Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			**B**	1	**<u>Examiner's Comments</u>** This question did discriminate, but the correct option of B was missed by many candidates. D was the main distractor, despite the question assessing basic chemical facts. This multiple-choice question required candidates to choose the option that is not correct, and some candidates may not have read the question closely enough. It is recommended that candidates underline the word **not** in such MCQs to highlight what is required.
			Total	**1**	
2			**Level 3 (5–6 marks)** Describe the types of structure and bonding of all four elements **AND** explains most of the differences in melting points in terms of the relative strengths of the forces between the particles. *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)** Attempt to describe the types of bonding of three elements **AND** explains most of the differences in melting points in terms of the relative strengths of the forces between the particles. **OR** Describe in detail and bonding of two of the three types of structure **AND** explains most of the differences in melting points in terms of the relative strengths of the forces between the particles.	6	**Indicative scientific points may include:** **ALLOW** minor omissions as we are looking for a holistic approach to LoR marking. **Al (Giant metallic)** • Giant metallic structure/lattice • Strong metallic bonding • Electrostatic attraction between (positive) metal ions/cations and delocalised electrons • A lot of energy needed to break bonds **Si (Giant covalent)** • Each Si atom forms 4 bonds / bonds with 4 other Si atoms

			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)** Attempt to describe the bonding of two elements **AND** explains most of the differences in melting points in terms of the relative strengths of the forces between the particles. **OR** Describes in detail the bonding of one of the three types of structure **AND** explains the melting point in terms of the strength of the forces between the particles. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 mark** *No response or no response worthy of credit.*		• Giant covalent structure/lattice • Strong covalent bonds between atoms • Between shared pair of electrons and adjacent nuclei. • Most energy needed to break bonds **P, S (Simple covalent)** • <u>Simple</u> covalent / molecular structure/lattice • Strong covalent bonds between atoms • Weak induced dipole-dipole interactions between molecules* • Least energy to overcome the forces • Melting point of S_8 > P_4 • More electrons • Stronger induced dipole-dipole interactions • **DO NOT ALLOW** breaks BONDS • **IGNORE** van der Waals' (VDW) ***ALLOW** London (dispersion) forces for induced dipole–dipole interactions. Aspects of the communication statement might typically not have been met when irrelevant information (e.g. ionisation energies, ionic radius etc) have been included. **<u>Examiner's Comments</u>** Structure and bonding continue to be a difficult concept for many candidates. High-attaining candidates were able to identify why the element had a certain magnitude of melting point. They clearly linked the structure type

					with the type of bonding. They then described, in detail, the nature of the bond. The strength of force required to break/overcome the bond/London Force was linked to the melting point. It was very common for 'giant' to be omitted in the name of the lattice, especially in Al. Candidates find it particularly challenging to associate the correct terminology with the correct structure, often describing intermolecular forces in giant covalent explanations or use of molecules in giant metallic explanations. London forces were mentioned widely but sometimes not described as being forces between molecules and not linked to the increased number of electrons. A holistic, rather than a point based, approach is used in marking these responses. This allowed Level 2 to be given when the candidate did not use all of the correct terminology throughout the three structure types. Several candidates described the varying melting point going across the period as being due to atoms having more electrons in the outer shell and a greater nuclear charge. **OCR support** Our bonding delivery guide provides details of common misconceptions students hold relating to this topic, and also includes resources and guidance that can help overcome them: Teach Cambridge (ocr.org.uk)

