

Chemistry A

Advanced Subsidiary GCE

Unit **F321**: Atoms, Bonds and Groups

Mark Scheme for June 2011

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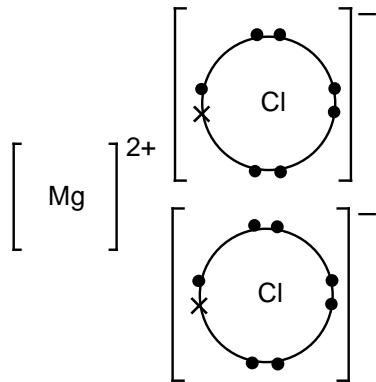
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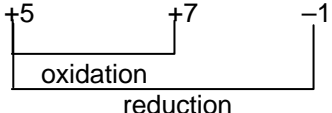
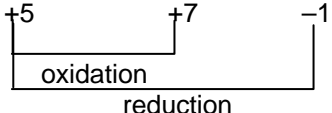
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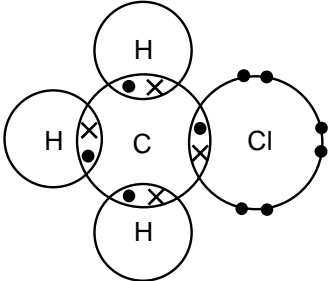
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Question	Answer	Mark	Guidance																
1 (a)	<table border="1"> <thead> <tr> <th>particle</th> <th>rel charge</th> <th>rel mass</th> <th>position</th> </tr> </thead> <tbody> <tr> <td>proton</td> <td>+1</td> <td>1</td> <td>nucleus</td> </tr> <tr> <td>neutron</td> <td>nil/0</td> <td>1</td> <td>nucleus</td> </tr> <tr> <td>electrons</td> <td>-1</td> <td>1/2000</td> <td>in shells</td> </tr> </tbody> </table> <p>✓</p>	particle	rel charge	rel mass	position	proton	+1	1	nucleus	neutron	nil/0	1	nucleus	electrons	-1	1/2000	in shells	1	<p>1 mark for whole table</p> <p>ALLOW '+' on its own for rel charge of proton DO NOT ALLOW '1' on its own for rel charge of proton DO NOT ALLOW 'positive' for rel charge of proton</p> <p>For neutron ALLOW 'neutral'</p> <p>ALLOW '-' on its own for rel charge of electron DO NOT ALLOW 'negative' for rel charge of electron</p> <p>IGNORE '+' if precedes '1' for mass IGNORE 'middle/centre' for nucleus</p>
particle	rel charge	rel mass	position																
proton	+1	1	nucleus																
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(b)	<p>The energy required to remove an electron ✓</p> <p>from each atom in one mole ✓</p> <p>of atoms in the gaseous state ✓</p>	<p>1</p> <p>1</p> <p>1</p>	<p>ALLOW 'energy to remove one mole of electrons from one mole of gaseous atoms' for three marks</p> <p>ALLOW 'The energy required to remove an electron from one mole of gaseous atoms to form one mole of gaseous 1+ ions' for two marks as it does not meet the 2nd marking point</p> <p>For third mark: ALLOW ECF of wrong particle being gaseous</p> <p>If no attempt at a definition, ALLOW one mark for the equation below, including state symbols $X(g) \rightarrow X^+(g) + e^-$ OR $X(g) - e^- \rightarrow X^+(g)$ ALLOW e for electrons IGNORE state symbol for electron</p>																
(c)	<table border="1"> <tbody> <tr> <td>a 2p orbital</td> <td>2 ✓</td> </tr> <tr> <td>the 3s sub-shell</td> <td>2 ✓</td> </tr> <tr> <td>the 4th shell</td> <td>32 ✓</td> </tr> </tbody> </table>	a 2p orbital	2 ✓	the 3s sub-shell	2 ✓	the 4th shell	32 ✓	<p>1</p> <p>1</p> <p>1</p>											
a 2p orbital	2 ✓																		
the 3s sub-shell	2 ✓																		
the 4th shell	32 ✓																		
(d)	A repeating pattern (of properties shown across different periods) ✓	1	ALLOW 'repeating trend' DO NOT ALLOW just 'trend' OR 'pattern'																
(e) (i)	C ✓	1																	
(ii)	Al ✓	1																	
(iii)	N ✓	1																	
(iv)	Al ✓	1																	
(v)	Mg ✓	1																	
	Total	13																	

