

Chemistry A

Advanced Subsidiary GCE F321

Atoms, Bonds and Groups

Mark Scheme for June 2010

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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General advice to Assistant Examiners on the procedures to be used

YOU WILL BE REQUIRED TO UNDERTAKE 10 PRACTICE AND 10 STANDARDISATION SCRIPTS BEFORE STARTING TO MARK LIVE SCRIPTS.

- 1 The schedule of dates for the marking of this paper is very important. It is vital that you meet these requirements. If you experience problems then you must contact your Team Leader (Supervisor) without delay.
- 2 An element of professional judgement is required in the marking of any written paper. Candidates often do not use the exact words which appear in the detailed sheets which follow. If the science is correct and also answers the question then the mark(s) should normally be credited. If you are in doubt about the validity of any answer then consult your Team Leader (Supervisor) by phone, the messaging system within SCORIS or e-mail.
- 3 Correct answers to calculations always gain full credit even if no working is shown. (The 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)
- 4 Some questions may have a 'Level of Response' mark scheme. Any details about these will be in the Additional Guidance.
- 5 If an answer has been crossed out and no alternative answer has been written then mark the answer crossed out.
- 6 In addition to the award of 0 marks, there is a NR (No Response) option on SCORIS.

Award 0 marks

- if there is any attempt that earns no credit (including copying out the question or some crossed out working)

Award NR (No Response)

- if there is nothing written at all in the answer space
OR
- if there is any comment which does not in any way relate to the question being asked (e.g. 'can't do', 'don't know')
OR
- if there is any sort of mark which is not an attempt at the question (e.g. a dash, a question mark)

- 7 Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	= alternative and acceptable answers for the same marking point
not	= answers which are not worthy of credit
reject	= answers which are not worthy of credit
ignore	= statements which are irrelevant
allow	= answers that can be accepted
()	= words which are not essential to gain credit
<u> </u>	= underlined words must be present in answer to score a mark
ECF	= error carried forward
AW	= alternative wording
ora	= or reverse argument

8 Annotations: the following annotations are available on SCORIS.

✓	= correct response
×	= incorrect response
bod	= benefit of the doubt
nbod	= benefit of the doubt not given
ECF	= error carried forward
^	= information omitted
I	= ignore
R	= reject

9 The Comments box

The comments box will be used by your PE to explain their marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts. You should only type in the comments box yourself when you have an additional object of the type described in Appendix B of the Handbook for Assistant Examiners and Subject Markers.

Please do not use the comments box for any other reason.

Any questions or comments you have for your Team Leader should be communicated by phone, SCORIS messaging system or e-mail.

10 Please send a brief report on the performance of the candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

Question			Expected Answers	Marks	Additional Guidance
1	a	i	^{118}Sn 50p 68n 50e Complete row ✓	1	
		ii	$^{120}_{50}\text{Sn}$ has (two) more neutrons / 70 neutrons ✓ ora	1	ALLOW There is a different number of neutrons IGNORE correct reference to protons / electrons DO NOT ALLOW incorrect references to protons / electrons ALLOW ECF for stated number of neutrons from 1a(i)
	b	i	The (weighted) mean mass of an atom (of an element) OR The (weighted) average mass of an atom (of an element) ✓ compared with 1/12th (the mass) ✓ of (one atom of) carbon-12 ✓	3	ALLOW average atomic mass DO NOT ALLOW mean mass of an element ALLOW mean mass of isotopes OR average mass of isotopes DO NOT ALLOW the singular; 'isotope' For second and third marking points ALLOW compared with (the mass of) carbon-12 which is 12 ALLOW mass of one mole of atoms ✓ compared to 1/12th ✓ (mass of) one mole OR 12g of carbon-12 ✓ ALLOW $\frac{\text{mass of one mole of atoms}}{1/12\text{th mass of one mole OR 12g of carbon-12}}$
	c		moles of Sn = $\frac{2080}{118.7} = 17.52$ ✓ $17.52 \times 6.02 \times 10^{23} = 1.05 \times 10^{25}$ atoms ✓	2	ALLOW 17.5 up to (correctly rounded) calculator value of 17.52316765 DO NOT ALLOW use of 118, which makes moles of Sn = 17.63 ALLOW 105×10^{23} atoms DO NOT ALLOW answers which are not to three sig figs for second marking point ALLOW two marks for answer only of 1.05×10^{25} ALLOW one mark for answer only if not 3 sig figs up to calculator value of $1.054894693 \times 10^{25}$ Eg 100×1 ALLOW ECF for any calculated moles of Sn (based on use of any A_r value) $\times 6.02 \times 10^{23}$ if shown to 3 sig figs DO NOT ALLOW mass of Sn $\times 6.02 \times 10^{23}$

