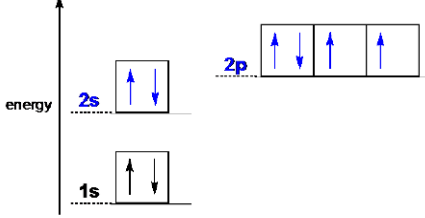


Mark scheme – Electron Structure

Question	Answer/Indicative content	Marks	Guidance
1	<p>Sub-shells labels 2s (single box) AND 2p (3 boxes) ✓</p> <p>Electrons as arrows unpaired electrons in 3 boxes: ↑↓ ↑↑ ↑ AND Paired electrons in single box: ↑↓ ✓</p>	2 (AO1.1) (AO1.2)	 <p>ALLOW single headed arrows, e.g. 1</p> <p>Examiner's Comments</p> <p>Most candidates added arrows correctly to the boxes but the sub-shell labels were sometimes omitted. Lower attaining candidates sometimes paired electrons, rather than showing them singly or showed six electrons in the 2p sub-shell. This suggested either a lack of understanding or failure to read the question.</p>
	Total	2	
2	<p>(1s²) 2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴ ✓</p> <p>Look carefully at (1s²) 2s²2p⁶3s²3p⁶ – there may be a mistake</p>	1	<p>ALLOW subscripts</p> <p>ALLOW in any order i.e. 3d¹⁰ after 4s² or after 4p⁴</p> <p>ALLOW upper case D, etc and subscripts, e.g.3S₂3P⁶</p> <p>DO NOT ALLOW [Ar] as shorthand for 1s²2s²2p⁶3s²3p⁶</p> <p>Examiner's Comments</p> <p>Most candidates answered this correctly. The most common error seen was 4p⁶ instead of 4p⁴</p>
	<p>Gas B H₂Se / Hydrogen selenide / Selenium hydride ✓</p> <p>Equation Na₂Se + 2HCl → 2NaCl + H₂Se</p>	2	<p>ALLOW SeH₂</p> <p>ALLOW correct multiples</p>

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			All formulae and balancing ✓		<p>IGNORE STATE SYMBOLS</p> <p>DO NOT ALLOW H₂S for gas B BUT ALLOW ECF from H₂S for equation: Na₂S + 2HCl → 2NaCl + H₂S</p> <p>Examiner's Comments</p> <p>The majority of candidates obtained 1 or 2 marks on this question. The most common errors seen were identifying the gas as H₂S or incorrect balancing.</p>
			Total	3	
3		i	(1s ²) 2s ² 2p ⁶ ✓	1	<p>IGNORE 1s² seen twice ALLOW upper case letters AND subscripts</p> <p>Examiner's Comments</p> <p>Many incorrect answers but I am happy to report that the use of incorrect notation, mentioned in last year's report, was not an issue in the 2017 paper.</p>
		ii	<p><i>Products of reaction</i> A = Barium hydroxide / Ba(OH)₂ ✓ B = Ammonia / NH₃ ✓</p> <p><i>Formula for barium nitride</i> Ba₃N₂ ✓</p> <p><i>Balanced equation AND state symbols</i> Ba₃N₂(s) + 6H₂O(l) → 3Ba(OH)₂(aq) + 2NH₃(g) ✓ State symbols are required</p>	4	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC ALLOW one mark for correct products incorrectly labelled Formulae must be correct No ECF from any incorrect formula ALLOW multiples Correct equation with state symbols scores 4 marks</p> <p>Examiner's Comment:</p> <p>This question discriminated well and only the most able candidates were able to score full marks with a correctly balanced equation including state symbols. Weaker candidates were able to pick up some marks for identifying barium hydroxide or ammonia, although barium oxide and nitrogen were not uncommon. Some failed to score the more accessible marks because they used an incorrect formula instead of writing the name of the product.</p>

