Questions

Q1.

* Figure 6 shows some properties of three substances, **A**, **B** and **C**.

substance	melting point in °C	ability to conduct electricity	
		solid	molten
A	1180	poor	good
B	1538	good	good
C	115	poor	poor

Figure 6

Deduce, using the information in Figure 6, the structure and bonding of substances **A**, **B** and **C**, explaining their properties in terms of their structure and bonding.

(6)

(Total for question = 6 marks)

Q2.

Diamond and carbon dioxide are both covalent substances.

(i) Draw a dot and cross diagram to show the covalent bonding in a molecule of carbon dioxide, CO_2.

Show outer electrons only.

(2)

(ii) Diamond has a very high melting point.

Explain why the melting point of diamond is very high.

(2)

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(Total for question = 4 marks)

Q3.

Figure 10 shows the equipment used to electrolyse a sample of sodium sulfate solution.

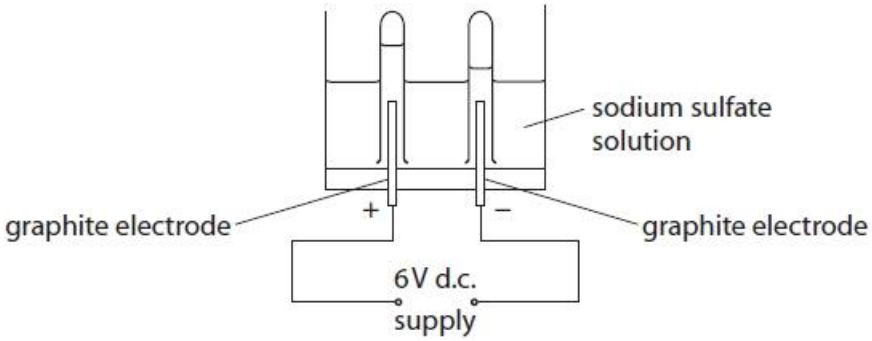

Figure 10

Graphite electrodes are used in the electrolysis of sodium sulfate solution.
Graphite is used because it is inert and conducts electricity.

(i) Figure 11 shows the ions in the sodium sulfate solution.

Draw a circle around each of the ions in Figure 11 that are attracted to the negative graphite electrode during the electrolysis.

(1)

H^+ OH^- Na^+ SO_4^{2-}

Figure 11

(ii) State why it is important that the electrodes are inert.

(1)

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(iii) Explain, in terms of its structure, how graphite conducts electricity.

(2)

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(Total for question = 4 marks)

Q4.

Two compounds of barium are barium sulfide and barium chloride.

The sodium chloride solution is electrolysed in the apparatus shown in Figure 8.

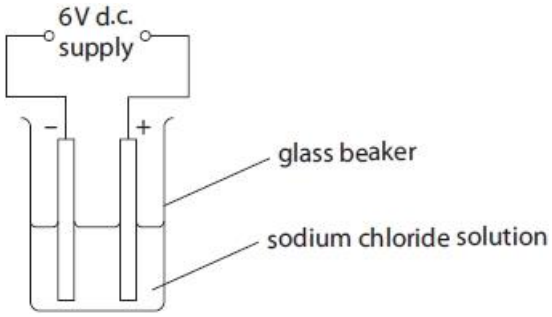

Figure 8

(i) State why sodium chloride solution, rather than solid sodium chloride, must be used in this experiment.

(1)

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(ii) The formulae of the ions present in the sodium chloride solution are

Na^+ Cl^- H^+ OH^-

Circle the ions that would be attracted to the anode.

(1)

(iii) Molten lead bromide can be electrolysed to form molten lead and bromine gas.

Explain how a student could modify the apparatus shown in Figure 8 to carry out this electrolysis.

(2)

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(Total for question = 4 marks)

Q5.

Explain, in terms of its structure, how graphite conducts electricity.

(2)

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(Total for question = 2 marks)

Q6.

* Figure 12 shows the melting points of two substances, A and B, and the abilities of the substances to conduct an electric current when solid and when molten.

substance	melting point in °C	ability to conduct electric current	
		when solid	when molten
A	35	no	no
B	801	no	yes

Figure 12

One of the substances has an ionic structure and one has a simple molecular, covalent structure.

Explain, in terms of bonding and the forces between the particles, the relative melting points and abilities to conduct the electric current of substances A and B.

(6)

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(Total for question = 6 marks)

Q7.

Calcium nitrate and calcium carbonate are both ionic compounds.

Calcium nitrate mixed with water behaves as an electrolyte.
Calcium carbonate mixed with water does not behave as an electrolyte.

