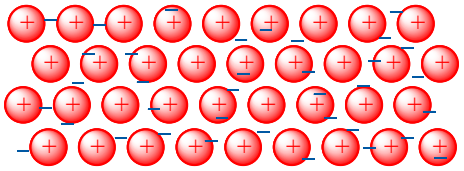
Old Specification - F321 Style Question Paper - June 2008 - Mark Scheme

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>a</td><td></td><td>
<table>
<tr><th></th><th>protons</th><th>neutrons</th><th>electrons</th></tr>
<tr><td>^{113}In</td><td>49</td><td>64</td><td>49</td></tr>
<tr><td>^{115}In</td><td>49</td><td>66</td><td>49</td></tr>
</table>
^{113}In line correct ✓
^{115}In line correct ✓</td><td>2</td><td>mark by row</td></tr>
<tr><td></td><td>b</td><td></td><td>A_r = 113 x 4.23/100 + 115 x 95.77/100 /
114.9154 ✓ (calculator value)
= 114.9 ✓ to 1 decimal place</td><td>2</td><td>Allow one mark for A_r = 114.9154 with no working out
Allow two marks for A_r = 114.9 with no working out

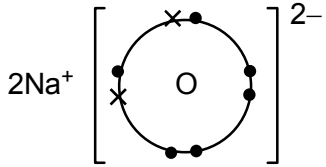
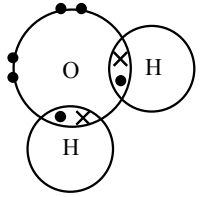
If a candidate uses incorrect values in 1st line, then the 2nd mark can still be awarded if the calculated value is from 113.1 to 114.9 expressed to one decimal place. ie if %s are the wrong way round in 1st line, then an answer of 113.1 gets the 2nd mark.</td></tr>
<tr><td></td><td>c</td><td></td><td>  with labels:
scattering of labelled electrons between other species ✓

regular 2-D arrangement of labelled + ions with some attempt to show electrons ✓</td><td>2</td><td>1st mark is for any symbol that is labelled an electron that is between something else:
ie: between + ions, atoms, protons, nuclei, +, p, circles, etc.

Allow: e or e$^-$ with no label
Do not allow '–' with no label

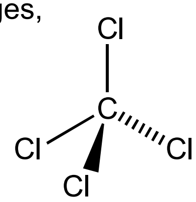
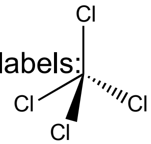
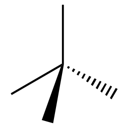
2nd mark for labelled + ions, positive ions, cations that can be touching and must be 2-D
(ie not just a row).
Allow In$^+$ or In+ with charge from 1+ to 7+
NOT protons (commonest mistake)</td></tr>
</table>

Question			Expected Answers	Marks	Additional Guidance
	d	**i**	M_r = weighted mean/average mass of a **molecule** ✓ compared with carbon-12 ✓ 1/12th (of mass) of carbon-12/ on a scale where carbon-12 is 12 ✓ *(but not 12 g)*	3	**1st mark**: reference to **molecule** is essential **Allow** just 'average mass of molecule' or 'mean mass of molecule' *alternative **allowable** definitions:* mass of one mole of molecules ✓ compared to $1/12^{th}$ ✓ (the mass of) one mole/12 g of carbon-12 ✓ mass of one mole of molecules ✓ $1/12^{th}$ ✓ the mass of one mole/12 g of carbon-12 ✓
		ii	ratio: In : I = 23.19/115 : 76.81/127 Empirical formula: InI_3 ✓ Molecular formula = In_2I_6 ✓ *OR* mass In = 23.19 x 992/100 *OR* 230 (g) *AND* mass I = 76.81 x 992/100 *OR* 762 (g) ✓ moles In = 230/115 *OR* 2 *AND* moles I = 762/127 *OR* 6 ✓ Molecular formula = In_2I_6 ✓	3	**Allow** use of 114.9 for In (ie from answer to 1(b)) If a candidate uses atomic numbers, the ratio is still 1:3. The 2nd and 3rd marks can still be awarded by error carried forwards. Although unlikely, an correct answer of In_2I_6 with no working should be awarded **all** three marks. If candidate shows inverse for ratios: ie In : I = 115/23.19 : 127/76.81 ……then the candidate can be awarded the 2nd mark **only** for In_3I by error carried forwards.
			Total	**12**	

