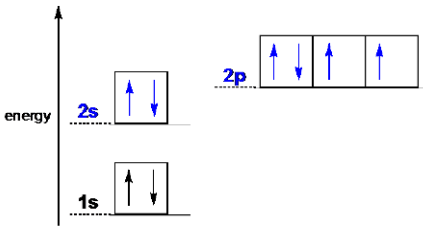
Mark scheme – Electron Structure

Question			Answer/Indicative content	Marks	Guidance
1			**Sub-shells labels** 2s (single box) **AND** 2p (3 boxes) ✓ **Electrons as arrows** unpaired electrons in 3 boxes: ↑↓ ↑ ↑ **AND** Paired electrons in single box: ↑↓ ✓	2 (AO1.1) (AO1.2)	 **ALLOW** single headed arrows, e.g. **1** **Examiner's Comments** 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.
			Total	**2**	
2		i	$(1s^2)\ 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$ ✓ Look carefully at $(1s^2)\ 2s^2 2p^6 3s^2 3p^6$ – there may be a mistake	1	**ALLOW** subscripts **ALLOW** in any order i.e. $3d^{10}$ after $4s^2$ or after $4p^4$ **ALLOW** upper case D, etc and subscripts, e.g. ……$3S_2 3P^6$ **DO NOT ALLOW** [Ar] as shorthand for $1s^2 2s^2 2p^6 3s^2 3p^6$ **Examiner's Comments** Most candidates answered this correctly. The most common error seen was $4p^6$ instead of $4p^4$
		ii	**Gas B** H_2Se / Hydrogen selenide / Selenium hydride ✓ **Equation** $Na_2Se + 2HCl \rightarrow 2NaCl + H_2Se$	2	**ALLOW** SeH_2 **ALLOW** correct multiples

			All formulae and balancing ✓		**IGNORE STATE SYMBOLS** **DO NOT ALLOW** H_2S for gas B **BUT ALLOW ECF** from H_2S for equation: $Na_2S + 2HCl \rightarrow 2NaCl + H_2S$ **Examiner's Comments** The majority of candidates obtained 1 or 2 marks on this question. The most common errors seen were identifying the gas as H_2S or incorrect balancing.
			Total	**3**	
3		i	$(1s^2)\ 2s^2\ 2p^6$ ✓	**1**	**IGNORE** $1s^2$ seen twice **ALLOW** upper case letters **AND** subscripts **Examiner's Comments** 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.
		ii	*Products of reaction* **A** = Barium hydroxide / $Ba(OH)_2$ ✓ **B** = Ammonia / NH_3 ✓ *Formula for barium nitride* Ba_3N_2 ✓ *Balanced equation **AND** state symbols* $Ba_3N_2(s) + 6H_2O(l) \rightarrow 3Ba(OH)_2(aq) + 2NH_3(g)$ ✓ State symbols **are** required	**4**	**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 **Examiner's Comment:** 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.

			Total	**5**	
4			$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$ ✓	1	**ALLOW** $4s^2\ 3d^{10}$ **Examiner's Comments** 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.
			Total	**1**	
5		i	s-orbital = spherical **AND** p-orbital = dumb-bell shape ✓	1	For s-orbital **IGNORE** 'circular' 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 **Examiner's Comments** 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
		ii	p-orbitals have greater energy than s-orbitals ✓ (three) p-orbitals have equal energy ✓	2	**ALLOW** reverse argument **ALLOW** suitable energy diagram for either part **Examiner's Comments** 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

					able to give concise, accurate responses for two marks.
			Total	**3**	
6		i	$1s^2 2s^2 2p^6 3s^2$ ✓	1	**ALLOW** upper case S and P, and subscripts, e.g. .....$2S_2 3P_6$ **Examiner's Comments** 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.
		ii	(Mg) loses / transfers / donates **two** electrons ✓	1	**ALLOW** Mg loses the 3s electrons provided electronic configuration in **(i)** is 3_s^2 **ALLOW** $Mg \rightarrow Mg^{2+} + 2e^-$ **IGNORE** reference to oxidation numbers / states **Examiner's Comments** 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.
			Total	**2**	
7			$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$ ✓	1	**ALLOW** $4s^2\ 3d^5$ **IGNORE** $1s^2$ seen twice **Examiner's Comments** Answers proved that candidates were familiar with electron configurations.
			Total	**1**	

8		i	32 ✓	1	**Examiner's Comments** 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.
		ii	9 ✓	1	**Examiner's Comments** 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.
			Total	**2**	
9		i	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$ ✓	1	**ALLOW** … $4s^2\ 3d^{10}4p^6$ **ALLOW** subscripts **AND** 3D **IGNORE** $1s^2$ seen twice **Examiner's Comments** 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^+.
		ii	Cream **AND** precipitate ✓	1	**ALLOW** solid **OR** ppt for precipitate **IGNORE** 'does not dissolve' OR 'partially dissolves' **Examiner's Comments** 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

					gaining the mark by omitting the colour of the precipitate.
		iii	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ ✓	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			$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$	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**	