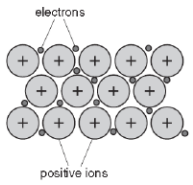
Mark scheme – Bonding (F)

Question			Answer/Indicative content	Marks	Guidance
1			B	1 (AO2.1)	
			Total	**1**	
2			C	1 (AO2.1)	**Examiner's Comments** A and B were common incorrect responses.
			Total	**1**	
3			C	1 (AO 2.1)	**Examiner's Comments** Candidates found this difficult. Either missing Period 1 and answering D or confusing Period with Group and answering B.
			Total	**1**	
4		i	Idea of preventing potassium reacting with air or oxygen / idea of preventing potassium reacting with water ✓	1 (AO1.1)	**ALLOW** potassium reacts with air or oxygen / potassium reacts with water
		ii	(Sodium and potassium) both have 1 electron in their outer shell / both have the same number of electrons in their outer shell ✓	1 (AO1.1)	**ALLOW** both form 1+ ions
			Total	**2**	
5	a		**Any two from:** In order of (Increasing) atomic mass / weight ✓ In groups showing similar chemical properties ✓ Left gaps for elements that had not been discovered ✓	2 (AO1.1)	**ALLOW** (increasing) mass number **IGNORE** just in order of mass
	b		In order of (Increasing) atomic number / proton number ✓	1 (AO1.1)	**IGNORE** electrons **DO NOT ALLOW** atomic mass
	c	i	Germanium ✓	1 (AO3.1a)	

		ii	Idea of similar atomic mass **/** 72.6 is closest to 72 / closest atomic mass ✓ Idea of similar density **/** 5.35 is closest to 5.5 / closest density ✓	2 (AO3.2 a)	**ALLOW** (Relative) atomic mass of 72.6 is very close to 72 **IGNORE** just atomic masses are 72 and 72.6 **ALLOW** density of 5.35 is very close to 5.5 **IGNORE** just densities are 5.35 and 5.5 **IGNORE** comments about melting point or colour If no marks awarded **ALLOW** 1 for density and relative atomic mass and not melting point
	d	i	Unreactive ✓ Full outer shell (of electrons) ✓	2 (AO2.1 1.1)	**ALLOW** doesn't bond / doesn't lose or gain electrons / doesn't share electrons **ALLOW** (argon has a) stable electronic structure / 8 electrons in outer shell
		ii	<table><tr><th></th><th>$^{20}_{10}Ne$</th><th>$^{22}_{10}Ne$</th></tr><tr><td>Proton</td><td>10</td><td>10</td><td>✓</td></tr><tr><td>Neutron</td><td>10</td><td>12</td><td>✓</td></tr><tr><td>Electron</td><td>10</td><td>10</td><td>✓</td></tr></table>	3 (AO2.1)	1 mark for each row
			Total	**4**	
6	a	i	ionic✓ oppositely charged ions✓	2 (AO1.1)	**ALLOW** oppositely charged particles / has + and – particles **IGNORE** contains anions and cations (in diagram) **IGNORE** oppositely charged atoms / molecules **DO NOT ALLOW** positive nucleus and negative electrons **Mark independently**
		ii	**Any two from:** Idea of many strong ✓	2 (AO1.1)	**Reference to intermolecular forces / bonds / molecular forces scores 0 for question**

