



Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> (strong electrostatic) attraction (1) between two nuclei and the shared /bonding pair of electrons (1) 		(2)

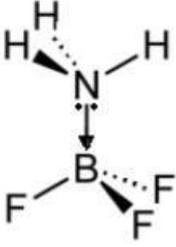
Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> diagram showing two AlCl_3 molecules joined through two chlorine atoms 	<p>Example of diagram</p> <p>Allow dot-and-cross diagram</p> <p>Ignore missing arrows / direction of arrows</p> <p>Ignore missing lone pairs</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> dative (covalent) bonds or coordinate bonds 	<p>Allow this labelled on diagram in (i)</p> <p>Do not award this mark if dative bonds shown as arrows starting from aluminium in (c)(i)</p>	(1)



Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> donation of lone pair (of electrons) from nitrogen / lone pair from ammonia (1) to the boron (atom) which is electron deficient / has only 6 electrons in outer shell / has 6 valence electrons / can accept two electrons to complete octet / can accept two electrons to get a full (outer) shell (1) 	<p>Allow 'non-bonding pair' for lone pair Allow 'sharing' for donation</p> <p>Do not penalise donation to F atoms, but can only score M1 in this case</p> <p>Allow just 'boron has an incomplete outer shell' Allow boron has an empty (p-)orbital</p> <p>Do not award M2 for just 'nitrogen shares lone pair with boron atom' or similar</p> <p>M1 may be scored from a diagram here OR a diagram in (d)(ii) e.g.</p>  <p>scores only M1</p>	(2)



Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> • HNH angle is (approximately) 109.5° (1) • FBF angle is (approximately) 109.5° (1) 	<p>May be shown on a diagram, including on a diagram in (i) e.g.</p> <p>Allow 1 for just 109.5° if it has not been made clear that this angle applies to BOTH bond angles</p> <p>Both angles change to 109.5° scores 2</p> <p>Allow 109-110°</p>	(2)

Q4.

Question Number	Acceptable Answers	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • electronegativity is the (relative) ability of an atom to attract the (bonding) electrons (in a covalent bond) (1) • fluorine is more electronegative than chlorine/fluorine is the most electronegative (element) (1) • so fluorine is δ^- and chlorine is δ^+ (1) 	<p>Penalise fluoride/chloride / molecules once only Allow 'element' for atom</p> <p>Do not allow 'species' for atom</p> <p>Allow fluorine has an electronegativity of 4.0 and chlorine of 3.0</p> <p>Could be shown on a diagram</p> <p>Ignore references to overall polarity No TE on incorrect M2</p>	(3)



Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> silicon(IV) oxide/ silicon dioxide (is a giant structure therefore) contains many (strong covalent) bonds (1) iodine – (only) weak intermolecular / London forces/bonds must be broken (1) more energy is required to break the stronger bonds in silicon(IV) oxide/ silicon dioxide (hence higher melting temperature) (1) 	<p>Allow silicon oxide</p> <p>Do not award covalent bonds are broken Accept dispersion force / instantaneous dipole-induced dipole / van der Waals</p> <p>Allow reverse argument M3 can be awarded even if M2 is incorrect</p>	(3)

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> (electrostatic / electric(al)) attraction of (two) nuclei (1) with a shared pair /2 electrons (1) 	Allow a pair of electrons between the nuclei	(2)



Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> correct dot and cross diagram 	<pre> XX XX H X N X N X H X X X X X H H </pre> <p>Allow diagram with all dots, all crosses, dots and crosses in reversed order, or a mix of dots and crosses Allow non-bonding pairs on N to be shown separated Allow H at any position around N Ignore circles used to show shells Ignore inner electrons if shown Ignore lines representing bonds</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<ul style="list-style-type: none"> bond angle = 107° 	Allow angles in the range 105 to 108°	(1)

Q7.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> (M1) oxygen is more electronegative than hydrogen and carbon (1) (M2) which results in a polar bond with oxygen δ^- so carbon and hydrogen δ^+ (1) (M3) carbon dioxide is a symmetrical/linear molecule and so the dipole moments/vectors cancel (1) (M4) the lone pairs of electrons of oxygen/ the V-shape of the water molecule mean that the dipole moments/ vectors do not cancel (1) 	<p>Accept supporting diagrams which illustrate the following:</p> <p>Accept electronegativity values stated Allow oxygen has a greater force of attraction for the bonded electron pairs than hydrogen or carbon</p> <p>Penalise the failure to refer to carbon and hydrogen once only</p> <p>Allow 'symmetrical so dipoles/ polar bonds cancel'</p> <p>Allow angular/bent for V-shape</p> <p>Penalise reference to just 'charges' once only in M3 and M4 if dipoles not stated or shown in the answer</p>	(4)