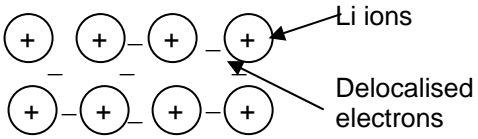
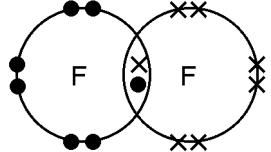
Question		Expected Answers	Marks	Additional Guidance
1	d	$\frac{78.8}{118.7}$ and $\frac{21.2}{16.0}$ OR $= 0.66(4)$ and $= 1.3(25)$ ✓ $\frac{0.66(4)}{0.66(4)} = 1$ $\frac{1.325}{0.66(4)} = 2$ ans = SnO ₂ ✓	2	ALLOW SnO ₂ for one mark if no working shown ALLOW use of 118 for this part IGNORE incorrect rounding provided given to two sig figs IGNORE incorrect symbols e.g. T or Ti for Tin, as long as correct A _r of tin (118.7 or 118) used ALLOW Sn ₂ O for 1 mark ECF if both inverted mole calculations are shown ALLOW Sn ₃ O ₅ with evidence of use of both atomic numbers for one mark ALLOW 2 marks if candidate has adopted the following approach 78.8% of mass = 118.7 100% of mass = 118.7/0.788 = 150.6 (151) 150.6 – 118.7 = 31.9 (32) Both masses would get one mark 31.9/16 = 2
Total			9	


Question			Expected Answers	Marks	Additional Guidance
2	a	i	Any two from ✓✓ H ⁺ SO ₄ ²⁻ HSO ₄ ⁻	2 max	DO NOT ALLOW OH ⁻ IGNORE state symbols Charge is essential ALLOW H ₃ O ⁺ for H ⁺ and SO ₄ ⁻² for SO ₄ ²⁻ One answer incorrect = 1 mark max Two answers incorrect = 0 marks
		ii	Effervescence OR fizzing OR bubbling OR gas produced ✓ K ₂ CO ₃ dissolves OR disappears OR colourless solution is formed ✓ H ₂ SO ₄ + K ₂ CO ₃ → K ₂ SO ₄ + CO ₂ + H ₂ O ✓	3	DO NOT ALLOW 'carbon dioxide produced' without 'gas' DO NOT ALLOW incorrectly named gas produced DO NOT ALLOW 'precipitate forms' = CON ALLOW 'it' for K ₂ CO ₃ DO NOT ALLOW mark for 'dissolves' from state symbols in equation DO NOT ALLOW 'potassium' IGNORE state symbols ALLOW ionic equation
	b	i	$\frac{24.6 \times 0.100}{1000} = 0.00246 \text{ mol}$ ✓ ($2.46 \times 10^{-3} \text{ mol}$)	1	DO NOT ALLOW 0.0025 as this would lead to 100% in part (iii) DO NOT ALLOW 0.0024 due to incorrect rounding
		ii	$0.00246 \times 2 = 0.00492 \text{ mol}$ ✓ ($4.92 \times 10^{-3} \text{ mol}$)	1	ALLOW ECF for ans (i) × 2
		iii	Moles of NaOH in 250 cm ³ = $0.00492 \times \frac{250}{25} = 0.0492 \text{ mol}$ ✓ Mass of NaOH in original sample = $0.0492 \times 40.0 = 1.968 \text{ g}$ ✓ % purity $\frac{1.968}{2.00} \times 100 = 98.4\%$ ✓	3	ALLOW ECF for ans (ii) × 10 ALLOW 1.97g ALLOW ECF for moles of NaOH × 40 ALLOW 98.5% (from use of 1.97) ALLOW ECF for $\frac{\text{mass of NaOH}}{2.00} \times 100$ DO NOT ALLOW ECF for 3rd marking point if answer >100% ALLOW ECF for 3rd marking point if answer = 100% ALLOW molar approach for second and third marks i.e. mol of (expected) NaOH in 2.00 g = $2/40 = 0.05(00) \text{ mol}$ $(0.0492/0.0500) \times 100 = 98.4\%$ 1.6% (the percentage of the impurity present) is likely to be 2 marks, but please check 9.84% has not multiplied up by 10 for first marking point is likely to be 2 marks, but please check
Total				10	