			covalent bonds ✓ (which) require a lot of energy to break ✓		**ALLOW** many covalent bonds break at high temperatures for 2 marks **ALLOW** idea that each atom has 4 strong covalent bonds for 2 marks **ALLOW** giant covalent structure for 1 mark
		iii	No delocalised electrons / no sea of electron / no mobile charge carriers / ions / electrons structure contains atoms ✓	1 (AO1.1)	**IGNORE** just free electrons
	b		Layers / metal ions ✓ slide over each other ✓	2 (AO1.1)	**IGNORE** metal atoms / electrons **Mark independently**
			Total	**7**	
7	a	i	A **AND** D ✓	1 (AO3.1a)	
		ii	**Any two from:** Conducts electricity in molten state ✓ Does not conduct electricity in solid state ✓ High melting point ✓	2 (AO3.2b)	ALLOW dissolve in water
	b	i	Add water (and stir) ✓ Filtration ✓ **B** collects on filter paper ✓	3 (AO3.3a 1.2 3.3a)	
		ii	Distillation **OR** evaporation **OR** heating ✓ Removes water **OR** dries C **OR** removes some water and leave to crystalise ✓	2 (AO1.2 3.3a)	**ALLOW** boiling
			Total	**8**	
8		i	Positive (metal) ions / cations ✓ Surrounded by sea of or delocalised electrons ✓	2 (AO1.1)	**Any reference to ionic or covalent bonding or IMF scores 0** **ALLOW** a labelled diagram



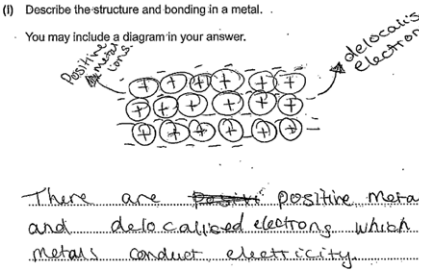
If diagram must be at least one electron in the body of the ions
Diagram must show **close packed** metal ions, in a regular arrangement
ALLOW - / e / e^- / dots for electrons
ALLOW Circles with + or circles labelled ions
IGNORE free electrons

If e or e^- used don't need labelling

Examiner's Comments

Very few candidates drew a creditworthy diagram and of those that did, few included labels. Most candidates drew a lithium atom or a lithium atom changing into a lithium ion and discussed the formation of ions and ionic bonding. A significant number omitted the question.

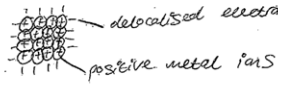
Exemplar 8

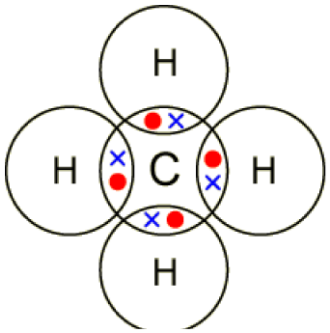


The diagram scores both marks. The circles have a + and are labelled as ions. The electrons surround the ions and are labelled.

The writing underneath the diagram would only have scored marking point one for the positive ions. Although delocalised electrons are mentioned there is no mention of where they are.

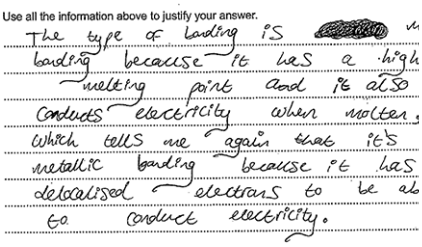
Exemplar 9

					You may include a diagram in your answer.  It is a giant lattice structure they're all together and there no space in between. The diagram scores marking point one, the circles have a + and are labelled as ions. The electrons are only shown around the outside of the bulk of the ions and so do not score marking point two, they should also be among the positive ions. This is a common misconception of the phrase “surrounded by”.
		ii	Idea that layers or rows or sheets (of particles) slide over each other ✓	1 (AO1.1)	**IGNORE** layers can bend **IGNORE** IMF **Examiner’s Comments** Most able candidates discussed layers sliding, the majority discussed the metal bending and many omitted the question.
		iii	Has electrons ✓ That can move / that can carry the charge ✓ **BUT** Delocalised electrons scores 2 marks	2 (AO1.1)	**DO NOT ALLOW** free ions – scores 0 **IGNORE** free (electrons) for idea of movement **Examiner’s Comments** Higher ability candidates identified electrons but fewer included the movement of the electrons. A small number discussed delocalised electrons. Discussions of melting point or reactivity were common. A significant number omitted the question.
			Total	**5**	
9		i		2 (AO2.2)	**ALLOW** all dots or all crosses Inner shell electrons on carbon not needed **ALLOW** 1 mark only for correct bonding pairs and a non bonding electron on H