Question		Answer	Mark	Guidance
2	(a)	$\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$ ✓	1	IGNORE state symbols
	(b)	(i) $\text{MgCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ Correct balanced equation ✓ Correct states for correct species ✓	1 1	ALLOW states mark if MgCl used in place of MgCl ₂
		(ii) Similarity: (Both) dissolve OR disappear. ✓ Difference: One effervesces OR fizzes OR bubbles OR gas produced ✓	1 1	ALLOW (both) 'go clear' ALLOW CO ₂ produced DO NOT ALLOW incorrect gases DO NOT ALLOW responses which suggest A will effervesce e.g. as B will fizz more
		(iii) 203.3	1	DO NOT ALLOW 203 or 203.0 IGNORE units
		(iv)  magnesium (ion) with 8 (or no) outermost electrons AND 2 x chloride (ions) with 'dot-and-cross' outermost octet ✓ correct charges ✓	1 1	For 1st mark , if 8 electrons shown around cation then 'extra' electron around anion must match symbol chosen for electrons in cation Shell circles not required IGNORE inner shell electrons ALLOW correct diagram of a [Cl ⁻] ion with '2 x' OR '2' in front OR 'x 2' after the diagram. ALLOW correct diagram of [Cl ⁻] ion with subscript 2. i.e. [Cl ⁻] ₂ . DO NOT ALLOW [Cl ⁻] ₂ [Cl] ₂ ⁻ i.e. for first mark charges do not need to be seen

Question		Answer	Mark	Guidance
2	(c)	$\frac{1.82}{24.3} \quad \frac{1.05}{28.1} \quad \frac{2.40}{16.0}$ To give 0.0749 0.0374 0.150 Ratio of moles ✓ Answer = Mg ₂ SiO ₄ ✓	1 1	ALLOW '24' for Mg (giving 0.0758) and '28' for Si (giving 0.0375) ALLOW any correct ratios of moles as calculator value OR correct rounding to 2 sig figs or more ALLOW method from masses being converted to percentages ALLOW correct answer from a ratio of moles where it is clear that the candidate has divided by the atomic numbers. ALLOW ECF for formula from incorrect ratio of moles due to over-rounding calculator error or upside down mole calculation
	(d)	(i)	1	ALLOW 0.016 (mol) IGNORE trailing zeroes
		(ii)	1	ALLOW ECF for answer <u>d(i)</u> $\frac{1.60 \times 10^{-2}}{2} = 8.00 \times 10^{-3} \text{ (mol)}$ ALLOW 0.00800 (mol) ✓ ALLOW 0.008 or 8×10^{-3} (mol) Ignore trailing zeroes ALLOW 0.0080 or 8.0×10^{-3}
		(iii)	1 1 1	DO NOT ALLOW 58 OR 58.0 ALLOW answer to d(ii) × 58.3 ALLOW 0.47 ALLOW ECF for d(ii) × incorrect molar mass as calculator value OR correct rounding to 2 sig figs or more ALLOW 93% OR 93.2% OR 93.28% DO NOT ALLOW d(ii)/0.5 × 100 ALLOW (answer to second marking point/0.500) × 100 as calculator value OR correct rounding to 2 sig figs or more ALLOW moles method for 3 marks Molar mass = 58.3 $0.500/58.3 = 0.00857(6)$ $0.00800/0.00857(6) \times 100 = 93.3\%$ ALLOW correct answer without working for 3 marks
Total			15	

Question		Answer	Mark	Guidance
3	(a)	$2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaClO} + \text{NaCl} + \text{H}_2\text{O} \checkmark$	1	ALLOW NaOCl IGNORE state symbols
	(b)	(i)	1	ALLOW sodium chlorate V DO NOT ALLOW sodium chlorate 5
		(ii)	1	<i>USE annotations with ticks, crosses, con, ECF, etc for this part.</i> ALLOW 5+, 7+ 1– Look for oxidation numbers seen above equation. DO NOT ALLOW Cl ⁻ in NaCl
		Cl in NaClO ₃ is (+)5 AND Cl in NaClO ₄ is (+)7 AND Cl in NaCl is -1 ✓ Chlorine has been both oxidised and reduced OR The oxidation number of chlorine has increased AND decreased ✓ Chlorine has been oxidised from (+)5 to (+)7 AND chlorine has been reduced from (+)5 to -1 ✓ (These points would secure marking points 2 and 3) $4\text{NaClO}_3 \rightarrow 3\text{NaClO}_4 + \text{NaCl}$  This diagram gets all 3 marks	1	The second and third marking points must refer to chlorine ALLOW 'it' for 'chlorine' if oxidation numbers of chlorine are given ALLOW Cl for 'chlorine' DO NOT ALLOW Cl ₂ for 'chlorine'
		Chlorine has been oxidised from (+)5 to (+)7 AND chlorine has been reduced from (+)5 to -1 ✓ (These points would secure marking points 2 and 3) $4\text{NaClO}_3 \rightarrow 3\text{NaClO}_4 + \text{NaCl}$  This diagram gets all 3 marks	1	ALLOW 'correct' references to oxidation and reduction even if based on incorrect oxidation numbers of chlorine IGNORE references to electron loss / gain if correct. DO NOT ALLOW 3rd mark for reference to electron loss/gain If oxidation numbers are correct, ALLOW 1 mark for 'chlorine is oxidised to form NaClO ₄ ' ALLOW 1 mark for 'chlorine is reduced to form NaCl' ALLOW one mark for 'disproportionation is when a species is both oxidised and reduced' whether or not chlorine is mentioned
	(c)	(i)	1	ALLOW CH ₃ Cl for 'chlorinated hydrocarbons' IGNORE 'harmful' IGNORE 'carcinogenic' for chlorine
		(Chlorine) kills bacteria OR 'kills germs' 'kills micro-organisms' OR 'makes water safe to drink' OR 'sterilises water' OR 'disinfects' ✓	1	DO NOT ALLOW 'antiseptic' ALLOW 'to make water potable' ALLOW 'removes' for 'kills' IGNORE 'virus' IGNORE 'purifies water' IGNORE 'cleans water'