Question		Expected Answers	Marks	Additional Guidance
3	a	3d 4p ✓	1	Correct order is essential ALLOW '3D'
	b	i	1	ALLOW 'can be found' for 'can hold' ALLOW 'area' OR 'volume' OR 'space' for region DO NOT ALLOW 'place' for region DO NOT ALLOW path of an electron IGNORE references to 'orbitals being parts of sub-shells'
		ii	1	
	c	18 ✓	1	
	d	i	2	Mark as pairs IGNORE references to 12th and 13th Three answers with one correct pair = 1 mark Four answers with one correct pair = 1 mark Five answers with both pairs correct = 1 mark Five answers with only one pair correct = 0 marks Six (or more) answers = 0 marks
		ii	2	ALLOW $\text{Al}^{2+}(\text{g}) - \text{e}^- \rightarrow \text{Al}^{3+}(\text{g})$ for 2 marks ALLOW 1 mark for $\text{Al}(\text{g}) \rightarrow \text{Al}^{3+}(\text{g}) + 3\text{e}^-$ as states are correct ALLOW 1 mark for $\text{Al}^{2+}(\text{g}) + 2\text{e}^- \rightarrow \text{Al}^{3+}(\text{g}) + 3\text{e}^-$ as states are correct ALLOW 1 mark if symbol of Al is incorrect, but equation is otherwise fully correct. ALLOW e for electron (i.e. no charge) IGNORE states on electron
Total			8	

