OCR
RECOGNISING ACHIEVEMENT

GCE

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
__ = 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	$^{120}_{50}$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 isotope**s OR** average mass of isotope**s** **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** 12**g** of carbon-12 ✓ **ALLOW** mass of **one mole** of atoms 1/12th mass of **one mole** OR 12**g** 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) × 6.02×10^{23} if shown to 3 sig figs **DO NOT ALLOW** mass of Sn × 6.02×10^{23}

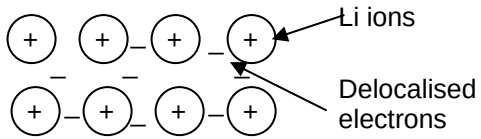
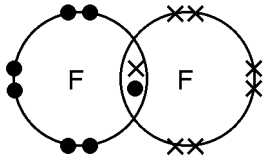
Question			Expected Answers	Marks	Additional Guidance
1	d		$\frac{78.8}{118.7}$ and $\frac{21.2}{16.0}$ **OR** = 0.66(4) and = 1.3(25) ✓ $\frac{0.66(4)}{0.66(4)}$ = 1 $\frac{1.325}{0.66(4)}$ = 2 ans = SnO_2 ✓	2	**ALLOW** SnO_2 for one mark if no working shown **ALLOW** use of 118 for this part **IGNORE** 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_2O for 1 mark ECF if **both** inverted mole calculations are shown **ALLOW** Sn_3O_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**	

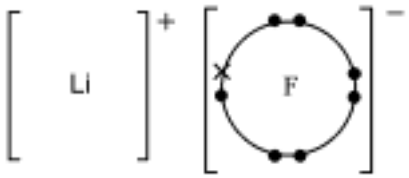
Question			Expected Answers	Marks	Additional Guidance
2	a	i	Any **two** from ✓✓ H^+ SO_4^{2-} HSO_4^-	2 max	**DO NOT ALLOW** OH^- **IGNORE** state symbols Charge is essential **ALLOW** H_3O^+ for H^+ and SO_4^{-2} for SO_4^{2-} One answer incorrect = 1 mark max Two answers incorrect = 0 marks
		ii	Effervescence **OR** fizzing **OR** bubbling **OR** gas produced ✓ K_2CO_3 dissolves **OR** disappears **OR** colourless solution is formed ✓ $H_2SO_4 + K_2CO_3 \rightarrow K_2SO_4 + CO_2 + H_2O$ ✓	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_2CO_3 **DO NOT ALLOW** mark for 'dissolves' from state symbols in equation **DO NOT ALLOW** 'potassium' **IGNORE** state symbols **ALLOW** ionic equation
	b	i	$\frac{24.6}{1000} \times 0.100 = 0.00246$ mol ✓ (2.46×10^{-3} 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	$0.00246 \times 2 = 0.00492$ mol ✓ (4.92×10^{-3} mol)	1	**ALLOW** ECF for ans **(i)** × 2
		iii	Moles of NaOH in 250 cm^3 = $0.00492 \times \frac{250}{25} = 0.0492$ mol ✓ Mass of NaOH in original sample $= 0.0492 \times 40.0 = 1.968$ 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) mol (0.0492/0.0500) × 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	A region (within an atom) that can hold (up to) two electrons ✓ (with opposite spin)	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	11 ✓	1	
	c		18 ✓	1	
	d	i	2nd, 3rd **OR** 1817, 2745 ✓ 10th, 11th **OR** 38458, 42655 ✓	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	$Al^{2+}(g) \rightarrow Al^{3+}(g) + e^{-}$ ✓✓	2	**ALLOW** $Al^{2+}(g) - e^{-} \rightarrow Al^{3+}(g)$ for 2 marks **ALLOW** 1 mark for $Al(g) \rightarrow Al^{3+}(g) + 3e^{-}$ as states are correct **ALLOW** 1 mark for $Al^{2+}(g) + 2e^{-} \rightarrow Al^{3+}(g) + 3e^{-}$ 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	$Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$ ✓	1	**IGNORE** state symbols **ALLOW** correct multiples, including fractions
		iii	Addition of $Br_2(aq)$ to $I^-(aq)$ 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** $Br_2 + I^-$ 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** chlor**IDE** 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	$\frac{1.47}{84.3}$ = 0.0174 mol of $MgCO_3$ ✓ $0.0174 \times 24.0 = 0.418\ dm^3$ **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 $MgCO_3$** $\times$ 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		 Diagram showing a regular arrangement of **labelled** '**Li^+**' or **'+ ions'** with some attempt to show electrons ✓ Scattering of **labelled** electrons **between** other species **OR** a statement anywhere of **delocalised** electrons (can be in text or in diagram) ✓ The attraction between + ions and e^- is strong **OR** metallic bonding is strong ✓	3	Lattice diagram must have at least two rows of correctly charged ions and a minimum of 2 ions per row **ALLOW** as label: + ions, positive ions, cations If '+' is unlabelled in diagram, award label from a correct statement within the text below **DO NOT ALLOW** 2+, 3+ etc ions **DO NOT ALLOW** for label or in text: nuclei **OR** positive atom **OR** protons **ALLOW** e^- **OR** e as label for electron **ALLOW** a lot of energy is needed to break the (metallic) bond **DO NOT ALLOW** incorrect particles or incorrect attraction e.g. 'intermolecular attraction' or 'nuclear attraction'
	b	i	 Dot and cross bond + 6 matching electrons on each F atom ✓	1	**ALLOW** diagram consisting of all dots **OR** all crosses Circles not essential **ALLOW** 'Fl' for fluorine
		ii	F_2 has induced dipoles **OR** temporary dipoles **OR** van der Waals' forces (between the molecules) ✓ which are **weak** ✓	2	**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