Question			Answer	Mark	Guidance
3	(c)	(ii)	Electron pairs in covalent bonds shown correctly using dots and crosses in a molecule of CH ₃ Cl AND lone pairs correct on Cl ✓ 	1	Must be ' <i>dot-and cross</i> ' ALLOW different symbol for third 'type' of electron Circles for outer shells not needed IGNORE inner shells Non-bonding electrons of chlorine do not need to be shown as pairs
		(iii)	Tetrahedral OR tetrahedron ✓	1	
	(d)		Add AgNO ₃ (aq) OR Ag ⁺ (aq) OR silver nitrate OR AgNO ₃ ✓ White precipitate ✓ $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$ ✓ Add dilute NH ₃ and precipitate (completely) dissolves OR disappears ✓	1 1 1 1	ALLOW Ag ⁺ (aq) seen in the ionic equation IGNORE references to nitric acid IGNORE references to adding water or dissolving the brine DO NOT ALLOW references to any other additional reagent as well as the silver nitrate for the first mark White AND precipitate required DO NOT ALLOW hint of any other colour IGNORE 'turns grey' ALLOW solid as alternative for precipitate IGNORE states DO NOT ALLOW conc. NH ₃ DO NOT ALLOW any mention of incomplete dissolving ALLOW (for 4th mark) 'add Cl ₂ (aq)' AND 'no colouration would be seen' OR 'no change' OR 'no reaction'
			Total	13	

Question		Answer	Mark	Guidance
4	(a)	(i)	1	<p>ALLOW Zn ions OR positive ions replace H ions OR a metal ion has replaced a hydrogen ion OR protons</p> <p>DO NOT ALLOW Zn replaces H. Ions are key either in word form or symbol form</p> <p>DO NOT ALLOW Zn⁺ i.e. if charge is shown it must be correct</p>
		(ii)	1	<p>ALLOW ZnHPO₄ OR Zn(H₂PO₄)₂</p> <p>ALLOW Zn₃P₂O₈</p>
	(b)	<p>reactivity increases (down the group) ✓</p> <p><i>Increasing size mark</i></p> <p>atomic radii increases OR there are more shells ✓</p> <p><i>Increased shielding mark</i></p> <p>there is more shielding ✓</p> <p><i>Nuclear attraction mark</i></p> <p>The nuclear attraction decreases OR (outermost) electrons experience less attraction (to nucleus) OR Increased shielding / distance outweighs the increased nuclear charge ✓</p> <p>easier to remove (outer) electrons OR ionisation energy decreases ✓</p> <p>ORA throughout</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p><i>USE annotations with ticks, crosses, con, ECF, etc for this part.</i></p> <p>'down the group' not required</p> <p>ALLOW alternative phrases for 'reactivity increases'</p> <p>ALLOW 'there are more energy levels'</p> <p>ALLOW 'electrons are in a higher energy level'</p> <p>ALLOW 'the electrons are further from nucleus'</p> <p>IGNORE there are more orbitals OR more sub-shells</p> <p>IGNORE 'different shell' or 'new shell'</p> <p>ALLOW 'more screening'</p> <p>There must be a clear comparison i.e. 'more shielding' OR 'increased shielding'.</p> <p>i.e. DO NOT ALLOW 'there is shielding'</p> <p>ALLOW 'there is more electron repulsion from inner shells' 'more' is essential</p> <p>ALLOW 'there is less nuclear pull' OR 'electrons less tightly held'</p> <p>IGNORE 'there is less effective nuclear charge'</p> <p>IGNORE 'nuclear charge' for 'nuclear attraction'</p> <p>ALLOW 'easier to oxidise'</p> <p>Quality of Written Communication – 'electron(s)' OR 'ionisation' OR 'ionization' OR 'oxidise' OR 'oxidize' spelled correctly at least once for 5th marking point</p>
Total			7	