Explain, in terms of solubility and movement of ions, this difference in behaviour.

(2)

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(Total for question = 2 marks)

Q8.

Part of the structure of graphene is shown in Figure 5.

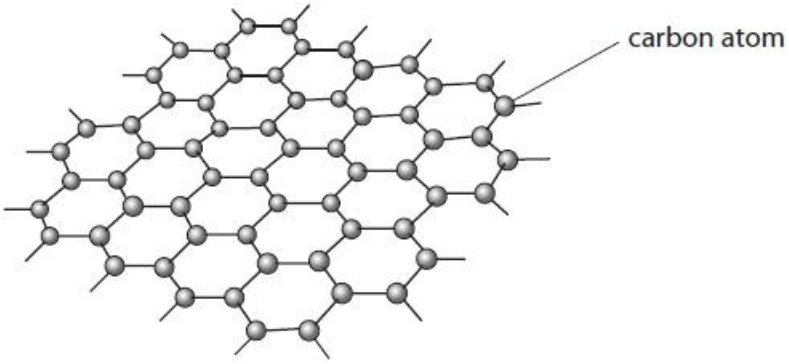

Figure 5

Explain why graphene will be a good conductor of an electric current.

(3)

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(Total for question = 3 marks)

Q9.

Part of the structure of potassium chloride is shown in Figure 6.

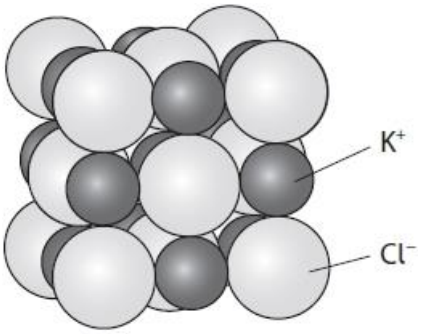

Figure 6

Potassium chloride has a melting point of 770°C.

Explain why potassium chloride has a high melting point.

(2)

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(Total for question = 2 marks)

Q10.

Figure 3 shows a metal spoon and two test tubes being heated in a water bath.

One test tube contains a piece of chocolate, the other some liquid egg white.

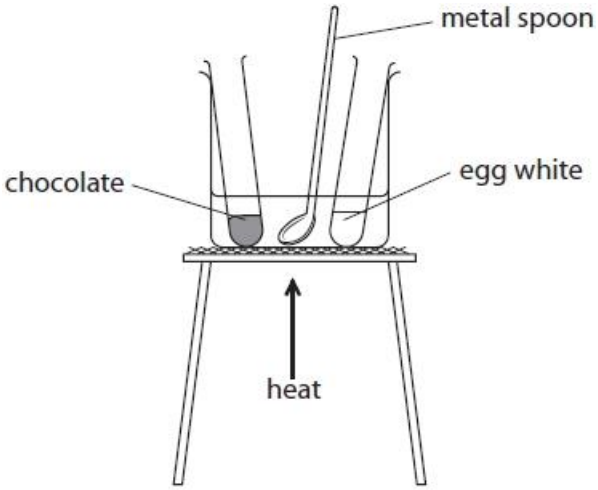

Figure 3

After heating, the spoon, the chocolate and the egg white are allowed to cool to room temperature.

Figure 4 shows the state of the three different substances before heating, when hot and after cooling.

substance	before heating	when hot	after cooling
metal spoon	solid	solid	solid
chocolate	solid	liquid	solid
egg white	liquid	solid	solid

Figure 4

Give a reason why the metal spoon has not changed state during the experiment.

(1)

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(Total for question = 1 mark)

Q11.

*Calcium chloride can be prepared by the reaction of calcium with chlorine gas.

Figure 9 shows some properties of calcium, chlorine and calcium chloride.

substance	relative melting point	ability to conduct electricity	
		when solid	when molten
calcium	high	good	good
chlorine	low	poor	poor
calcium chloride	high	poor	good

Figure 9

Explain, in terms of bonding and structure, why the properties of the product, calcium chloride, are different from the properties of the reactants, calcium and chlorine.

(6)

(Total for question = 6 marks)

Q12.

Diamond has a giant covalent structure.

State one property of diamond that is the result of its giant covalent structure.

(1)

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(Total for question = 1 mark)

Q13.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Sodium sulfate, Na_2SO_4, is an ionic solid.

(i) Which of these is most likely to be a property of solid sodium sulfate?

(1)

☐ **A** good conductor of electricity

☐ **B** high melting point

☐ **C** low boiling point

☐ **D** malleable

(ii) The formula of the sodium ion is Na^+.