			Total	**6**	
3			**D**	1	**Examiner's Comments** The correct answer was D. Most candidates were able to select this response, but the common error was the selection of A. It is important that candidates can distinguish the difference between oxidation states and charge on the ions. Oxidation state is the measure of the number of electrons that an atom uses to bond with atoms of another element.
			Total	**1**	
4	a	i	Be: $1s^2 2s^2$ F: $1s^2 2s^2 2p^5$ ✓ Mg: $1s^2 2s^2 2p^6 3s^2$ *Cl*: $1s^2 2s^2 2p^6 3s^2 3p^5$ ✓ Block: s p ✓	3	**1 mark** per correct row **ALLOW** upper case letter S and P, and subscripts, e.g. $2S_2 2P_5$ **IGNORE** superscripts/numbers given on block (e.g. s^2 and p^5) if the letter is clear **Examiner's Comments** A very well answered question with most candidates very confident in giving the correct electron configurations and blocks. Errors were rare but included: $2p^5$ or $3p^6$ ending for Cl; using mass number for number of electrons; and assigning group 17 as d block and giving orbital box diagrams rather than block.
		ii	Across period 2, the (2)s subshell fills first, followed by the (2)p ✓ **same pattern or trend** of filling (the subshells) repeated in other periods ✓	2	**ALLOW** Elements in the same group have same number of electrons in their outer shells or subshell e.g. s^2 in group 2/ s^2p^5 in group 17(7) **ALLOW** Elements in the same period have the same number of energy levels/shells **ALLOW** for both marks for indication that the pattern

					repeats across each period e.g Across each period, elements repeat the pattern of electrons filling the s-subshell then p-subshell ✓ ✓ **<u>Examiner's Comments</u>** Many found this question challenging despite doing well in Question 2(a)(i). The question states 'use your answers from (a)(i)' but not many candidates wrote about the electron configurations they had given. Many gave very simplistic responses in terms of the number of electrons increasing but made no reference to how those electrons are arranged (e.g. 'number of electrons increases across a period as the electron configuration gets higher' or 'atomic number increases'). Some candidates struggled with terminology, often referring to 'block' or 'orbital' instead of subshell (e.g. 'outer electrons are in same block', 'going across a period the number of orbitals increases', 'elements in same group have their highest energy electron in same block' or 'orbital'). Candidates need clarity on the terminology used for electron configurations and periodic table i.e. blocks, shells, sub-shells and orbitals. It was rare for candidates to score both marks as this was a question that they were unfamiliar with. However, some did gain a mark for linking the number of outer shell electrons to the group number or stating that elements in the same period have the same number of shells. It was not enough to refer to the highest energy electron being in

					the s-subshell or p-subshell as this is the link to the block, but all groups in same block will be the same. Some described the trend in other physical or chemical properties. Some examples included: ‘Elements have same chemical and physical properties due to similar electronic configuration’; ‘as you go across period, number of electrons increase and their boiling and melting points increase’; and ‘electrons are more easily lost in a paired orbital, due to greater repulsion and so have lower ionisation energies’. **OCR support** We have produced a transition guide on the topic of atomic structure. It covers content from KS4 and how this is developed at KS5 with a wide range of suggested resources to support teaching. At KS4, candidates are expected to be able to explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms, with development at KS5 to arrangement in to s, p and d orbitals. https:/ocr.org.uk/Images/170375-atomic-structure-ks4-ks5.pdf
		iii	Mg loses (2) electrons **AND** Cl gains an electron ✓ To gain a full/complete shell **OR** Noble gas configuration **OR** Stable/full octet✓	2	**ALLOW** Mg is oxidised **AND** Cl is reduced **<u>Examiner’s Comments</u>** Generally, this question was well answered with a clear understanding of how and why ions are formed. However, approximately a quarter of students only gained 1 mark as

					they either didn't explain electrons being lost by Mg and gained by Cl or gave no justification. A common slip was stating Cl has one electron in its outer shell. Some described bonding between Mg and Cl, which wasn't what the question asked, but this didn't prevent them from scoring both marks.
		iv	$2Mg + O_2 \rightarrow 2MgO$ ✓	1	**ALLOW** multiples e.g. $Mg + \frac{1}{2}O_2 \rightarrow MgO$ **IGNORE** state symbols even if wrong **<u>Examiner's Comments</u>** Many candidates correctly gave the balanced equation here. However, some didn't balance but had the correct formula. A few gave Mg_2 as a reactant or MgO_2 as a product. Some had O_2 on both sides of the equation.
	b	i	B is below Be but above Li (about 800 kJ mol^{-1}) ✓ Mg is above Na but below Be (about 700 kJ mol^{-1}) ✓	2	**DO NOT ALLOW** if on the line of 900 kJ mol^{-1}. It must be clear that IE for Mg is less than Be as below it in group 2 **<u>Examiner's Comments</u>** Approximately a quarter of candidates scored both marks here. Many candidates omitted to plot a point for Mg or positioned the point for Mg at 900 or above so higher than Be.
		ii	$B^{+}(g) \rightarrow B^{2+}(g) + e^{-}$ *Equation correct* ✓ *Correct state symbols* ✓	2	**ALLOW** $B^{+}(g) - e^{-} \rightarrow B^{2+}(g)$ for 2 marks The second mark is dependent upon the first mark except for the following close attempts: **ALLOW** one mark for the following for state symbols $B(g) \rightarrow B^{2+}(g) + 2e^{-}$

