Mark scheme

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>a</td><td></td><td>Level 3 (5–6 marks)
Demonstrates detailed knowledge and understanding of the structure and bonding in all 3 structures
AND
Accurately applies knowledge and a detailed understanding to explain why diamond has the highest melting point.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)
Demonstrates clear knowledge and understanding of the structure and bonding in some of the structures
AND
Applies clear knowledge and understanding to explain why diamond has the highest melting point.

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)
Demonstrates limited knowledge and understanding of the structure and bonding in some of the structures
OR
Attempts to apply knowledge and understanding to explain why diamond has the highest melting point.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 mark
No response or no response worthy of credit.</td><td>6 (3 x AO 1.1) (3 x AO 2.1)</td><td>AO1.1 – Demonstrates knowledge and understanding of structures and bonding.

• covalent bonds are very strong
• a lot of energy is required to break covalent bonds
• intermolecular forces are weaker than covalent bonds
• more energy is needed to break covalent bonds than overcome intermolecular forces
• more atoms in a molecule mean more intermolecular forces
• more intermolecular forces require more energy to overcome

AO2.1 – Applies knowledge and understanding of structures and bonding to diamond, Cl_2 and polyethene

• diamond only contains covalent bonds
• diamond requires high energy to break covalent bonds between atoms
• chlorine has intermolecular forces between the molecules
• chlorine requires low energy to break intermolecular forces between molecules
• polyethene has intermolecular forces between the polymer chains
• covalent bonds in chlorine and polyethene are not broken on melting
• polyethene has more / stronger intermolecular forces between chains than chlorine does between molecules</td></tr>
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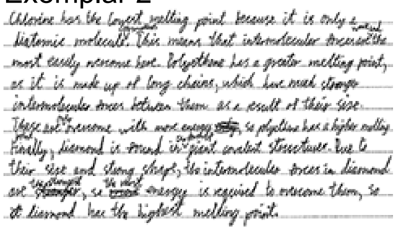
Examiner's Comments

This 6 mark Level of Response question assessed AO1 and AO2. At Level 3 (5 – 6 marks) candidates needed to demonstrate detailed knowledge and understanding of the structure and bonding in all three structures and accurately apply this knowledge to explain why diamond has the highest melting point. All candidates attempted the question which generated a wide range of responses and differentiated well between those who had a detailed level of knowledge and understanding of the three types of structure and bonding and those who had limited understanding. Most candidates correctly identified diamond as having the highest melting point and there were some excellent answers describing it as a giant covalent structure requiring large amounts of energy to break the many strong covalent bonds.

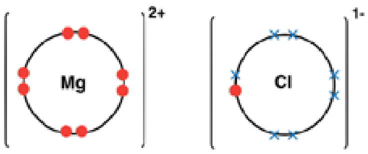
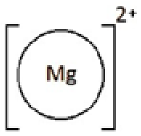
However, there were a significant proportion of candidates who went on to write about diamond also having intermolecular forces.

Many candidates were able to identify chlorine as a simple covalent molecule and poly(ethene) as a polymer but only those who expanded their answers to include correct reference to intermolecular forces for both achieved Level 3 marks. Many candidates ranked chlorine and poly(ethene) by the number of covalent bonds needing to be broken or wrote about poly(ethene) having crosslinks rather than intermolecular forces.

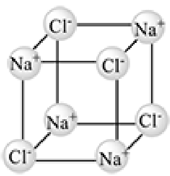
Exemplar 2

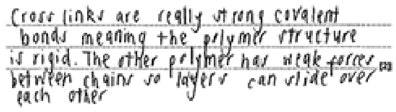
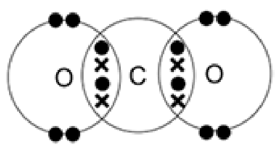

Chlorine has the lowest melting point because it is only a small diatomic molecule. This means that intermolecular forces are the most easily overcome here. Polyethene has a greater melting point, as it is made up of long chains, which have much stronger intermolecular forces between them as a result of their size. These are overcome with more energy, so polythene has a higher melting point. Finally, diamond is found in a giant covalent structure. Due to their size and strong shape, the intermolecular forces in diamond are strongest, so the most energy is required to overcome them, so diamond has the highest melting point.

