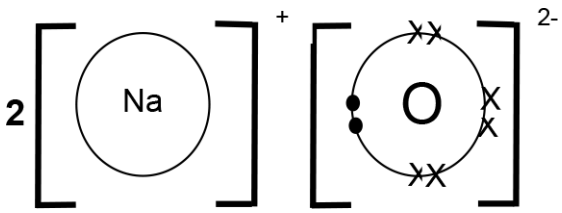
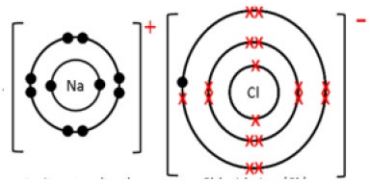
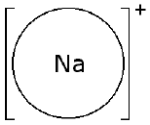
Mark scheme – Bonding (H)

Question			Answer/Indicative content	Marks	Guidance
1			D ✓	1 (AO1.1)	
			Total	**1**	
2			D ✓	1(AO2.1)	
			Total	**1**	
3			C ✓	1(AO2.1)	
			Total	**1**	
4			D ✓	1(AO1.1)	
			Total	**1**	
5			C ✓	1(AO1.1)	
			Total	**1**	
6			D ✓	1 (AO1.1)	
			Total	**1**	
7			 Outer shells correctly drawn ✓ Correct charges ✓	2 (AO2.1)	**ALLOW** all dots / all crosses / mix of dots and crosses **ALLOW** eight electrons shown on outer shell of sodium ion **ALLOW** just one sodium ion drawn **If inner shells are drawn, they must be correct** **ALLOW** 1 mark for correct diagram of either a Na^+ or O^{2-} ion, if no other mark awarded
			Total	**2**	
8	a	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 (AO2×3.2a)	**ALLOW** (Relative) atomic mass of 72.6 is very close to 72 **IGNORE** just atomic masses are 72 and 72.6

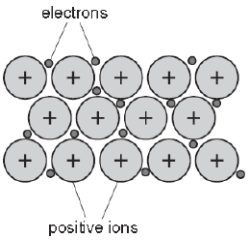
					ALLOW density of 5.35 is very close to 5.5 **IGNORE** just densities are 5.35 and 5.5 **IGNORE** comments about melting point or colour If no marks awarded, **ALLOW** 1 for density and relative atomic mass and not melting point
	b	i	<u>Unreactive</u> ✓ Full outer shell (of electrons) ✓	2 (AO2.1 1.1)	**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	**8**	
9	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 ✓ covalent bonds ✓ (which) require a lot of energy to break ✓	2 (AO1.1)	**Reference to intermolecular forces / bonds / molecular forces scores 0 for question** **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 electrons / 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**	
10	a		**Any two from:** In order of (increasing) atomic mass / weight ✓ In groups showing similar <u>chemical</u> 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
			Total	**3**	
11		i	**Any two from:** Size of atoms or ions is not accurate ✓ Idea that atoms or ions are held together by forces not physical bonds ✓ Idea that it show the atoms or ions **too far apart** ✓ There are not really 'sticks' holding the atoms or ions together ✓ Charges on **ions** are not shown ✓	2(AO3.1b)	**ALLOW** doesn't show relative size of atoms or ions **IGNORE** idea that you cannot see the forces between the atoms / ions **DO NOT ALLOW** charges on **atoms** are not shown **<u>Examiner's Comments</u>** Good responses to this question usually described that the ball-and-stick model does