					$B^+(g) + e^- \rightarrow B^{2+}(g) + 2e^-$ $B(g) \rightarrow B^+(g) + e^-$ **ALLOW** e for electron (i.e. charge omitted) **IGNORE** states on the electron **Examiner's Comments** More than half of candidates scored both marks here. Errors seen included missing or incorrect state symbols, especially (s), but also (aq) was seen. Some had electrons on the left hand side of the equation, i.e. '$B^+ + e^- \rightarrow Be^2$+'. Some included negatively charged ions and occasionally the wrong element was used, e.g. Mg or Be.
			Total	**12**	
5	a		O ✓	1 (AO 2.1)	**ALLOW** S **BOD** **Examiner's Comments** Most successful candidates looked for the large difference between successive ionisation, usually shown by annotations below the table. The commonest incorrect response was F, the element after the large difference. Other incorrect responses were random.
	b		P **OR** S ✓	1 (AO 1.1)	**ALLOW** S_8, P_4 **ALLOW** As, Se **Examiner's Comments** Candidates found this question harder than Questions 1 (a) and (b) with S and P being the most common correct elements seen. As and Se were also allowed. Si was a common incorrect response.
	c		Si ✓	1 (AO 1.1)	**Examiner's Comments**

					Most candidates correctly chose Si. As with earlier questions, there seemed to be little pattern with incorrect elements.
			Total	**3**	
6			**Ist IE of Mg and Sr** (Mg) removes electron from shell closer to the nucleus / smaller **atomic** radius ✓✓ Greater nuclear **attraction** (between atom and outer electron) ✓ **2nd/1st IE of Sr** 2nd electron removed from cation/positively charged **ion** **OR** proton:electron ratio (in (1)+ ion) is great**er** (than in atom) ✓ Greater nuclear **attraction** / **attraction** between ion (and outer electron)✓	4 (AO 1.1) (AO 1.2) (AO 1.1) (AO 1.2)	**ORA** throughout **ALLOW** going down the group for comparison of Mg/Sr Assume 'it' means Mg **ALLOW** (Mg) fewer shells **ALLOW** less shielding **ALLOW** removal of electron from 3s rather than 5s **ALLOW** Greater attraction between nucleus (and outer electron) **ALLOW** Sr^+ **ion** smaller (than Sr atom) **ALLOW same** number of protons/nuclear charge **attracting** one fewer electron **IGNORE** repulsion between electrons in the s orbital **IGNORE** shielding **<u>Examiner's Comments</u>** Most candidates were able to explain why the first ionisation energy of Mg is greater than that of Sr due to the Mg's smaller atomic radius/less shielding and therefore increased nuclear attraction. Candidates should be reminded that there is no requirement to restate the question in their answers. Terminology is important and some candidates lost marks as

					they referred to nuclear radius instead of atomic radius. However, most candidates did not recognise that the second ionisation energy of Sr involves removing an electron from a +1 ion and instead discussed the repulsion between electrons in the s orbital. Atomic radius instead of ionic radius was often seen when discussing the Sr^{+} ion. Some candidates were still referring to Mg in this part of their answer and they should be advised to reread the question between each part to remain focused on the requirement.
			Total	**4**	
7			**A**	1 (AO 1.2)	ALLOW Li **<u>Examiner's Comments</u>** The correct answer was A. This question proved to be challenging, with the common incorrect answer being C.
			Total	**1**	
8			**C**	1 (AO 2.1)	**<u>Examiner's Comments</u>** Most candidate chose the correct response of C. From the annotations on the scripts, most candidates identified the largest jump between the 3rd and 4th ionisation energies. Option D proved to be the main distractor. Having identified the correct large jump, a significant number of candidates chose the group at the end of the jump (Group 4) rather than the group at the start of the jump (Group 3). This suggests a misconception.
			Total	**1**	
9		i	Substance / Magnesium sulfide / Aluminium / Silicon / Phosphorus trichloride	4 (AO 1.1 × 2) (AO 2.1 × 2)	**ALLOW** Simple covalent instead of simple molecular **<u>Examiner's Comments</u>**