Question			Expected Answers	Marks	Additional Guidance
5	c	i	 Li shown with either 2 or 0 electrons **and** F shown with 8 electrons with 7 crosses and one dot (or *vice versa*) ✓ correct charges on both ions ✓	2	**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** 'Fl' for fluorine Circles not essential **DO NOT ALLOW** Li^+ with 8 electrons Second mark is independent
		ii	Ions cannot move in a solid ✓ **Ions** can move **OR** are mobile when molten ✓	2	**ALLOW** ions are fixed in place **IGNORE** electrons **IGNORE** 'charge carriers' or 'charged particles' **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**
	d	i	$2B + 3F_2 \longrightarrow 2BF_3$ ✓	1	**ALLOW** B_2 **ALLOW** multiples including fractions
		ii	*Shape*: trigonal planar ✓ *Bond angle:* 120° ✓ *Explanation*: **Pairs** of electrons repel (one another equally) ✓ **Boron** has 3 bonded pairs (and 0 lone pairs) ✓	4	**'Trigonal planar' must be seen and spelt correctly at least ONCE** **DO NOT ALLOW** 'atoms repel' or 'electrons repel' **ALLOW** 'bonds repel' **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'

Question			Expected Answers	Marks	Additional Guidance
5	e		F is more electronegative than N **OR** $^{\delta-}$F–N$^{\delta+}$ ✓ Dipoles do not cancel **OR** NF_3 is pyramidal (in words) / asymmetrical ✓	2	**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 **ALLOW** unsymmetrical, non-symmetrical etc
	f		(As you go across the period) The atomic radii decreases ✓ The nuclear charge increases **OR** protons increase ✓ electrons are added to the same shell **OR** shielding remains the same ✓ great**er** (nuclear) attraction on (outer) electrons / (outer) shell(s) ✓	4	**Use annotations with ticks, crosses ECF etc. for this part** Assume 'across the period from Li to F' **ALLOW** (outer shell) electrons get closer (to nucleus) **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' **Nuclear OR proton(s) OR nucleus spelt correctly ONCE and used in context of 2nd marking point** **ALLOW** shielding is similar **ALLOW** screening for shielding **DO NOT ALLOW** 'subshells' **DO NOT ALLOW** 'distance is similar' This will CON first marking point **ALLOW** 'greater (nuclear) pull for greater nuclear attraction' **DO NOT ALLOW** 'pulled in more' as this is a restatement of the first marking point
			Total	**21**	

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