Question			Expected Answers	Marks	Additional Guidance
2	**a**	**i**	Ca ✓	1	***Allow*** *names throughout (i)–(vi)*
		ii	N✓	1	
		iii	Cl✓	1	
		iv	B✓	1	**Allow** Al
		v	K✓	1	
		vi	C/Si/B✓	1	
	b	**i**	cation shown with either 8 or 0 electrons ***AND*** anion shown with 8 electrons ***AND*** correct number of crosses and dots for example chosen ✓ Correct charges on both ions ✓ e.g.  	2	***An ionic compound must be chosen and it must have correct formula to score at all*** **For 1st mark,** if 8 electrons shown around cation then 'extra' electron(s) around anion must match symbol chosen for electrons in cation. *Circles not required* **Ignore** inner shell electrons **Allow:** $2[Na^+]$ $2[Na]^+$ $[Na^+]_2$ (brackets not required) Do **not** allow: for Na_2O, $[Na_2]^{2+}$ $[Na_2]^+$ $[2Na]^{2+}$ $[Na]$
		ii	electron pair(s) in covalent bond shown correctly using dots and crosses in a molecule of a compound ✓ correct number of outer shell electrons in example chosen ✓ e.g.  2 'x o' between O and H for 1st mark correct outer shell electrons for O and H for 2nd mark	2	***A covalent compound must be chosen and it must have correct formula to score at all*** For '*dot-and-cross*' diagram, accept different symbols for electrons from each atom. ie X and / If example chosen is molecule of an element, then 2nd mark can be awarded if candidate has used dots and crosses for **all** outer shell electrons around each atom. *Circles not required*

Question			Expected Answers	Marks	Additional Guidance
	c			4	***USE annotations with ticks, crosses, con, ecf, etc for this part.***
			(across a period)		Ignore 'down a period', 'across a group'
			atomic radius decreases/ outer electrons closer to nucleus ✓ electrons are (pulled in) closer		If candidate responds with 'electrons are same distance from the nucleus' anywhere is a CON. …… but ignore '**about** the same distance'
			nuclear charge increases/ protons increase ✓		Ignore 'atomic number increases' Ignore 'nucleus gets bigger' 'charge increases' is not sufficient **Allow** 'effective nuclear charge increases' *OR* 'shielded nuclear charge increases'
			greater attraction/ greater pull ✓		A comparison must be included: ie 'greater pull', 'more pull', 'held more tightly'; so …… 'pulled in closer' would score the 1st marking point but not the 3rd marking point here
			electrons added to the same shell *OR* screening / shielding remains the same or similar ✓		**Allow** 'very small increase' for 'similar'
			Total	**14**	

Question			Expected Answers	Marks	Additional Guidance
3	a	i	moles = 55/24,000 = 2.3×10^{-3} / 0.0023 (mol) ✓	1	**Allow** calc $2.291666667 \times 10^{-3}$ and correct rounding to a minimum of 2 sig fig, ie 0.0023 (ie rounding is being assessed here)
		ii	[bleach] = $1000 \times 2.3 \times 10^{-3} / 3 = 0.77$ (mol dm^{-3}) ✓	1	From (a)(i), allow use of calc value = 0.763888888 For any rounded value of $2.291666667 \times 10^{-3}$ down to a minimum of 2 sig fig, ie 0.0023, **allow** any value in range **0.76** to **0.77** mol dm^{-3} (ie rounding has been assessed above) For **ECF**, = 1000 x ans to (i) / 3
		i i i	moles HCl at start = $1.0 \times 6.0/1000 = 6 \times 10^{-3}$ ✓ moles HCl that reacted = $2 \times 2.3 \times 10^{-3}$ $= 4.6 \times 10^{-3}$ / 0.0046 mol ✓ excess HCl = $6 \times 10^{-3} - 4.6 \times 10^{-3}$ $= 1.4 \times 10^{-3}$ mol / 0.0014 mol ✓ (mark is for answer)	3	Marking screen shows parts (i) and (iii) **ECF** = ans to (i) x 2 **ECF**: moles HCl at start – moles HCl that reacted Common mistake: If a candidate does not multiply ans to (i) by 2, then ECF answer will be 0.00371 (from 0.00229) or 0.0037 (from 0.0023) Both answers would gain 2 marks for this part.
	b	i	iodine / I_2 produced ✓ correct balanced equation: $Cl_2 + 2I^- \longrightarrow I_2 + 2Cl^-$ / $Cl_2 + 2NaI \longrightarrow I_2 + 2NaCl$ ✓	2	I_2 as a product in an attempted equation would score 1st mark
		i i	chlorine reacts with water forming Cl^- *OR* chloride / $Cl_2 + H_2O \longrightarrow ClO^- + 2H^+ + Cl^-$ ✓ AgCl(s) / precipitate is silver chloride *OR* AgCl(s) ✓ chloride *OR* Cl^- reacts with silver nitrate *OR* Ag^+ ✓ $Ag^+ + Cl^- \longrightarrow AgCl$ / $AgNO_3 + HCl \longrightarrow AgCl + HNO_3$ ✓	4	**Allow**: $Cl_2 + H_2O \longrightarrow HClO + HCl$ can be credited for this marking point in equation as AgCl(s) can be credited for this marking point in equation as Cl^- State symbols **not** required $Ag^+ + Cl^- \longrightarrow$ AgCl(s) would get last three marks!