			<table><tr><td>Melting point / °C</td><td>2000</td><td>660</td><td>1414</td><td>–94</td></tr><tr><td>Electrical conductivity</td><td></td><td>Good</td><td>Poor</td><td></td></tr><tr><td>Type of lattice structure</td><td>Giant Ionic</td><td>Giant Metallic</td><td>Giant Covalent</td><td>Simple Molecular</td></tr></table> ✓ ✓ ✓ ✓		About half the candidates gained all 4 marks. Candidates often find it tricky to recognise the type of structure even when given some details about physical properties. Often giant was omitted especially for Al as metallic bonding. Some used 'small' in place of 'simple'. Common errors included MgS as metallic and Si as simple covalent with PCl_3 as giant covalent. Many added unnecessary detail such as filling in the greyed-out boxes for conductivity or adding lattice to each box.
		ii	**Melting points** MgS: ionic bonds (between oppositely charged ions) ✓ PCl3: intermolecular forces ✓ More energy needed (to separate ions in MgS) **OR** <u>Strong</u> ionic bonds **AND** <u>weak</u> intermolecular forces✓ **Conductivity** Al: mobile/delocalised electrons **AND** Si: no mobile/delocalised electrons **OR** no charge carriers **OR** no mobile ions	4 (AO 1.1) (AO 2.1) (AO 3.1 × 2)	**ALLOW** London forces or permanent dipole dipole interactions **ORA** answer must be comparative **ALLOW ECF** from incorrect type of bonding i.e. stronger attraction/more energy **IGNORE** 'free electrons' for mobile/delocalised electrons **<u>Examiner's Comments</u>** Candidate explanations often lacked clarity even if the correct structure had been identified in (i). Most gained at least 1 mark, usually for recognising that for MgS to have a higher melting point that it must contain stronger bonds than in PCl_3. Responses highlighted a range of misconceptions including the presence of intermolecular forces in ionic/metallic substances, oppositely charged atoms in ionic compounds, and thinking London forces are between atoms. Most were able to gain the conductivity mark, but some compared to PCl_3 rather than Si as asked in the question.

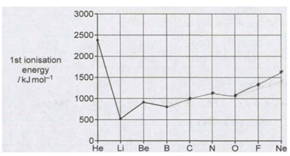
					Some described 'mobile ions' in Al or that Si has 'no electrons'. The use of 'free electrons' was seen in many responses, and we would encourage the use of 'delocalised electrons' for a more accurate description of metallic bonding. **OCR support** OCR have produced a KS4-KS5 transition guide for bonding and structure to support teaching of these tricky concepts. A bonding delivery guide is also available. **Assessment for learning** Checking understanding of different types of bonding and structure plus links to their physical properties is very important. OCR have produced a range of multiple choice question quizzes that can be used to help check understanding - these are available as digital versions as well, enabling you to view responses. Guidance is given on how to use the digital versions on the OCR website. A useful multiple-choice quiz to use here is on electrons, bonding and structure..
			Total	**8**	
10		i	Titanium (IV) oxide ✓	1 (AO2.5)	**DO NOT ALLOW** titanium dioxide **Examiner's Comments** Very few candidates gave the correct answer for this question.