Question			Expected Answers	Marks	Additional Guidance
4	a	i	1 = purple / lilac / violet / pink / mauve ✓ 3 = orange ✓	2	ALLOW any combination of these but no others for 1 ALLOW yellow as an alternative for 3 DO NOT ALLOW 'precipitate' in either
		ii	$\text{Cl}_2 + 2\text{Br}^- \longrightarrow 2\text{Cl}^- + \text{Br}_2$ ✓	1	IGNORE state symbols ALLOW correct multiples, including fractions
		iii	Addition of $\text{Br}_2(\text{aq})$ to $\text{I}^-(\text{aq})$ ions ✓	1	ALLOW Addition of bromine to iodide (i.e. aqueous not needed) DO NOT ALLOW Addition of bromine to iodine ALLOW Addition of I_2 to Br^- , but NOT if accompanied by description of displacement of bromine ALLOW $\text{Br}_2 + \text{I}^-$ even if seen in an unbalanced equation
	b	i	Cl_2 is 0 AND HCl is -1 AND HClO is $(+1)$ ✓ Chlorine has been both oxidised and reduced OR Chlorine's oxidation state has increased and decreased ✓ Chlorine has been oxidised (from 0) to $+1$ AND chlorine has been reduced (from 0) to -1 ✓ (These two points together subsume the second marking point)	3	ALLOW $1-$ ALLOW $1+$ Oxidation states may be seen above the equation DO NOT ALLOW Cl^- in HCl DO NOT ALLOW Cl^+ in HClO in text of answer DO NOT ALLOW chlorIDE in place of 'chlorine' IF CORRECT OXIDATION STATES ARE SEEN, ALLOW second and third marking points for: Chlorine is oxidised to form HClO Chlorine is reduced to form HCl ALLOW Cl or Cl_2 for 'chlorine' IGNORE reference to electron loss / gain if correct DO NOT ALLOW 3rd mark for reference to electron loss / gain if incorrect ALLOW one mark for 'disproportionation is when a species is both oxidised and reduced' if chlorine / chloride is not mentioned
		ii	Kills bacteria OR 'kills germs' kills micro-organisms OR makes water safe to drink OR sterilises water ✓ OR 'disinfects'	1	ALLOW to make water potable ALLOW 'removes' for 'kills' IGNORE 'virus' IGNORE 'purifies water'
	c	i	Thermal decomposition ✓	1	DO NOT ALLOW just 'decomposition' or 'thermodecomposition'
		ii	$1.47 = 0.0174$ mol of MgCO_3 ✓ 84.3 $0.0174 \times 24.0 = 0.418$ dm ³ OR (Calculator value $\times 24.0$) = 0.419 dm ³ ✓	2	ALLOW mol of MgCO_3 as calculator value of 0.017437722 or correct rounding to 2 sig figs or more DO NOT ALLOW 0.0175 (this has taken M_r of MgCO_3 as 84) ALLOW , for 2nd mark calculated moles of $\text{MgCO}_3 \times 24(.0)$ as calculator value or correct rounding to 2 sig figs or more [e.g. $0.017 \times 24(.0) = 0.408$] DO NOT ALLOW 84.3 or $1.47 \times 24(.0)$ as no mole calculation has been done ALLOW two marks for correct answer with no working shown

Question			Expected Answers	Marks	Additional Guidance
4	c	iii	The ease of (thermal) decomposition decreases (down the group) ora ✓	1	ALLOW (thermal) stability increases IGNORE more heat would be needed IGNORE 'takes longer' or 'is slower' IGNORE reference to trend in reactivity IGNORE answers which include 'more / less mol of CO ₂ '
			Total	15	

Question	Expected Answers	Marks	Additional Guidance
5 a	 <p>Diagram showing a regular arrangement of labelled 'Li⁺' or '+ ions' with some attempt to show electrons ✓</p> <p>Scattering of labelled electrons between other species OR a statement anywhere of delocalised electrons (can be in text or in diagram) ✓</p> <p>The attraction between + ions and e⁻ is strong OR metallic bonding is strong ✓</p>	3	<p>Lattice diagram must have at least two rows of correctly charged ions and a minimum of 2 ions per row</p> <p>ALLOW as label: + ions, positive ions, cations If '+' is unlabelled in diagram, award label from a correct statement within the text below</p> <p>DO NOT ALLOW 2+, 3+ etc ions DO NOT ALLOW for label or in text: nuclei OR positive atom OR protons</p> <p>ALLOW e⁻ OR e as label for electron</p> <p>ALLOW a lot of energy is needed to break the (metallic) bond</p> <p>DO NOT ALLOW incorrect particles or incorrect attraction e.g. 'intermolecular attraction' or 'nuclear attraction'</p>
b i	 <p>Dot and cross bond + 6 matching electrons on each F atom ✓</p>	1	<p>ALLOW diagram consisting of all dots OR all crosses Circles not essential ALLOW 'F' for fluorine</p>
	<p>ii F₂ has induced dipoles OR temporary dipoles OR van der Waals' forces (between the molecules) ✓ which are weak ✓</p>	2	<p>ALLOW little energy needed to overcome intermolecular bonding for second mark ALLOW 'weak' intermolecular bonding for second mark ALLOW max 1 mark if structure is referred to as giant with first and second marking points correct Award no marks if 'weak' is applied to incorrect bonding. E.g. ionic, covalent, metallic or unspecified bonding</p>