What is the formula of the sulfate ion?

(1)

☐ **A** SO_4^+

☐ **B** SO_4^-

☐ **C** SO_4^{2+}

☐ **D** SO_4^{2-}

(iii) Explain, in terms of electrons, how a sodium atom, Na, forms a sodium ion, Na^+.

(2)

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(Total for question = 4 marks)

Q14.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Which of the following is true for most metals?

(1)

☒ **A** they are dull

☒ **B** they have low melting points

☒ **C** they are found on the right-hand side of the periodic table

☒ **D** they are malleable

(Total for question = 1 mark)

Q15.

Substance X is a gas at room temperature.
It is a simple molecular, covalent substance.

Which row of the table shows the properties that substance X is most likely to have?

(1)

	boiling point in °C	relative solubility in water
☒ **A**	−6	low
☒ **B**	600	high
☒ **C**	−6	high
☒ **D**	600	low

(Total for question = 1 mark)

Q16.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Gallium, Ga, is in the same group of the modern periodic table as aluminium.

The formula of aluminium oxide is Al_2O_3.

(i) Predict the formula of gallium oxide.

(1)

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(ii) Gallium oxide has a very high melting point.

Gallium oxide does not conduct electricity when solid but does conduct electricity when molten.
What type of substance is gallium oxide?

(1)

- ☐ **A** giant covalent
- ☐ **B** ionic
- ☐ **C** metallic
- ☐ **D** simple molecular

(Total for question = 2 marks)

Q17.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Magnesium carbonate has the formula $MgCO_3$.

Magnesium carbonate contains Mg^{2+} and CO_3^{2-}.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the Mg^{2+} ion?

(1)

- ☐ **A** 2
- ☐ **B** 2.8
- ☐ **C** 2.8.2
- ☐ **D** 2.8.4

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

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(Total for question = 4 marks)

Q18.

State **two** characteristic properties of metals.

(2)

property 1

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property 2

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(Total for question = 2 marks)

Q19.

Covalent substances can be simple molecular covalent or giant covalent.

(i) Ammonia is a simple molecular, covalent substance.

Which is the most likely set of properties for ammonia?

(1)

	melting point in °C	boiling point in °C	ability to conduct electricity in liquid state
☒ A	1713	2950	does not conduct
☒ B	−78	−33	does not conduct
☒ C	−39	357	conducts
☒ D	801	1413	conducts

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

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(Total for question = 3 marks)

Q20.

This question is about the metal gold.

(i) Gold can be hammered into shape.

State the name of this property.

(1)

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(ii) Gold alloys can be used to repair teeth.
One reason that gold alloys are used is that they can be hammered into shape.

Give **one other** reason why gold alloys are used to repair teeth.

(1)

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(Total for question = 2 marks)

Q21.

Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

Metals have high melting points.

Explain, in terms of their structure and bonding, why metals have high melting points.

(2)

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(Total for question = 2 marks)

Q22.

Covalent substances can be simple molecular covalent or giant covalent.

* Figure 8 shows the arrangement of carbon atoms in diamond, graphene and a fullerene (C_{60}).

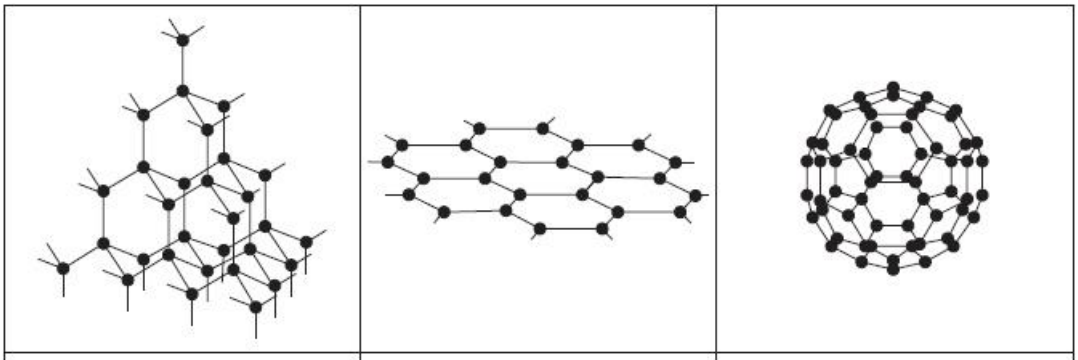

Figure 8

Consider these three substances.

Explain, in terms of their structures and bonding, their relative melting points, strengths and abilities to conduct electricity.