					**Examiner's Comments** Common errors included one electron in each bond, an extra non-bonding electron on each hydrogen and four extra non-bonding electrons on carbon.
		ii	Weak forces ✓ Between molecules ✓	2 (AO2.1)	**DO NOT ALLOW** mention of intramolecular bonding **IGNORE** weak bonds alone **DO NOT ALLOW** weak covalent bonds weak intermolecular forces/bonds ✓✓ **Examiner's Comments** Candidates found this extremely difficult. Many discussed weak bonding, weak covalent bonds, few electrons or only single bonds.
			Total	**4**	
10			*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Describes the bonding in compound X in detail. **AND** Links explanation to at least two of the properties to the bonding in compound X. *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)** Describes the bonding in compound X. **AND** Links explanation to one of the properties to the bonding in compound X. *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)** Attempts to describe the bonding in compound X. **OR** Attempts to link explanation to one of the properties to the bonding.	6 (AO1.1 ×2) (AO2.1 ×2) (AO3.2 a ×2)	**AO1.1 Knowledge and understanding of ionic bonding** • Ions cannot move in a solid so will not conduct electricity • No delocalised electrons, cannot conduct as a solid • Ions can move in a liquid, so it will conduct electricity when molten • Bonding is very strong and takes a lot of energy to break, so it will have a high melting point • Ionic bonds are strong electrostatic forces of attraction between oppositely charged ions **AO2.1 Application of knowledge and understanding of properties linked to the bonding in a compound** • Compound X has positive and negative ions. • Compound X contains ions • Compound X does not have mobile electrons

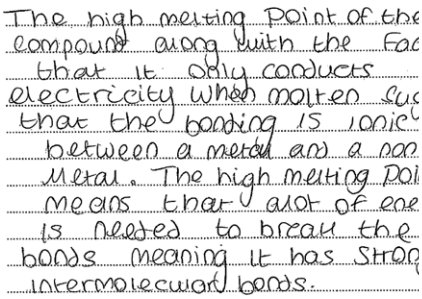
			There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant. **0 marks** *No response or no response worthy of credit.*		**AO3.2a Analysis of information and ideas to make judgements** • The bonding in compound X is ionic • The bonding in compound X is very strong • The bonding cannot be metallic • The bonding cannot be covalent **Examiner's Comments** Candidates found this question very difficult. Some repeated the properties listed in the notebook without applying them to a type of bonding. High melting point meaning strong bonding was the most common creditworthy response. Many candidates named a type of bonding but found explaining their choice very difficult. Covalent was the most chosen bonding with many explaining conductivity in terms of moving or delocalised electrons not appreciating that non-conduction in solid but conduction when molten signals ions and ionic bonding. Some chose metallic bonding due to the conduction when molten. Those who chose ionic bonding did not link to the ions making up compound X or the electrostatic charge between them. **Exemplar 1** Use all the information above to justify your answer. the type of bonding is co because it has a high melting point it cannot cond electricity when solid but it can conduct electricity when molten covalent bonding is between one metal t non metals.

Exemplar 2


Use all the information above to justify your answer.
The type of bonding is [redacted] bonding because it has a high melting point and it also conducts electricity when molten, which tells me again that it's metallic bonding because it has delocalised electrons to be able to conduct electricity.

The candidate has chosen a type of bonding, metallic. They have taken a property from the notebook, in this case conduction of electricity, and have explained that delocalised electrons are responsible for this conduction. This is Level 1, 2 marks.