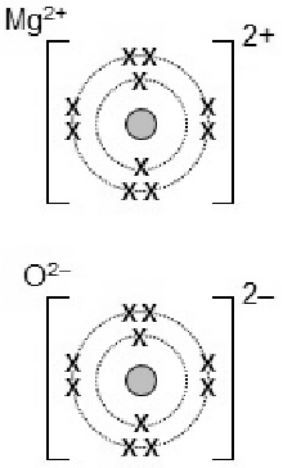
					not show the charges on the ions and the idea that it shows the ions too far apart. **AfL** Candidates should be encouraged to use precise terminology. In this question credit was given for the idea that the size of the atoms or ions is not accurate or the diagram doesn't show the relative size of the ions. Many candidates, however, simply wrote that the diagram doesn't show the size of the ions. Many candidates also did not seem to understand the word '**limitations'**.
		ii	 Correct sodium ion / 2.8 **OR** empty outer shell ✓ ie  Correct chloride ion / 2.8.8 **OR** correct chloride ion showing full outer shell only ✓	2(AO2.1)	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 Award 0 marks for structures with shared electrons 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 **Examiner's Comments** This question required candidates to draw a correct 'dot and cross' diagram, including the charges on the ions. Many excellent diagrams were seen by examiners. Others lost marks as the chloride ion was often drawn as 2.8 rather than 2.8.8. Lower ability candidates tended to draw diagrams showing the sharing of electrons.
			Total	**4**	
12	a	i	C ✓ Low density **and** good **electrical** conductor ✓	2(AO3.2a) (AO1.1)	**Second mark is dependent on correct choice of C** **BOTH** properties required for second mark **IGNORE** good conductor **DO NOT ALLOW** light / lighter for low density **Examiner's Comments** Element C was usually correctly identified. When candidates did not gain the second mark it was usually because they omitted to refer low density being an important property. Lower ability candidates tended to use imprecise terminology, e.g. 'good conductor' rather than 'good **electrical** conductor' or 'light' instead of 'low density'.

		ii	Idea of a feature of a substance that can be observed or measured ✓	1(AO1.1)	**ALLOW** a specific example eg the appearance of something or the state (of matter) or melting point / boiling point **IGNORE** idea of a property that is reversible **Examiner's Comments** Good responses to this question described a physical property as a feature that can be observed or measured. Credit was also given for a specific example of a physical property, e.g. melting / boiling point or state of matter.
	b		Dissolve gas or oxide in water / make a solution of the oxide ✓ Test with universal indicator (paper) ✓ (universal indicator) would turn blue / pH greater than 7 ✓	3(AO3.3a)	**ALLOW** shake gas or oxide with water **ALLOW** use a pH meter / pH probe **ALLOW** test with (damp) red litmus (paper) **ALLOW** (damp red litmus paper) turns blue **Examiner's Comments** Good responses to this question described the idea of making a solution of the oxide, testing the pH and obtaining a pH greater than 7 (or universal indicator / damp red litmus paper turning blue). Examiners saw a wide range of incorrect responses including: • addition of acid, followed by testing for hydrogen gas • flame test

					• electrolysis • testing electrical conductivity.
			Total	**6**	
13		i	Positive (metal) **ions or cations** (in a lattice structure) ✓ 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** This question required candidates to appreciate that a metal contains positive metal ions in a sea of delocalised electrons. When candidates did not gain credit it was usually because they described the atomic structure of lithium (often also describing how it bonds with other elements), rather than the metallic structure.
		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** Good responses to this question described that metals are malleable because the **layers** of particles can slide or move over each other. A common misconception was that metals have weak bonding.
		iii	Has electrons ✓ (Electrons) 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** Good responses to this question described that metals contain delocalised electrons.
			Total	**5**	
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

<table>
<tr><td></td><td></td><td>iii</td><td>KAt (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>15</td><td></td><td></td><td> 

electronic structure of magnesium ion (1)
electronic structure of oxide ion (1)
charges correct on both ions (1)</td><td>3</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>16</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>Electronic structure</th></tr>
<tr><td>A</td><td>11</td><td>23</td><td>11</td><td>12</td><td>11</td><td>2.8.1</td></tr>
<tr><td>B</td><td>9</td><td>19</td><td>9</td><td>10</td><td>9</td><td>2.7</td></tr>
<tr><td>C</td><td>17</td><td>37</td><td>17</td><td>20</td><td>17</td><td>2.8.7</td></tr>
<tr><td>D</td><td>13</td><td>27</td><td>13</td><td>14</td><td>10</td><td>2.8</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></td><td></td><td>Total</td><td>10</td><td></td></tr>
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