Question			Expected Answers	Marks	Additional Guidance
	c	i	attraction of an atom/nucleus for electrons ✓ attraction for electrons in a (covalent) bond ✓	2	For **1st mark**, atom/nucleus is essential Commonest correct answer: ‘Attraction of an atom for the electrons in a covalent bond’
		ii	four bonds shown with at least 2 wedges, one in; one out ✓  bond angle = 109.5^{o} ✓	2	For bond into paper, accept:  **Allow** correct shape with no atom labels:   Bond angle can just be stated as this is the only one bond angle that applies, so no labelling required. **Allow** 109° – 110°
		iii	Cl is more electronegative (than H or C) ✓ CCl_4 is symmetrical ✓ In CCl_4 dipoles cancel ✓	3	***USE annotations with ticks, crosses, con, ecf, etc for this part.*** **Allow**: Cl is δ– /slightly negative *OR* shown as dipole: $H^{\delta+}–Cl^{\delta-}$ *OR* $C^{\delta+}–Cl^{\delta-}$ Do **not** allow ‘negative’ OR Cl^{-} *OR* chloride ion *OR* chlorine ion **Allow** CCl_4 is tetrahedral
			Total	**18**	

Question			Expected Answers	Marks	Additional Guidance
4	a		**A**: CaO ✓ **B**: CO_2 ✓ **C**: $Ca(OH)_2$ ✓ **D**: $CaCl_2$ ✓ **E**: H_2O ✓ **F**: $Ca(HCO_3)_2$ / $CaH_2C_2O_6$ ✓	6	**Brackets essential** **Allow** any order of atoms in a correct formula
	b		$2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$ / $Ca(s) + ½ O_2(g) \longrightarrow CaO(s)$ state symbols for Ca, O_2 and CaO ✓ correct balanced equation ✓ Oxidation is loss of electrons AND reduction is gain of electrons ✓ Ca loses 2 electrons AND O gains 2 electrons OR Ca loses 2 electrons AND O_2 gains 4 electrons ✓	4	***USE annotations with ticks, crosses, con, ecf, etc for this part.*** **Allow** 'multiples', ie $4Ca(s) + 2O_2(g) \longrightarrow 4CaO(s)$ **Allow** balanced equation with a species on both sides, ie $Ca(s) + O_2(g) \longrightarrow CaO(s) + ½ O_2(g)$ Must be in terms of electrons Ignore any reference to oxidation number **Allow** equations (**accept** 'e' without '–' sign): $Ca \longrightarrow Ca^{2+} + 2e^- / Ca - 2e^- \longrightarrow Ca^{2+}$ $O_2 + 4e^- \longrightarrow 2O^{2-} / O + 2e^- \longrightarrow O^{2-}$
			reactivity increases (down the group) ✓ atomic radii increases/ there are more shells ✓ there is more shielding/ more screening ✓ Increased shielding and distance outweigh the increased nuclear charge / the nuclear attraction decreases ✓ easier to remove outer electrons/ ionisation energy decreases/ ✓	5	***USE annotations with ticks, crosses, con, ecf, etc for this part.*** 'down the group' not required '**more'** *is essential* allow 'more electron repulsion from inner shells' **Allow** 'nuclear pull' ignore any reference to 'effective nuclear charge'
			QWC – At least two sentences that show legible text with accurate spelling, punctuation and grammar so that the meaning is clear. ✓	1	QWC mark **must** be indicated with a tick or cross through the Quality of Written Communication prompt at the bottom of page 9. **Then scroll up to start of (b), counting ticks.**
			Total	**16**	