Edexcel Chemistry A-level - Covalent bonding





Q8.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • silicon – giant atomic / giant covalent / giant molecular / macromolecular and contains covalent bonds (1) • chlorine - (simple) molecular / molecules / diatomic / Cl₂ and contains London forces (1) • (covalent) bonds in silicon are stronger than London forces/ intermolecular forces in chlorine or covalent bonds take more energy to break than London forces / intermolecular forces (1) 	<p>Do not allow just 'silicon is a covalent molecule' Do not allow reference to ions or metallic bonding</p> <p>Allow dispersion forces / van der Waals' / attractions between temporary dipole and induced dipole/ attractions between instantaneous dipole (- induced dipole) for London forces</p> <p>Do not award covalent bonds being broken in chlorine</p> <p>Ignore silicone for silicon as correct spelling is given in the paper</p>	(3)



Q9.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> iodine is (simple) molecular diamond is a giant (covalent / lattice) structure (with 4 covalent bonds per carbon atom) iodine molecules are held together by weak London forces / dispersion forces / van der Waal's forces / instantaneous induced dipole-dipole attractions carbon atoms in diamond are held together by (strong) covalent bonds strong covalent bonds require more energy to break than intermolecular forces 	<p>(1) Allow iodine is made up of (I₂) molecules</p> <p>(1) Do not award diamond molecules</p> <p>(1) Allow weak intermolecular forces</p> <p>(1) Do not award strong intermolecular forces</p> <p>Award converse argument for less energy need to break intermolecular forces</p> <p>Single sentences may contain more than one marking point. For example 'iodine molecules are held together by weak intermolecular forces' scores (2)</p>	(5)

Q10.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> correct formulae and state symbols of each species 	$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$	(1)

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(ii)	<ul style="list-style-type: none"> ionic and covalent (bonding) 	Ignore reference to single/double/dative	(1)



Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<ul style="list-style-type: none"> strong bonds within the carbonate ion / CO_3^{2-} / C-O bond / C=O bond 	Ignore bonds between the ions / (Ca^{2+} and CO_3^{2-}) are strong	(1)

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark												
*	<p>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="384 1115 847 1361"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>4</td> </tr> <tr> <td>5-4</td> <td>3</td> </tr> <tr> <td>3-2</td> <td>2</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0	<p>Guidance on how the mark scheme should be applied:</p> <p>The mark for indicative content should be added to the mark for lines of reasoning.</p> <p>For example, an answer with five indicative marking points, which is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points														
6	4														
5-4	3														
3-2	2														
1	1														
0	0														



Question Number	Acceptable Answer	Additional Guidance	Mark								
* contd	<p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table border="1"> <thead> <tr> <th></th> <th>Number of marks awarded for structure of answer and sustained line of reasoning</th> </tr> </thead> <tbody> <tr> <td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td> <td>2</td> </tr> <tr> <td>Answer is partially structured with some linkages and lines of reasoning.</td> <td>1</td> </tr> <tr> <td>Answer has no linkages between points and is unstructured.</td> <td>0</td> </tr> </tbody> </table>		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2	Answer is partially structured with some linkages and lines of reasoning.	1	Answer has no linkages between points and is unstructured.	0	<p>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.</p> <p>Reasoning marks may be reduced for extra incorrect chemistry</p>	(6)
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Answer is partially structured with some linkages and lines of reasoning.	1										
Answer has no linkages between points and is unstructured.	0										

	<p>Indicative content:</p> <ul style="list-style-type: none"> aluminium and chlorine electronegativity difference 1.5 AND aluminium and fluorine electronegativity difference 2.5 aluminium chloride (mostly) covalent / (small) molecule aluminium fluoride (bonds) more polar aluminium chloride molecular so weak(er) intermolecular forces / London forces aluminium fluoride is a giant structure/ strong electrostatic forces of attraction between the ions more energy needed to break the stronger bonds to cause sublimation in aluminium fluoride 	<p>Allow all 3 electronegativity values / difference between F and Cl is 1 / difference between differences is 1/ F is 4, CL is 3 and this is a significant difference</p> <p>Allow mostly/more ionic</p> <p>Allow weak(er) dipole-dipole interactions Do not award any suggestion of breaking covalent bonds</p> <p>Allow stronger dipole-dipole attractions</p> <p>Allow (dative) covalent bonds breaking (to form small molecule / AlF_3)</p>	
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