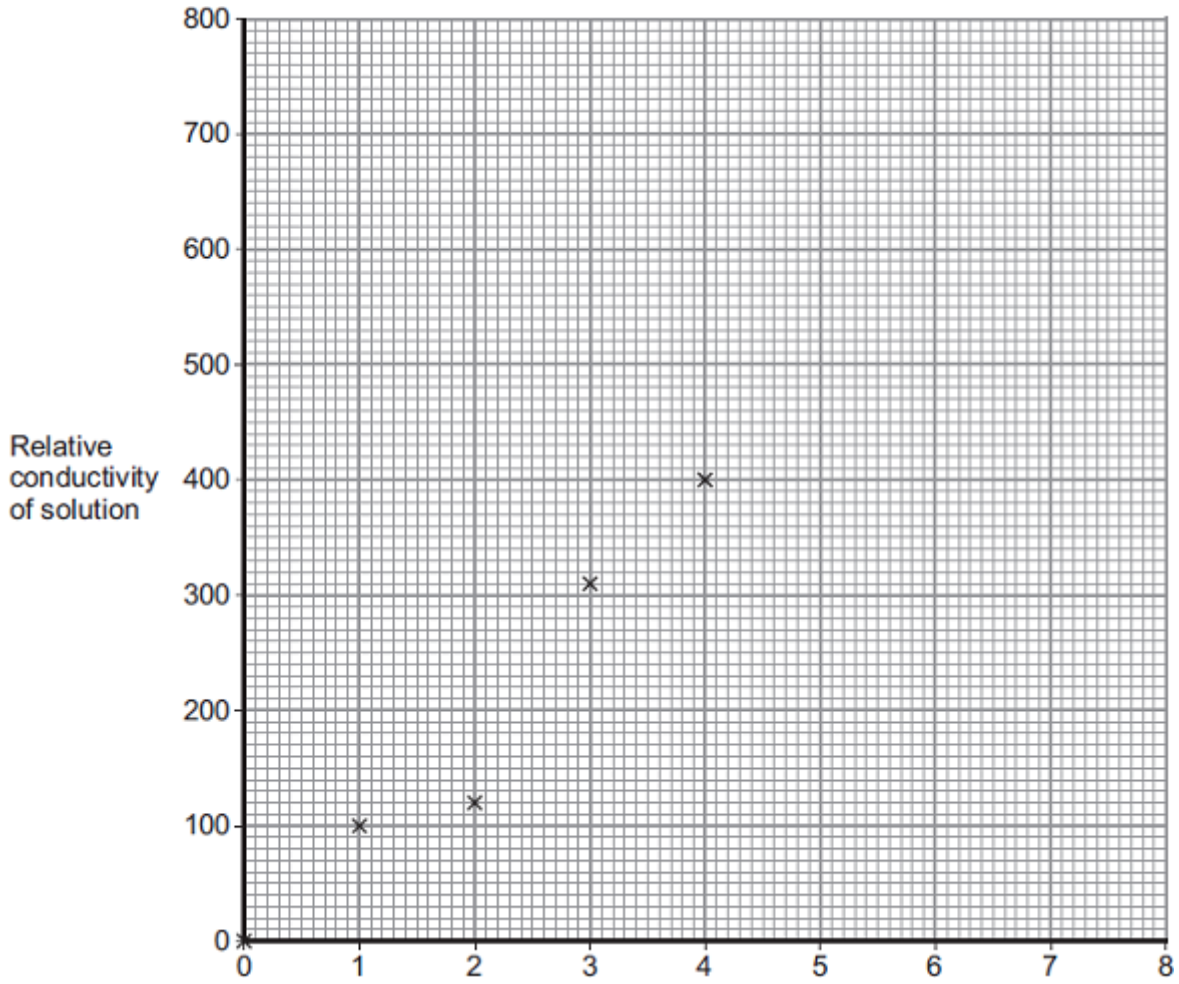
[1 mark]

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]

_____

2.4 Explain why sodium chloride solution conducts electricity.

[3 marks]

_____

_____

_____

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]

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]

4.0 Sodium chloride is an ionic compound.

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

[2 marks]

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.

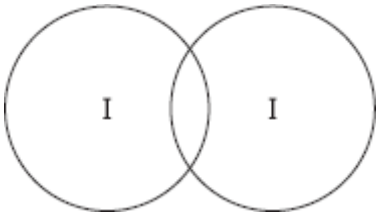
[3 marks]

5.0 Iodine is in Group 7.

5.1 Complete the diagram below to show the bonding in iodine, I_2.

Show the outer electrons only.

[2 marks]



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

[3 marks]

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]

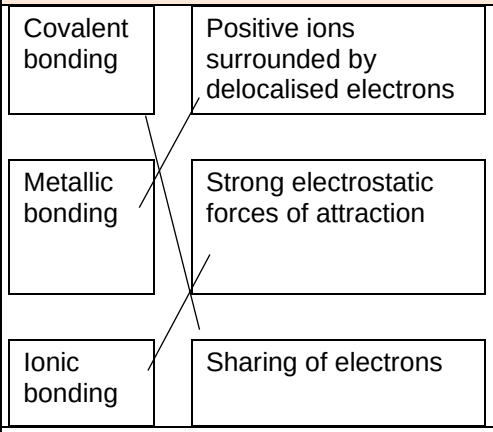
6.0 A student was investigating a compound, **X**.

The student decided that compound X was an ionic compound.

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

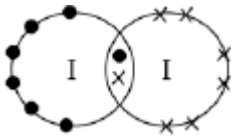
[3 marks]

MARK SCHEME

Qu No.		Extra Information	Marks
1.1		Do **not** allow 2 lines from one type of bonding. Allow **1** mark for 1/2 correct	2
1.2	Molecule containing two atoms	Allow 2 atoms bonded together	1
1.3	CF_4		1
1.4	low		1

Qu No.		Extra Information	Marks
2.1	Points correctly plotted Line of best fit	Allow tolerance of ± ½ small square	1 1
2.2	2 drops, 120 relative conductivity		1
2.3	Any **one** from: • concentration (of solution) • volume (of drops) of solution added	Allow reasonable alternatives	1
2.4	Ions in sodium chloride solution can move and carry the charge / current	Allow Na^+ **and** Cl^-	1 1 1
Qu No.		**Extra Information**	**Marks**
3.1			
Level 3:	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
Level 2:	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
Level 1:	Simple statements are made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.		1-2
Level 0	No relevant content		0
Indicative content			
Graphite properties • conducts electricity • soft • slippery • brittle • high melting point **Copper properties** • can be bent or malleable • ductile or can be shaped into wires • strong / not brittle • conducts electricity • high melting point **Conclusion** Copper would be more suitable with a justification			
3.2	Conductivity will decrease as an ionic compound formed which will not conduct electricity when solid		1 1 1

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

Qu No.		Extra Information	Marks
5.1	One bonding pair of electrons 6 unbonded electrons on each atom	 Accept dot, cross or e or − or any combination, eg 	1 1
5.2	Iodine has no delocalised / free electrons iodine has no ions so cannot carry charge / current	Allow iodine molecules have no overall charge for **1** mark if MP 1 and 2 not awarded.	1 1 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 Conducts electricity when molten / dissolved Does not conduct when solid	Any three properties that could be reasonably found from experiment	1 1 1