(Total for question = 6 marks)

Q23.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Bromine is a liquid at room temperature and vaporises readily.
Bromine has a simple molecular structure.

Which row of the table shows the most likely melting and boiling points of bromine?

(1)

		melting point in °C	boiling point in °C
☐	**A**	–70	–6.3
☐	**B**	–17	6.3
☐	**C**	–7	63
☐	**D**	17	630

(Total for question = 1 mark)

Q24.

A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.

(3)

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(Total for question = 3 marks)

Q25.

Molten zinc chloride is an electrolyte.

(i) Which row shows the products formed at the anode and at the cathode when molten zinc chloride is electrolysed?

(1)

		product at anode	product at cathode
☒	**A**	oxygen	zinc
☒	**B**	chlorine	hydrogen
☒	**C**	chlorine	zinc
☒	**D**	oxygen	hydrogen

(ii) Which of the following is the reason why molten zinc chloride is an electrolyte?

(1)

☒ **A** it contains molecules that can move
☒ **B** it has a giant structure
☒ **C** it contains delocalised electrons
☒ **D** it contains ions that can move

(Total for question = 2 marks)

Q26.

Sodium chloride is an ionic compound, containing sodium ions, Na^+, and chloride ions, Cl^-.

Figure 15 shows the electronic configuration of sodium and chlorine.

	electron configuration
sodium	2.8.1
chlorine	2.8.7

Figure 15

Explain how sodium and chlorine atoms form the ions in sodium chloride and how the ions are arranged in the solid sodium chloride.

You may wish to use diagrams in your answer.

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(Total for question = 6 marks)

Q27.

A student used the equipment in Figure 3 to investigate whether electricity can pass through solid ammonium chloride and through ammonium chloride solution.

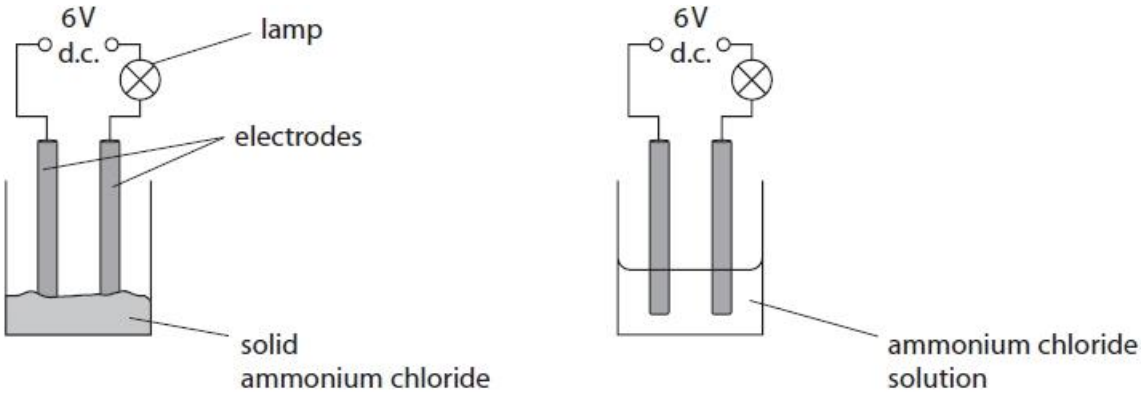

Figure 3

If an electrical current flows in the circuit, the lamp will light up.

Figure 4 shows the results of the investigation.

substance	lamp
solid ammonium chloride	did not light up
ammonium chloride solution	lit up brightly

Figure 4

Explain the results of the investigation.

(3)

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(Total for question = 3 marks)

Q28.

Carbon dioxide is a simple molecular, covalent compound.

It has a low boiling point of –78.5 °C.

Explain why carbon dioxide has a low boiling point.

(2)

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(Total for question = 2 marks)

Q29.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Magnesium carbonate has the formula $MgCO_3$.

Magnesium carbonate contains Mg^{2+} and CO_3^{2-} ions.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the Mg^{2+} ion?