					This is a Level 2, (3 mark) response. Chlorine is identified as having the lowest melting point with weak intermolecular forces, which are most easily overcome. The candidate has also identified chlorine as a simple covalent molecule. Poly(ethene) is identified as a polymer, with stronger intermolecular forces than chlorine. Although the candidate appreciates that diamond is a giant covalent structure, its melting point is then discussed in terms of its intermolecular forces. This response has demonstrated clear knowledge and understanding of the structure and bonding in some of the structures but has not applied this to explain why diamond has the highest melting point.
	b	i	Idea that ionic compounds contain ions ✓ Idea that the ions cannot move in a solid/ions are held in fixed positions ✓ Idea that when ionic compounds are dissolved, the ions are free to move ✓	3 (3 x AO 1.1)	**DO NOT ALLOW** reference to (delocalised) electrons in the incorrect context – scores 0 for the question **ALLOW** ions are free **<u>Examiner's Comments</u>** Good responses to this question described that ionic compounds contain ions. In a solid the ions are held in fixed positions whereas when ionic compounds are dissolved the ions are free to move. **Misconception** A key misconception in this question was that electrical conductivity in ionic compounds is the result of the movement of electrons rather than ions. This led to many candidates gaining no marks for this question.

		ii	 Correct magnesium ion / 2.8 **OR** one shell showing 8 electrons **OR** empty outer shell ✓  Correct chloride ion / 2.8.8 **OR** correct chloride ion showing full outer shell only ✓	2 (2 x AO 1.2)	**DO NOT ALLOW** structures with shared electrons Two correct electronic structures but no charges award one mark Two correct charges with incorrect electronic structure award one mark The ionic charges must **not** be shown in the nucleus One electronic structure must be labelled in some way to indicate which ion is which in order to score two marks. **ALLOW** answers showing the transfer of electrons providing the same electrons are not shown twice All electrons can be dots or crosses If dots and crosses are used the number of each must be correct Inner shell electrons do not need to be shown but must be correct if they are shown. **Examiner's Comments** Many excellent dot and cross diagrams were seen by examiners. The most common mistake was showing 6 dots and 2 crosses (or vice versa) in the outer shell of a chloride ion or omitting the charges on the ions. There were however a significant proportion of candidates who drew diagrams showing sharing of electrons/covalent bonding.
			Total	**11**	
2			**D**	1 (AO 1.2)	
			Total	**1**	
3			**A**	1 (AO 1.1)	**Examiner's Comments** Only the higher attaining candidates recalled that Mendeleev grouped elements based on chemical properties and left gaps with D being a common incorrect answer.

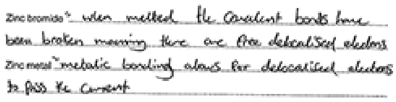
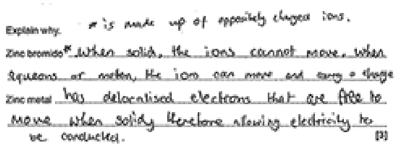
			Total	**1**	
4			**C**	1 (AO 1.1)	
			Total	**1**	
5		i	Idea that 2 electrons are lost to form a full outer shell ✓	1 (AO 2.1)	**ALLOW** idea that magnesium has (only) 2 <u>outer</u> shell electrons which are lost / idea that magnesium loses 2 electrons to become stable **IGNORE** just the idea that magnesium loses 2 electrons **<u>Examiner's Comments</u>** Many candidates did not give enough detail in their responses, for example stating that magnesium has 2 electrons on its outer shell but failing to explain that it loses them to become the 2+ion. Statements that magnesium loses two electrons were also seen, with no reference to the electrons being lost from the outer shell, or to allow the magnesium atom to become stable.
		ii	$Mg^{2+} + 2OH^{-} \rightarrow Mg(OH)_2$ Correct formulae ✓ Balancing ✓	2 (2 × AO 2.1)	**ALLOW** any correct multiple, including fractions **ALLOW** = instead of → **DO NOT ALLOW** and / & instead of '+' **IGNORE** state symbols **DO NOT ALLOW** $Mg^{2+}(OH)^{-}{}_2$ **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g., $Mg^{2+} + 2Oh^{-} \rightarrow Mg(OH)_2$ **<u>Examiner's Comments</u>** The formula for magnesium hydroxide was frequently incorrect despite many candidates correctly using Mg^{2+} and OH^{-} ions in the reactant side of their equations. Common errors were MgOH and $MgOH^2$. The GCSE Science Exam Hints for students highlighted that when writing the chemical formula of an ionic compound, candidates need to

					remember the charges have to balance in ionic formulas.
			Total	3	
6			 Sodium ion labelled as Na^+ **and** chloride ion labelled as Cl^- ✓ Alternately labelled ions ✓	2 (2 × AO 1.2)	**DO NOT ALLOW** atoms rather than ions; scores 0 mark **ALLOW** information provided in the form of a key **IGNORE** labelling as 'sodium ion' / 'chloride ion'; must be symbols **Examiner's Comments** Some candidates omitted this question, and many candidates labelled the circles as Na and C*l* rather than Na^+ and Cl^-. S/S^+ instead of Na/Na^+ was a common error. Some candidates who correctly labelled the ions did not appreciate that the ions alternate in the lattice structure.
			Total	2	
7			Idea that polymer chains without cross-links can slide or move over each other / **ORA** ✓ The intermolecular forces holding polymer chains together are weaker than cross-links / **ORA** ✓	2 (2 × AO 1.1)	**Assume unqualified answer refers to polymers without cross-links** **IGNORE** references to the polymer chains stretching **ALLOW** idea that cross-links are covalent bonds **Examiner's Comments** The chemistry of polymer structures was not well known by candidates, with very few candidates referencing chains of polymers. Most candidates just wrote about layers being able to slide over each other. Some candidates did score 1 mark for recognising that the cross-links were covalent bonds. Many talked about the layers not being attached together so the polymer could easily be stretched. Exemplar 3