Question		Expected Answers	Marks	Additional Guidance
5	c i	 <p>Li shown with either 2 or 0 electrons and F shown with 8 electrons with 7 crosses and one dot (or <i>vice versa</i>) ✓ correct charges on both ions ✓</p>	2	<p>For first mark, if 2 electrons are shown in the cation then the 'extra' electron in the anion must match symbol chosen for electrons in the cation IGNORE inner shell electrons ALLOW 'F' for fluorine Circles not essential DO NOT ALLOW Li⁺ with 8 electrons</p> <p>Second mark is independent</p>
	ii	<p>Ions cannot move in a solid ✓</p> <p>Ions can move OR are mobile when molten ✓</p>	2	<p>ALLOW ions are fixed in place IGNORE electrons IGNORE 'charge carriers' or 'charged particles'</p> <p>DO NOT ALLOW ions can move when in solution IGNORE charge carriers IGNORE 'delocalised ions' or 'free ions' ALLOW 'ions can only move when molten' for one mark Any mention of electrons moving when molten is a CON</p>
	d i	$2\text{B} + 3\text{F}_2 \longrightarrow 2\text{BF}_3$ ✓	1	<p>ALLOW B₂ ALLOW multiples including fractions</p>
	ii	<p><i>Shape</i>: trigonal planar ✓ <i>Bond angle</i>: 120° ✓</p> <p><i>Explanation</i>: Pairs of electrons repel (one another equally) ✓</p> <p>Boron has 3 bonded pairs (and 0 lone pairs) ✓</p>	4	<p>'Trigonal planar' must be seen and spelt correctly at least ONCE</p> <p>DO NOT ALLOW 'atoms repel' or 'electrons repel' ALLOW 'bonds repel'</p> <p>ALLOW diagram showing B atom with three dot-and-cross pairs of electrons, but no lone pairs for 4th mark Must refer to boron / central atom ALLOW 'bonds' for 'bonded pairs'</p>

Question		Expected Answers	Marks	Additional Guidance
5	e	<p>F is more electronegative than N OR $\delta^- \text{F}-\text{N}^{\delta+}$ ✓</p> <p>Dipoles do not cancel OR NF_3 is pyramidal (in words) / asymmetrical ✓</p>	2	<p>ALLOW F attracts electrons more than N ALLOW N has a partial positive charge and F has a partial negative charge (partial must be seen) DO NOT ALLOW diagrams that contradict statements about polarity</p> <p>ALLOW unsymmetrical, non-symmetrical etc</p>
	f	<p>(As you go across the period) The atomic radii decreases ✓</p> <p>The nuclear charge increases OR protons increase ✓</p> <p>electrons are added to the same shell OR shielding remains the same ✓</p> <p>greater (nuclear) attraction on (outer) electrons / (outer) shell(s) ✓</p>	4	<p>Use annotations with ticks, crosses ECF etc. for this part</p> <p>Assume 'across the period from Li to F' ALLOW (outer shell) electrons get closer (to nucleus)</p> <p>IGNORE 'atomic number increases', but ALLOW 'proton number' increases IGNORE 'nucleus gets bigger' 'Charge increases' is insufficient ALLOW 'effective nuclear charge increases' OR 'shielded nuclear charge increases'</p> <p>Nuclear OR proton(s) OR nucleus spelt correctly ONCE and used in context of 2nd marking point</p> <p>ALLOW shielding is similar ALLOW screening for shielding DO NOT ALLOW 'subshells' DO NOT ALLOW 'distance is similar' This will CON first marking point</p> <p>ALLOW 'greater (nuclear) pull for greater nuclear attraction' DO NOT ALLOW 'pulled in more' as this is a restatement of the first marking point</p>
Total			21	

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