(1)

- ☐ **A** 2
- ☐ **B** 2.8
- ☐ **C** 2.8.2
- ☐ **D** 2.8.4

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

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(Total for question = 4 marks)

Mark Scheme

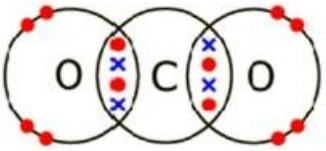
Q1.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. Substance A • giant ionic structure • (high melting point) strong electrostatic attractions between ions • due to a lot of energy required to overcome strong forces • (electrical conductivity) in solid ions strongly attracted in lattice ions cannot move, so poor conductor when solid • when molten ions free to move, so good conductor when molten Substance B • metallic structure • (high melting point) strong attraction between metal ions and delocalised electrons • due to a lot of energy required to overcome strong forces between particles in solid • (electrical conductivity) in solid delocalised electrons • free to move throughout metallic lattice, so good conductor when solid • delocalised electrons and ions free to move when molten, so good conductor when molten Substance C • covalent simple molecular • (low melting point) weak intermolecular forces/ attractions between molecules • little energy needed to separate molecules, so low melting point • (electrical conductivity) in solid and when molten no delocalised electrons or ions to carry charge, so poor conductor	(6) AO1 / AO3

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Identifies correct structure types OR explains a property of one substance	Possible candidate responses • A – giant ionic, B – metallic, C – simple molecular • High mp (for A or B) due to strong bonds (between atoms / ions) • Low mp for C due to weak intermolecular forces • A conducts when molten – ions can move • B conducts when solid / molten – electrons can move • C does not conduct – no free ions or electrons can't move
Level 2	3–4	Additional guidance Identifies correct structure type for one substance AND explains at least one property of that substance OR explains at least two properties	Possible candidate responses • A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move • B – metallic AND high mp due to strong bonds between {atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move • C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move
Level 3	5–6	Additional guidance Identifies correct structure types and explains properties for least two substances	Possible candidate responses • A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move AND / OR • B – metallic AND high mp due to strong bonds between {atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move AND / OR • C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. (AO3)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently (AO3)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. (AO3)

Q2.

Question number	Answer	Additional guidance	Mark
(i)	 • {2 pairs of/four} electrons shared between an oxygen atom and the carbon atom (1) • rest of structure correct (1)	ignore any inner electrons shown remaining electrons on oxygen either singly or paired allow all dots or all crosses 2nd mark dependent on 1st	(2) EXP

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark): • diamond has a giant (covalent) structure / strong (covalent) bonds / each carbon atom is bonded to four other carbon atoms / all carbon atoms in diamond are bonded together (1) • large amount of (heat) energy is needed to {separate the carbon atoms / break the bonds / break up lattice} (1)	reject ionic lattice reject layers reject bonds between molecules reject intermolecular forces being broken ignore just high heat mark independently	**(2)** **GRAD**

Q3.

Question number	Answer	Additional guidance	Mark
(i)	H^+ **and** Na^+ **only** circled		**(1)** **AO1-1**

Question number	Answer	Additional guidance	Mark
(ii)	so that they do not react (with the electrolyte/sodium sulfate solution / products formed)	allow graphite is unreactive allow so they do not corrode	**(1)** **AO1-1**

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking: • **electrons** (1) • move (through graphite) / are {delocalised / free / sea of electrons} (1)	 ignore 'charged particles' for MP1 but allow for MP2 reject ions for MP1 and MP2 'electrons in bonds/ electrons in outer shell' scores MP1 only MP2 depends on **electrons** or charged particles being mentioned ignore any other material about structure of graphite, correct or otherwise	**(2)** **AO1-1**

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	so that the ions can move	allow the solid does not conduct allow conducts when {in solution/liquid} ignore conducts when molten allow so cations / anions can move ignore so particles can move reject electrons move	**(1)** AO 2 2

Question Number	Answer	Mark
(ii)	OH^- and Cl^- only circled	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation linking one of the following pairs of points • use a crucible/metal container (instead of a beaker) (1) • which will not break/melt (when heated strongly) (1) OR • add a Bunsen burner (under the container) (1) • because heat needed to melt the lead bromide / to make the lead bromide a liquid (1)	allow blow torch ignore hot water bath	**(2)** AO 3 3b

Q5.

Question number	Answer	Additional guidance	Mark
	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (1 mark): • {delocalised/free} electrons (1) • (electrons) move (between the layers) (1)	ignore 'spare electrons' allow sea of electrons ignore 'carry the charge' / 'current to flow' reject between molecules free flowing electrons (2) electrons free to move (1)	**(2)** **EXP**

Q6.

Question number	Answer	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.	**(6)** **exp**

	AO2 (6 marks) Simple molecular substances have low melting points because • molecules (have) • weak (forces between molecules) • intermolecular forces • little energy needed to {separate the molecules / overcome the forces between molecules} (hence liquid at room temperature) they do not conduct whether solid or molten because • they do not contain any charged particles/ ions/ {delocalised/ free} electrons (hence does not conduct electricity) therefore • substance A is covalent Ionic substances have high melting points because • {charged particles/ ions} • strong (forces between ions) • electrostatic forces of attraction • a lot of (heat) energy is needed to {separate the ions / overcome the forces between ions} (hence high melting point) they conduct electricity when molten because • {ions/ charged particles} are present • free to move but they do not conduct when solid as • {ions/ charged particles} are present • not free to move therefore • substance B is ionic	

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Q7.