Exemplar 3


The high melting point of the compound along with the fact that it only conducts electricity when molten suggests that the bonding is ionic between a metal and a non metal. The high melting point means that alot of energy is needed to break the bonds meaning it has strong intermolecular bonds.

The candidate has chosen the correct bonding, ionic. They have taken a property from the notebook, in this case high melting point, and have explained that the strong bonds are responsible for this. They have also mentioned that since it only conducts when molten this leads them to ionic bonding. This is Level 2. The candidate has confused the bonding by discussing intermolecular forces and not forces between ions. This is 3 marks.

Exemplar 4

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>Use all the information above to justify your answer.
it would be ionic bonding bec it has a high melting point which me the bonds are strong and there is a metal ion present And it does conduct electricity when solid which suggests that there is not del electrons present unlike there is in metallic bonding bu the is when it's molten which also is not covalent as covalent does not con electricity so it must be ionic bonding.

The candidate has chosen the correct bonding, ionic. They have taken a property from the notebook, in this case high melting point, and have explained that the strong bonds are responsible for this. They have described why it cannot be metallic or covalent. This is Level 2, 4 marks.

To access Level 3 the candidate needed to include a detailed explanation of the properties e.g. ionic substances made up of positive and negative ions or the strong bonds being due to strong (electrostatic) attractions between positive and negative ions or non-conduction in solid because the ions cannot move or conduction in liquid because the ions can move.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
<tr><td>11</td><td>a</td><td></td><td>
<table>
<tr><th>Particle</th><th>Atomic number</th><th>Mass number</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th><th>E s</th></tr>
<tr><td>A</td><td>11</td><td>23</td><td>11</td><td>12</td><td>11</td><td></td></tr>
<tr><td>B</td><td>9</td><td>19</td><td>9</td><td>10</td><td>9</td><td></td></tr>
<tr><td>C</td><td>17</td><td>37</td><td>17</td><td>20</td><td>17</td><td></td></tr>
<tr><td>D</td><td>13</td><td>27</td><td>13</td><td>14</td><td>10</td><td></td></tr>
</table>
</td><td>4</td><td>one mark scored for each correct line</td></tr>
<tr><td></td><td>b</td><td></td><td>particle A – one electron in outer shell or energy level (1)
particle D – has more protons than electrons (1)</td><td>2</td><td></td></tr>
<tr><td></td><td>c</td><td></td><td>group 7 (1) as 7 electrons in outer shell (1)
period 3 (1) as 3 shells occupied (1)</td><td>4</td><td></td></tr>
<tr><td></td><td>d</td><td></td><td>
<table>
<tr><th></th><th>Charge</th><th>Mass in atomic mass units</th></tr>
<tr><td>proton</td><td>positive /+</td><td>1</td></tr>
<tr><td>neutron</td><td>neutral / no charge</td><td>1</td></tr>
<tr><td>electron</td><td>negative</td><td>0.0005</td></tr>
</table>
</td><td>2</td><td>one mark scored for each correct column (2)

ALLOW
1/1760
or 1/1836
or 1/2000</td></tr>
</table>

	e		idea of the nuclear atom (1)	1	
			Total	**14**	
12			C	1	
			Total	**1**	
13			D	1	
			Total	**1**	
14		i	Same number of electrons in outer shell / all have 7 electrons in outer shell (1)	1	**ALLOW** outer electrons or valence electrons rather than electrons in the outer shell **ALLOW** valence shell rather than outer shell **DO NOT ALLOW** the wrong number of electrons in the outer shell
		ii	$2Na + Br_2 \rightarrow 2NaBr$ Correct formulae of reactants and products (1) Balancing – depend on correct formulae (1)	2	**ALLOW** any correct multiple of the equation including fractions **ALLOW** = or ⇌ instead of → **DO NOT ALLOW** and or & instead of + **ALLOW** one mark for correct balanced equation with minor errors of case and subscript e.g. 2NA + Br2 → 2NaBr
		iii	KAt (1)	1	
			Total	**4**	