					The most common errors included: titanium oxide, titanium(IV) **di**oxide, titanium oxide(IV), titanium(II) oxide. A few also attempted to give names like those for organic compounds: 1,1-titanium dioxide or the reverse 1,1-dioxytitanium. **How Science Works** It is important in Chemistry to have clear communication by use of systematic and unambiguous nomenclature. This includes the use of Roman numerals to indicate the magnitude of the oxidation number when an element, such as Ti, may have different oxidation numbers in different compounds. See specification statement 2.1.5(c) and HSW8.
		ii	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 2.67 kg award 4 marks** --- *n*(Ti) = $\frac{1000}{47.9}$ **OR** 20.8768… (mol) ✓ *n*(Na) for 72% yield = 20.88 × 4 **OR** 83.5073… (mol) ✓ *n*(Na) for 100% yield = 83.51 × $\frac{100}{72}$ **OR** 115.98237… (mol) ✓ mass Na = 115.98 x 23.0 = 2667.659… (g) = 2.67 (kg) ✓ **3 SF AND kg required**	4 (AO2.2 × 4)	**ALLOW ECF** throughout **TAKE CARE: values shown may be truncated calculator values.** Steps can be calculated in any order which will change the intermediate answers**.** Marks are for the processing of the data. **ALLOW 3SF** up to calculated value throughout **IGNORE** rounding errors past **3SF** **Common Errors for 3 marks:** 1.92 (missing yield) 1.38 (yield wrong way round) 0.673 (use of Mr 189.9 for $TiCl_4$ instead 47.9 for Ti) **Examiner's Comments** Candidates found this calculation quite challenging, with less than a quarter achieving full marks. The most common errors are highlighted on the mark scheme. Many that struggled were often

					given credit for the x4 ratio mark but only if it was possible to see this in the working. Many gave multiple, often contradictory attempts at the calculation. It was not always clear how the final answer had been obtained. Clear working enables us to follow the logic and give ECF where appropriate. Many divided 1000 g by the molar mass for $TiCl_4$ and then found 72% of this. It was important here to read the question carefully to ensure complete understanding. Exemplar 1  This candidate achieved 3 out of the 4 possible marks. The steps in their calculation are logical and it is easy to follow their working and therefore spot the error in their calculation. They have divided by 4 rather than multiplying. It also shows the calculation can be performed in a different order to that on the mark scheme. All intermediate values are used in calculations as calculator values without rounding to ensure an accurate answer.
		iii	Add water **AND** filter ✓ Ti does not dissolve **OR** Na*Cl* does dissolve ✓	2 (AO 3.3 × 2)	**ALLOW** dissolve **in water** **ALLOW** Ti is insoluble **OR** NaCl is soluble/aqueous **ALLOW** Ti is the residue **OR** NaCl is the filtrate **<u>Examiner's Comments</u>**

					Most candidates did not gain any credit here. However, the range of responses seen highlighted some misconceptions in their understanding of how different mixtures can be separated. Many assumed that sodium chloride was in solution/aqueous, not recognising that water was not present in this reaction. Responses such as “sodium chloride will evaporate” or “remove the water” were seen. Some gave a description of the purification method for an organic liquid - the use of a separating funnel and/or distillation were common. Some suggested the use of a magnet to remove Ti despite it being a non-magnetic metal. **Misconception** Understanding how to separate mixtures is covered in both KS3 and KS4 but it is important that these concepts can be applied during further study. Asking this type of problem solving question would make a good starter activity. Some useful activities for separating mixtures can be found in the GCSE Chemistry B (Twenty First Century Science) Chemical analysis transition guide
			Total	**7**	
11			**Structure** Giant ✓ **Bonding** Metallic (bonding) ✓	4 (AO1.1 ×4)	**ALLOW** marks from labelled diagram **‘Giant metallic’** gains **BOTH** structure and bonding marks **ALLOW** attraction between cations and electrons Attraction

			Particles **2+ /Ca^{2+}**ions and delocalised electrons ✓ **Conductivity** (Delocalised) electrons **move**/flow ✓ ***Idea of movement required*** ***Delocalised can be seen anywhere***		between nucleus and electrons is **CON** **Watch for 'metallic' being CONNed within overall response** **ALLOW** charge flows **ONLY** when linked to electrons **IGNORE** electrons carry charge **IGNORE** electrons are free **BUT ALLOW mobile electrons** carry charge **<u>Examiner's Comments</u>** Many candidates answered this question well, with most identifying the model of metallic bonding as fixed positive ions and mobile delocalised electrons. The question did ask for bonding and structure and the **giant** feature of the structure was often omitted. Unfortunately, some candidates contradicted a correct metallic bonding statement by including descriptors of intermolecular forces, covalent bonding or attraction between electrons and the nucleus rather than with positive ions. Less successful responses demonstrated less understanding: some didn't realise that Ca is a metal and conductivity explanations were often given as ions moving in the molten and not in the solid state, clear confusion with ionic bonding. Full marks were only given for showing the correct charges on the Ca^{2+} cations (+ was insufficient) and for explaining conductivity in terms of electron movement, rather than the common 'the electrons carry charge' and 'the electrons are free'.Overall, this relatively simple question discriminated very well and demonstrated how