Question number	Answer	Additional guidance	Mark
	An explanation linking: • (calcium) nitrate {is soluble/ dissolves}/ (calcium) carbonate {is insoluble/ does not dissolve} (1) • so **ions** {free to move in solution / not free in solid} (1)	calcium nitrate dissolves so ions can move (2) or reverse argument for calcium carbonate	**(2)**

Q8.

Question number	Answer	Additional guidance	Mark
	An explanation linking • carbon has 4 outer shell electrons (1) • 3 electrons used in bond with other carbon atoms / each carbon forms 3 bonds (1) • (one) electron free to move / delocalised (1)	allow each carbon atom has 1 electron not involved in bonding (1) allow delocalised electron**s** reject reference to movement of ions	**(3)** AO1-1

Q9.

Question number	Answer	Additional guidance	Mark
	An explanation linking **EITHER** • {ionic / giant / lattice} structure (1) **OR** • strong forces of attraction (between ions of opposite charge) / strong (ionic) bonds (1) **AND** • (so) needs large amount of energy to overcome ionic forces (1)	reject covalent / molecular / intermolecular / atoms in the wrong context allow 'more energy' instead of 'large amount of energy' ignore temperature / heat	**(2)** AO2-1

Q10.

Question number	Answer	Additional guidance	Mark
	melting point (too) high / (temperature) below melting point / metals have high melting point / (water is) not hot enough	allow melting point higher (than chocolate) allow not enough {heat/ energy} / takes a lot of {heat / energy} allow metallic bonds are strong / no bonds have been broken (at temperature of water) ignore any statements referring to boiling point ignore 'hard to melt'	**(1)** **AO3-2b**

Q11.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **A01 (3 marks) and A02 (3 marks)** STRUCTURE • calcium chloride is an ionic compound with lattice of positive and negative ions • calcium is a metal and so has a metallic structure of delocalised electrons and {calcium/Ca^{2+} ions} • chlorine is a simple molecular covalent compound MELTING POINT • there are strong electrostatic forces of attraction/ionic bonds between the ions in calcium chloride • a large amount of heat energy is required to break the electrostatic forces (so calcium chloride has a high melting point) • strong electrostatic forces between ions and delocalised electrons in calcium • a large amount of heat energy is required to break the electrostatic forces (so calcium has a high melting point) • chlorine has weak forces of attraction between its molecules and these weak forces only take a small amount of energy to break down (so chlorine has a low melting point)	**(6)**
	CONDUCTIVITY WHEN SOLID • ions are fixed in a lattice and so cannot move (therefore calcium chloride cannot conduct a current) • delocalised electrons in metallic structure can move to carry a current (so calcium can conduct a current) • there are no delocalised electrons/ions/charged particles/overall charges in chlorine molecules and (so chlorine cannot conduct a current) CONDUCTIVITY WHEN MOLTEN • however, when molten ions are free to move (and therefore molten calcium chloride can conduct a current) • delocalised electrons in metallic structure can move to carry a current (so calcium can conduct a current) • there are no delocalised electrons/ions/charged particles/overall charges in chlorine molecules and (so chlorine cannot conduct a current) all incorrect information/explanations should be ignored reject contradictory explanations	

Level	Mark	Additional Guidance	General additional guidance Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Three structures named OR one structure described OR one property explained for one substance	Possible candidate responses • calcium is metallic, chlorine is a molecule (1) • calcium chloride is ionic with positive calcium ions and negative chloride ions (2) • calcium is metallic, chlorine is covalent, calcium chloride is ionic (2) • calcium is metallic it conducts when solid as it has mobile electrons (2)
Level 2	3–4	Additional guidance Three structures described or three properties explained.	Possible candidate responses • calcium has a metallic lattice of cations and delocalised electrons. Chlorine is made of simple molecules with weak intermolecular forces between them (3) • calcium has a metallic lattice of cations and delocalised electrons. Chlorine is made of simple molecules with weak intermolecular forces between them, this means that chlorine has a low melting point because little energy is needed to overcome these forces. (4)
Level 3	5–6	Additional guidance Six properties explained.	Possible candidate responses • calcium chloride has strong electrostatic forces between the ions so a high melting point and these ions are fixed in a lattice so the solid does not conduct. When melted, the ions are free to move and so the liquid does conduct. There are weak intermolecular forces between chlorine molecules so the melting point is low.(5) • calcium chloride has strong electrostatic forces between the ions so a high melting point and these ions are fixed in a lattice so the solid does not conduct. When melted, the ions are free to move and so the liquid does conduct. There are weak intermolecular forces between chlorine molecules so the melting point is low and molecules are uncharged so chlorine does not conduct electricity when solid or liquid (6)

Q12.