Question	Answer	Mark	Guidance
5 (a)	<p>Metallic lattice has delocalised OR mobile electrons OR metallic bonding has delocalised OR mobile electrons ✓</p> <p>Ionic lattice has no mobile ions OR ionic solid has no mobile ions ✓</p> <p>molten ionic (compounds) have mobile ions ✓</p>	<p>1</p> <p>1</p> <p>1</p>	<p>IGNORE 'free electrons' for 'mobile electrons' DO NOT ALLOW references to incorrect bonding</p> <p>ALLOW 'ions are fixed in place' IGNORE 'no mobile electrons' for solid ionic IGNORE 'no mobile charge carriers' for solid ionic</p> <p>IGNORE 'delocalised ions' OR 'free ions' for 'mobile ions' DO NOT ALLOW any mention of electrons moving IGNORE 'aqueous ionic compounds have mobile ions'</p>
(b) (i)	<p>Two (or more) ammonia molecules with at least one Hδ^+ and at least one Nδ^- (can be on the same or different molecules) ✓</p> <p>H-bond between H in one ammonia and lone pair of N in another ammonia molecule ✓</p> <p>hydrogen bond</p> <p style="text-align: center;"> $\begin{array}{ccc} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{N}^{\delta-} & \cdots & \text{H}-\text{N}^{\delta+} \\ & & \\ \text{H} & & \text{H} \end{array}$ </p>	<p>1</p> <p>1</p>	<p>There must be 3H atoms bonded to one N atom DO NOT ALLOW any Hδ^- OR Nδ^+ ALLOW 2-D NH₃ molecules IGNORE lone pair(s) for first marking point</p> <p>All H-bonds drawn must hit the lone pair H-bond does not need to be labelled but must be different from covalent bond DO NOT ALLOW more than one lone pair on N for second marking point</p> <p>ALLOW a pair of molecules with two 'correct' hydrogen bonds forming a 'dimer'</p>
(ii)	<p>Ice has stronger hydrogen bonds ✓</p> <p>O has two lone pairs (AND N has one) OR O more electronegative (than N) ✓</p>	<p>1</p> <p>1</p>	<p>ALLOW 'more' for 'stronger' OR Ice has twice as many hydrogen bonds as ammonia ALLOW ice has stronger intermolecular forces than ammonia OR bigger permanent dipole than ammonia DO NOT ALLOW comparisons between different types of force DO NOT ALLOW reference to van der Waals' IGNORE 'more energy needed'</p> <p>ALLOW O has more lone pairs</p>

Question		Answer	Mark	Guidance
5	(c)	<p>SiO₂ is giant covalent (lattice) ✓</p> <p>SiCl₄ is simple molecular (lattice) ✓</p> <p>van der Waals' forces in SiCl₄ ✓</p> <p>Covalent bonds broken in SiO₂ ✓</p> <p>Forces OR bonds are stronger in SiO₂ (than in SiCl₄) OR more energy is needed to break forces OR bonds in SiO₂ (than in SiCl₄) ✓ ORA</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p><i>USE annotations with ticks, crosses, con, ECF, etc for this part.</i></p> <p>ALLOW macromolecular OR giant atomic ALLOW SiO₂ is a 'giant structure with covalent bonds' ALLOW even if reference to 'covalent' only appears later in answer. DO NOT ALLOW any reference to 'ionic' OR 'intermolecular' OR 'metallic' Quality of Written Communication - Covalent OR macromolecular OR atomic spelt correctly ONCE and used in context of the first marking point</p> <p>ALLOW simple covalent DO NOT ALLOW any reference to 'giant' OR 'ionic' OR 'metallic'</p> <p>If neither of the 1st 2 marks have been awarded, ALLOW 1 mark for SiO₂ is giant AND SiCl₄ is simple OR molecular</p> <p>ALLOW induced dipoles DO NOT ALLOW permanent dipoles</p> <p>ALLOW alternative words to broken e.g. overcome</p> <p>ALLOW incorrect forces in SiCl₄ OR SiO₂ for this mark</p>
Total			12	

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