					well the candidates understood metal bonding and structure.
			Total	**4**	
12			**D**	1(AO1.2)	**ALLOW** Ar **<u>Examiner's Comments</u>** Candidates found this question difficult. Although argon looked to be the obvious choice, many candidates selected phosphorus (B) or chlorine (C). Candidate annotations alongside the question included atomic number and electron configurations suggesting that many find it difficult to link trends in melting point to the correct chemical concepts.
			Total	**1**	
13			**B**	1(AO2.1)	**<u>Examiner's Comments</u>** Although two steps were required to solve this problem, most candidates answered this question correctly. Candidate annotations showed that many identified element X as being in Group 2 and even as magnesium. The correct formula of XCl_2 (B) then usually followed.
			Total	**1**	
14			**B**	1(AO1.1)	**<u>Examiner's Comments</u>** Most candidates selected B (silicon) as the correct response. A and C featured more than D as theincorrect choice but there seemed to be no pattern.
			Total	**1**	
15	a		 All points show a **general** increase from B (i.e	2 (AO1.1) (AO1.2)	**<u>Examiner's Comments</u>** Few candidates scored full marks here, with some candidates not increasing the 1st IE across the period, and many getting the dip for the wrong element (not O) and finishing too

			ignore O) **AND** Ne lower than He ✓ O lower than N **AND** O is higher than C **AND** F higher than O✓		high with Ne. Less successful candidates had clearly confused it with MP trend across the period.
	b		8.3×10^{-22} (kJ) ✓ From $\frac{500}{6.02 \times 10^{23}}$ Answer **MUST** be to 2 SF **AND** in standard form.	1 (AO2.2)	**ALLOW** use of IEs close to 500 giving a range: *8.3* × 10^{-22} *(from 500)* *to 9.1* × 10^{-22} *(from 550)* **<u>Examiner's Comments</u>** This question proved demanding for candidates, with many simply quoting a molar value taken from the graph and converting into standard form. Of those who recognised the need to use the Avogadro constant, a few tried to multiply it by the molar ionisation enthalpy. For those who worked out the correct answer, several lost marks due to the requirement of 2 significant figures.
	c		**Explanation for He** *Distance/shielding* (Outer) electrons are in a lower energy/closer shell/smaller atomic radius/fewer shells ✓ **Explanation for Be** *Nuclear charge* number of protons/proton number increases **OR** greater **nuclear** charge ✓ *Distance/shielding* (Outer) electrons are in the same shell **OR**	4(AO1.1 AO1.1 AO1.2 AO1.2)	FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED **ORA** throughout Comparison needed for each mark **ALLOW** change of **shell** (i.e **2**s and **1**s) **IGNORE** 'different sub-shell' **IGNORE** atomic number increases **IGNORE** nucleus gets bigger **IGNORE** 'effective nuclear charge increases' **ALLOW** same orbital

			sub-shell **OR** (Outer) electrons experience the same/similar shielding **OR** Atomic radius decreases ✓ **For either Be or He** *Attraction* **Greater** nuclear attraction (on outer electrons) **OR** (outer) electrons attracted more strongly to the nucleus ✓		**IGNORE** 'there is shielding' **ALLOW** 'greater repulsion from inner shells' **IGNORE** just 'greater attraction' **OR** greater force **IGNORE** 'pull' for 'attraction' **IGNORE** 'held' for attracted, *e.g. IGNORE 'held more strongly* **<u>Examiner's Comments</u>** Some very wordy responses to this straightforward question were seen, with many candidates going onto the extra pages. Candidates are reminded that keeping responses concise and to the point can make their answer clearer and potentially avoid contradicting themselves in the process. There were a good number of excellent answers seen, although many candidates were distracted by arguments about the stability of full shells or subshells rather than explaining why nuclear attraction would be greater. Some students mixed up the explanation for Be/Li with the difference in ionisation energies between groups 5 and 6 (electron pair repulsion).
	d		***Sub-shells*** Be electron is in (2)s **AND** B electron is in (2)p ✓ ***Energy levels***	2(AO1.2×2)	**IGNORE** number before s and p **DO NOT ALLOW** "shell" **IGNORE** block **DO NOT ALLOW** unpaired electron removed more easily (**ORA**) **IGNORE** 'less energy to remove' **IGNORE** comments about