Question Number	Answer	Additional guidance	Mark
	high melting point / high boiling point / hard / insoluble (in water) / does not conduct (electricity)	ignore strong bonds ignore strong ignore values given ignore any other properties but reject contradictions to allowed answers	**(1)** AO 1 1

Q13.

Question number	Answer	Additional guidance	Mark
(i)	**B** high melting point		(1) comp

Question number	Answer	Mark
(ii)	D SO_4^{2-}	(1) comp

Question number	Answer	Additional guidance	Mark
(iii)	An explanation that combines identification - knowledge (1 mark) and reasoning/justification - understanding (1 mark): • loses electron(s) (1) • (loses) {one/an} (electron) (1)	allow transfers for loses mention of covalent bonding/sharing electrons = 0 ignore any reference to molecules.	(2)

Q14.

Question number	Answer	Mark
	D they are malleable	(1)

Q15.

Question Number	Answer	Mark
	A -6 low **1. The only correct answer is A** ***B** is not correct because bpt is too high and solubility not high* ***C** is not correct because solubility not high* ***D** is not correct because bot is too high*	(1) AO 3 2b

Q16.

Question number	Answer	Additional guidance	Mark
(i)	Ga_2O_3	allow $Ga2O3$ / GA_2O_3 reject Ga^2O^3	(1)

Question number	Answer	Mark
(ii)	**B** ionic **A** giant covalent structures do not conduct electricity at all **C** metallic structures conduct when solid **D** simple molecular structures do not conduct electricity when molten and have low melting points	(1)

Q17.

Question number	Answer	Mark
(i)	**B** 2.8 is the only correct answer **A** is incorrect as there are too few electrons **C** and **D** are incorrect as there are too many electrons	(1) AO1-1

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • **ions** (in magnesium carbonate) {cannot move / in a fixed position / held in a lattice / held together by strong electrostatic forces} (1) • magnesium contains {delocalised/free} **electrons** (1) • electrons (in magnesium) can {flow / move} / are mobile (1)	ignore charged particles throughout allow magnesium carbonate does not have {delocalised / free} electrons reject references to covalent bonding in magnesium carbonate for MP1 allow sea of electrons ignore ions in magnesium ignore carry a {charge / current}	(3) AO2-1

Q18.

Question Number	Answer	Additional guidance	Mark
	any two of the following • high melting points (1) • high boiling points (1) • malleable (1) • conduct electricity (1) • conduct heat (1) • high density (1) • shiny (1) • ductile (1) • strong (1) • sonorous (1)	 allow bendy as alternative to malleable ignore solid ignore hard allow good conductor for 1 mark	**(2)** AO 1 2

Q19.

Question Number	Answer	Mark
(i)	**B** -78 -33 does not conduct **The only correct answer is B** ***A*** *is not correct because simple molecular, covalent substances do not have high mpt and bpt* ***C*** *is not correct because ammonia is a gas at room temperature and does not conduct* ***D*** *is not correct because simple molecular, covalent substances do not have these properties*	**(1)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	$N_2 + 3H_2 \rightarrow 2NH_3$ (2) left hand side formulae (1) balancing of correct formulae (1)	accept multiples allow = or ⇌ in place of → ignore state symbols even if incorrect do not allow N2, n2, etc	**(2)** AO 2 1

Q20.

Question number	Answer	Mark
(i)	malleable / malleability	(1) AO2

Question number	Answer	Additional guidance	Mark
(ii)	does not corrode/ insoluble/ unreactive/ inert / non-toxic / hard	ignore references to appearance	(1) AO2

Q21.

Question Number	Answer	Additional guidance	Mark
	An explanation linking two of the following points • {metal ions / cations} surrounded by (delocalised) electrons (1) • strong {forces of attraction / bonding} (between (delocalised) electrons and {metal ions / cations}) (1) • needs lots of energy to {separate the particles / break bonds / break forces of attraction} (1)	ignore metal nuclei allow electrostatic bonds / metallic bonds ignore separating electrons any mention of intermolecular forces / covalent bonding / molecules / ionic bonding / atoms – max 1 mark marking points independent	(2) AO 1 1

Q22.