					 Cross links are really strong covalent bonds meaning the polymer structure is rigid. The other polymer has weak forces between chains so layers can slide over each other This response illustrates a correct, 2 mark response. The candidate has identified that cross-links are covalent bonds and realised that polymer chains without cross-links can slide over each other.
			Total	**2**	
8			 Two shared pairs of electrons between C and each O ✓ Rest of structure correct ✓	2 (2 × AO 2.2)	**ALLOW** electrons as all dots, all crosses, or a mix of dots and crosses **ALLOW** diagrams with inner electron shells, but inner shells must be correct if shown Second marking point is dependent on two shared pairs of electrons between C and each O **<u>Examiner's Comments</u>** This question required candidates to draw a correct 'dot and cross' diagram. Many excellent diagrams were seen by examiners. Less successful candidates tended to include diagrams showing only one shared pair of electrons between the carbon and oxygen atoms.
			Total	**2**	
9			B	1 (AO 1.2)	**<u>Examiner's Comments</u>** **Misconception** C was a common misconception in this question. Candidates often thought that a 3D space filling model does not show the relative size of the atoms, which is actually an advantage

					of representing a molecule using a 3D space filling model.
			Total	**1**	
10			C	1 (AO 1.1)	**Examiner's Comments** **Misconception** A was a common misconception in this question, with candidates identifying the Group 1, 2 and 3 metals rather than knowing that non-metals form acidic oxides.
			Total	**1**	
11		i	$Zn^{2+} + 2Br^{-} \rightarrow ZnBr_2$ Formulae ✓ Balancing ✓	2(2 ×AO2.1)	**ALLOW** any correct multiple, including fractions **ALLOW** = instead of → **DO NOT ALLOW** and / & instead of '+' **IGNORE** state symbols balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g. $Zn^{2+} + 2BR^{-} \rightarrow ZnBr2$ **Examiner's Comments** Higher achieving candidates were able to construct the correct balanced ionic equation for the formation of zinc bromide. One mark was given for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. The most common error was writing the formula of zinc bromide as ZnBr.

					OCR support Teachers might find the Chemical reactions Delivery Guide a useful resource for identifying common misconceptions and approaches to overcome them. In addition our GCSE (9-1) Science Exam hints for candidates is a useful resource to provide candidates with when revising to help them avoid this common issue. They can also be downloaded as an A3 version to display in classrooms.
		ii	**Zinc bromide** Idea that zinc bromide has ions that are free to move when zinc bromide is aqueous or molten / Idea that zinc bromide has ions that cannot move when zinc bromide is solid ✓ **Zinc metal** Has electrons ✓ (Electrons) can move / electrons can carry the charge ✓ **BUT** Delocalised electrons scores 2 marks	3(3 ×AO1.1)	**IGNORE** just charged particles throughout the question **DO NOT ALLOW** electrons can move **IGNORE** bromine ions **DO NOT ALLOW** free ions **IGNORE** free (electrons) for idea of movement **IGNORE** electrons can carry the electricity **Examiner's Comments** Good responses to this question described that zinc metal contain delocalised electrons and that zinc bromide contains ions that can only move when the compound is dissolved in water or molten **Assessment for learning** Candidates should be encouraged to use correct terminology. Many candidates attempted to explain the electrical conductivity of zinc bromide in terms of electrons, while others described molten zinc bromide as containing free electrons or ions, a contradiction which did not gain a mark.

					Exemplar 3  Zinc bromide*: when melted the covalent bonds have been broken meaning there are free delocalised electrons Zinc metal*: metallic bonding alows for delocalised electrons to pass the current This response shows the answer, given 2 marks, which examiners saw most often. Exemplar 4  Explain why. * is made up of oppositely charged ions. Zinc bromide*: when solid, the ions cannot move. when aqueous or molten, the ions can move and carry a charge Zinc metal: has delocalised electrons that are free to move when solid, therefore allowing electricity to be conducted. [3] This response, however, illustrates correct use of key terminology and was given 3 marks.
			Total	**5**	
12			D ✓	1(AO2.1)	
			Total	**1**	
13			C ✓	1(AO1.1)	**<u>Examiner's Comments</u>** ? **Misconception** A was a common misconception in this question. Candidates often think that because Group 1 elements form positive ions, they gain electrons and vice versa for Group 7 and centres should be aware of this frequent error.
			Total	**1**	