			B / (2)p is high**er energy** (level) **OR** Be / (2)s is low**er energy** (level) ✓		distance from nucleus **IGNORE** 2s shielding **Examiner's Comments** Many candidates did not achieve full marks as they did not discriminate between the three different comparisons that were being tested in Question 18 (c) and 18 (d). Few candidates did identify the electron being in the s or p but then explained the ionisation energy in terms of full subshells, electron pair repulsion and described the 2s sub-shell as closer to the nucleus rather than as lower energy.
			Total	**9**	
16		i	$Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$ All formulae and balancing correct ✓	1 (AO2.6)	**IGNORE STATE SYMBOLS** **ALLOW** multiples **IGNORE** state symbols (even if wrong) **Examiner's Comments** Around half of all candidates did not score this mark. The most common error was giving SrO as the product rather than the hydroxide. Other errors included incorrect balancing (missing 2 on H_2O, SrOH as the formula of the hydroxide and no hydrogen formed (often giving H_2O instead)). **Assessment for learning** Regular practice writing formulae and balancing chemical equations will help to consolidate

					these concepts, avoiding basic errors such as giving formula of group 2 hydroxide as SrOH.
		ii	**Oxidation** Sr from **0** to **+2** ✓ **Reduction** H from **+1** to **0** ✓	2 (AO 2.1 × 2)	**ALLOW** 2+ for +2 and 1+ for +1 '+' is required in +2 and +1 oxidation numbers **ALLOW** H_2 for hydrogen **ALLOW** 1 mark for elements **AND** all oxidation numbers correct but oxidation and reduction wrong way round **OR** not given. **IGNORE** numbers around equation in **(i)** *(treat as rough working)* **<u>Examiner's Comments</u>** Most candidates managed to score at least 1 mark for this question. The most common reason for losing a mark, despite demonstrating a good understanding of redox, was stating that H changed from +2 to 0 (need to give oxidation number per atom). Other errors seen included only giving change for Sr, descriptions in terms of electrons rather than oxidation numbers, Sr change from 0 to +1 (linked to SrOH), oxygen being reduced rather than H and mixing up oxidation/reduction or not specifying.
		iii	*Atomic radius* Ca has smaller atomic radius **OR** fewer shells ✓ *Effect of nuclear charge/shielding*	3 (AO 1.2) (AO 1.2) (AO 1.2)	**FULL ANNOTATIONS MUST BE USED** --- **ORA in terms of Sr** **Comparison** needed for each mark. **ALLOW** 'fewer energy levels' **ALLOW** 'electrons closer to

			Ca has **less/decreased** shielding ✓ *Nuclear attraction* Ca has greater nuclear attraction (for electrons) **OR** Ca has a higher ionisation energy **OR** more energy is required to lose the outer electrons✓		nucleus' **IGNORE** fewer orbitals **OR** fewer sub-shells **OR** different shell **ALLOW more** electron repulsion from inner shells **IGNORE** nuclear charge/effective nuclear charge **ALLOW** 'less nuclear pull' **OR** 'electrons held less tightly' **Examiner's Comments** Most candidates gained some marks here although a significant proportion were unable to score all 3 marks covering atomic radius, shielding, nuclear attraction/IE. The mark most often missed was for shielding. Some candidates did not answer the question asked and gave the trend down the group so could not be given marks unless they made it clear Sr is below Ca in the group. Care must be taken to answer question asked not similar questions they have seen before. The best responses were those with direct comparative statements, e.g. "Ca has a smaller atomic radius than Sr". It is worth noting that harder/easier to lose electrons didn't gain marks, but was seen fairly frequently, as response needs to be in terms of energy required or linked to nuclear attraction.
			Total	**6**	