Question Number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • in all structures the carbon atoms bonded by single covalent bonds • shared pair of electrons • strong bonds • in diamond each carbon atom joined to four others • diamond has a giant covalent {structure/lattice} • graphene has a giant covalent {structure/lattice} • fullerene has a molecular structure • in graphene and fullerene each carbon atom joined to three others • in diamond and graphene many bonds need to be broken to melt • need lots of energy • therefore very high melting / sublimation points • in fullerene weak forces between molecules • less energy needed to separate molecules • fullerene has the lowest melting / sublimation point • because diamond and graphene have lots of strong covalent bonds so both are very strong materials • because weak forces between fullerene molecules so its strength is very low • in diamond there are no free electrons • so diamond does not conduct • in graphene and fullerene each carbon atom has one free electron • hence delocalised electrons • graphene conducts electricity • fullerene only conducts electricity across the surface of the molecule • no/little movement of electrons between molecules • so fullerene is poor conductor of electricity (/ semi conductor)	**(6)** AO 1 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and fully devolved. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully devolved. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q23.

Question number	Answer	Mark
	C -7 63 is the only correct answer **A** and **B** have boiling points showing a gas at room temperature **D** has a boiling point that of a giant structure	**(1)** AO2-1

Q24.

Question Number	Answer	Additional guidance	Mark
	A description to include the following points	first two marks can be given for a suitable diagram	**(3)** AO 3 3a
	• insert electrodes (into aqueous solution)(1)	allow anode **and** cathode	
	• connect to electrical supply / powerpack /battery/cell (1)	allow carry out an electrolysis experiment alone / see if solution conducts electricity (1) allow pass an electric current through (the solution) (1) ignore electricity alone	
	• bulb lights / ammeter shows current / electrolyte decomposes (1)	allow correct observation at one electrode (1)	

Q25.

Question Number	Answer	Mark
(i)	**C** chlorine zinc **The only correct answer is C** ***A*** *is not correct because oxygen cannot be produced by the electrolysis of this molten salt* ***B*** *is not correct because hydrogen cannot be produced by the electrolysis of this molten salt* ***D*** *is not correct because hydrogen and oxygen cannot be produced by the electrolysis of this molten salt*	**(1)** AO 2 1

Question Number	Answer	Mark
(ii)	**D** it contains ions that can move **The only correct answer is D** ***A*** *is not correct because molten zinc chloride does not contain molecules* ***B*** *is not correct because molten zinc chloride does not have a giant structure* ***C*** *is not correct because delocalised electrons are not present*	**(1)** AO 1 1

Q26.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks) AO3 (3 marks)** • sodium atoms lose electrons • each sodium atom loses one electron • to obtain electronic configuration 2.8 • which is that of sodium ions, Na^+ • electrons transfer to chlorine atoms • chlorine atoms gain electrons • each chlorine atom gains one electron • to obtain electronic configuration 2.8.8 • which is that of chloride ions, Cl^- • sodium ions attract chloride ions • because of opposite charges • ions pack close together • ratio of ions 1:1 • ions arranged in lattice • giant (ionic) (structure)	**(6)**

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q27.

Question number	Answer	Additional guidance	Mark
	An explanation linking • ammonium chloride solution conducts electricity and solid ammonium chloride does not conduct electricity (1) • ammonium chloride contains **ions** (1) • in solution **ions** can move / in solid **ions** cannot move (1)	Answer must refer to both solid and solution for full marks	**(3)** **AO3**

Q28.

Question number	Answer	Additional guidance	Mark
	An explanation linking **weak** {forces between molecules / intermolecular forces} (1) (intermolecular forces need) little {heat/energy} required (1)	reject weak covalent bond for both mark points allow **weak** intermolecular bonds / **weak** bonds **between molecules** ignore easy to break ignore 'easier to separate molecules' ignore needs a low temperature to break	**(2)**

Q29.

Question number	Answer	Mark
(i)	**B** 2.8 is the only correct answer **A** is incorrect as there are too few electrons **C** and **D** are incorrect as there are too many electrons	**(1)** AO1-1

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking • **ions** (in magnesium carbonate) {cannot move / in a fixed position / held in a lattice / held together by strong electrostatic forces} (1) • magnesium contains {delocalised/free} **electrons** (1) • electrons (in magnesium) can {flow / move} / are mobile (1)	ignore charged particles throughout allow magnesium carbonate does not have {delocalised / free} electrons reject references to covalent bonding in magnesium carbonate for MP1 allow sea of electrons ignore ions in magnesium ignore carry a {charge / current}	**(3)** AO2-1