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			Total	5	
4			$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$ ✓	1	<p>ALLOW $4s^2 3d^{10}$</p> <p>Examiner's Comments</p> <p>The electron configuration of the d-block element zinc was extremely well known – once again suggesting that the knowledge gained from studying transition elements at A2 was of considerable benefit.</p>
			Total	1	
5	i		<p>s-orbital = spherical</p> <p>AND</p> <p>p-orbital = dumb-bell shape ✓</p>	1	<p>For s-orbital IGNORE 'circular'</p> <p>For p-orbital ALLOW other words indicating 3-D shape of p-orbital eg 'Peanut-shaped' OR hour glass etc ALLOW 'figure of eight' OR 'figure of 8' IGNORE diagrams</p> <p>Examiner's Comments</p> <p>Spherical was almost universally known as the shape of the s-orbital and this was mirrored in the responses for the shape of the p-orbital</p>
		ii	<p>p-orbitals have greater energy than s-orbitals ✓</p> <p>(three) p-orbitals have equal energy ✓</p>	2	<p>ALLOW reverse argument</p> <p>ALLOW suitable energy diagram for either part</p> <p>Examiner's Comments</p> <p>This question asked about the simple concept of relative energies of the 2s orbital and the 2p orbitals. However, many candidates decided that the irrelevant details of the numbers of electrons should be given in their answer and further compounded their confusion by relating this fact to the relative energies of these orbitals. This said, the better candidates were</p>

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					able to give concise, accurate responses for two marks.
			Total	3	
6		i	$1s^2 2s^2 2p^6 3s^2$ ✓	1	<p>ALLOW upper case S and P, and subscripts, e.g.2S₂3P₆</p> <p>Examiner's Comments</p> <p>This part was generally answered well showing a good understanding of electron configuration. Candidates frequently used subscripts rather than superscripts for denoting the number of electrons in a particular sub-shell and although this was still credited the correct use of notation should be emphasised in lessons.</p>
		ii	(Mg) loses / transfers / donates two electrons ✓	1	<p>ALLOW Mg loses the 3s electrons provided electronic configuration in (i) is $3s^2$</p> <p>ALLOW $Mg \rightarrow Mg^{2+} + 2e^-$</p> <p>IGNORE reference to oxidation numbers / states</p> <p>Examiner's Comments</p> <p>Most candidates understood that oxidation resulted in the loss of electrons although some answers considered changes in oxidation number. A significant number of candidates did not specify how many electrons were lost when magnesium was oxidised preventing the award of the mark.</p>
			Total	2	
7			$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ ✓	1	<p>ALLOW $4s^2 3d^5$</p> <p>IGNORE $1s^2$ seen twice</p> <p>Examiner's Comments</p> <p>Answers proved that candidates were familiar with electron configurations.</p>
			Total	1	

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8	i	32 ✓	1	<p>Examiner's Comments</p> <p>Although there is a clear statement in the specification that candidates should know the number of electrons in the first four shells many were uncertain about how many electrons would be found in a complete fourth shell.</p>
	ii	9 ✓	1	<p>Examiner's Comments</p> <p>This question proved to be slightly more demanding than (i). There were a range of answers suggested where it was not possible to see how the student had come to that conclusion but 3 was not an uncommon response presumably arising from a confusion between the number of orbitals and the number of sub-shells or different types of orbital.</p>
		Total	2	
9	i	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ ✓	1	<p>ALLOW ... $4s^2 3d^{10} 4p^6$ ALLOW subscripts AND 3D IGNORE $1s^2$ seen twice</p> <p>Examiner's Comments</p> <p>Most candidates were awarded the mark available for the electron configuration of the bromide ion, but weaker responses included the electronic configuration of a bromine atom or of the ion, Br^+.</p>
	ii	Cream AND precipitate ✓	1	<p>ALLOW solid OR ppt for precipitate IGNORE 'does not dissolve' OR 'partially dissolves'</p> <p>Examiner's Comments</p> <p>Many candidates focused exclusively in their answers on the solubility of silver bromide in aqueous ammonia, writing as a result that the precipitate would remain, or that it would not dissolve and so not</p>

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					gaining the mark by omitting the colour of the precipitate.
		iii	$\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s}) \checkmark$	1	Equation AND state symbols required Examiner's Comments The majority of candidates answered this question successfully with the only recurring error made being to omit some or all of the state symbols.
			Total	3	
10			$1s^22s^22p^63s^23p^63d^{10}4s^24p^5$	1	allow ...4s ² 3d ¹⁰ ...
			Total	1	
11	a		63 p 90 n 60 e	1	
	b		2 (1) 2 (1) 18 (1)	3	
			Total	4	