OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced Subsidiary GCE

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

Mark Scheme for January 2011

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

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.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Question			Answer	Mark	Guidance
1	(a)		Rb-87 has (two) more neutrons ✓	1	**ALLOW** Different numbers of neutrons **ALLOW** 2 neutrons **ALLOW** Rb-85 has 48 neutrons **AND** Rb-87 has 50 neutrons **IGNORE** correct references to protons and electrons **DO NOT ALLOW** incorrect references to protons and electrons
	(b)		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)		$\frac{(85.00 \times 72.15) + (87.00 \times 27.85)}{100}$ = **OR** *61.3275 + 24.2295* **OR** *85.557* ✓ A_r = 85.56 (to 2 decimal places) ✓	2	**ALLOW** two marks for correct answer A_r = 85.56 (with no working) **ALLOW** one mark for **ECF** from **seen** incorrect sum provided final answer is between 85 and 87 and is to 2 decimal places, e.g. 85.567 gives **ECF** of 85.57 for one mark

Question			Answer	Mark	Guidance
1	(d)		Spherical **OR** sphere ✓	1	**DO NOT ALLOW** 'circular' **IGNORE** unlabelled 2-D diagrams
	(e)	(i)	$Sr^{+}(g) \rightarrow Sr^{2+}(g) + e^{-}$ ✓	1	**ALLOW** e for electrons **ALLOW** $Sr^{+}(g) - e^{-} \rightarrow Sr^{2+}(g)$ **DO NOT ALLOW** $Sr^{+}(g) + e^{-} \rightarrow Sr^{2+}(g) + 2e^{-}$ **IGNORE** state symbols for electrons
	(e)	(ii)	Sr has one **more** proton **OR** great**er** nuclear charge ✓	3	**Use annotations with ticks, crosses ECF etc. for this part** Comparison should be used for each mark **ALLOW** Sr has more protons **ALLOW** 'across the period' for 'Sr' **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' ***Quality of Written Communication –*** *Nuclear* ***OR*** *proton(s)* ***OR*** *nucleus spelled correctly* ***ONCE*** *for the* ***first*** *marking point*
			(Outermost) electrons are in the same shell **OR** (outermost) electrons experience same shielding **OR** Atomic radius of Sr is small**er** ✓		**ALLOW** shielding is similar **ALLOW** screening for shielding **IGNORE** sub-shells **DO NOT ALLOW** 'distance is similar'
			Sr has great**er** nuclear attraction (on outer electrons / outer shell/s) **OR** the (outer) electrons are attracted more strongly (to the nucleus) ✓		**ALLOW** 'greater nuclear pull' for 'greater nuclear attraction' **DO NOT ALLOW** 'nuclear charge' for nuclear attraction **ORA** throughout

Question			Answer	Mark	Guidance
1	(e)	(iii)	2nd IE of Rb involves removing electron from shell closer to nucleus ✓	2	**IGNORE** new shell **ALLOW** There is one shell fewer in $Rb^{(+)}$ (than Sr^{+}) **ALLOW** $Rb^{(+)}$ has a smaller radius (than Sr^{+}) **ALLOW** $Rb^{(+)}$ loses an electron from the 4th shell **AND** $Sr^{(+)}$ loses an electron from the 5th shell.
			Strong**er** nuclear attraction on (outermost electron) of Rb **OR** (outermost electron) of Rb experiences **less** shielding ✓		**ALLOW** responses which do not specifically say 'nuclear' attraction (e.g. Rb has greater attraction) as long as nucleus is seen in first point A comparison of Rb to Sr must be used, e.g. 'Because of shielding' is not enough **ORA**
			Total	**13**	

Question			Answer	Mark	Guidance
2	(a)	(i)	mol of H_xA = $\frac{25.00 \times 0.0500}{1000}$ = 1.25×10^{-3} **OR** 0.00125 mol ✓	1	**ALLOW** 0.0013 **OR** 1.3×10^{-3} **ALLOW** correct answer only without working
		(ii)	mol of NaOH = $\frac{12.50 \times 0.200}{1000}$ = 2.5(0) × 10^{-3} **OR** 0.0025(0) mol ✓	1	**ALLOW** correct answer without working
		(iii)	Answer **2a(ii)** rounded to nearest whole number ✓ Answer **2a(i)** If **2a(i)** and **2a(ii)** are correct this will be $x = \frac{2.50 \times 10^{-3} \text{ mol}}{1.25 \times 10^{-3} \text{ mol}} = 2$ **OR** H_2A	1	**ALLOW** answer without working if answers to **2a(i) AND 2a(ii)** are seen **DO NOT ALLOW** responses without seeing answers in **2a(i) AND 2a(ii)**
	(b)	(i)	HNO_3 ✓ $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$ ✓	2	**IGNORE** state symbols **ALLOW** correct multiples
		(ii)	(Electrostatic) **attraction** between **oppositely** charged **ions** ✓	1	**Attraction** is essential **IGNORE** references to metal and non-metal
		(iii)	**Ions** are mobile **OR** ions can move ✓	1	**IGNORE** 'free ions' **IGNORE** 'delocalised ions' **IGNORE** ions can move when molten **IGNORE** charge carriers **DO NOT ALLOW** Any mention of electrons moving **ALLOW** ions move when **in** a liquid **IGNORE** responses which give liquid ions
		(iv)	(+) 5 ✓	1	**ALLOW** V

Question			Answer	Mark	Guidance
2	(c)		$Cu(NO_3)_2•6H_2O$ ✓	1	**ALLOW** $Cu(NO_3)_26H_2O$ **ALLOW** $Cu(NO_3)_2(H_2O)_6$ **ALLOW** $Cu(NO_3)_2.6H_2O$ **DO NOT ALLOW** $CuN_2O_6•6H_2O$
			Total	**9**	

Question			Answer	Mark	Guidance
3	(a)		The ability of an **atom** to attract electrons ✓ in a covalent bond ✓	2	**ALLOW** 'attraction of an **atom** for electrons' **ALLOW** 'pull' for 'attract' **DO NOT ALLOW** 'element' for 'atom' **ALLOW** 'shared pair' or 'bond(ing) pair' for 'covalent bond'
	(b)		δ^+N–Fδ^- **AND** δ^-N–Brδ^+ ✓	1	**ALLOW** d+ / d- **DO NOT ALLOW** + / –
	(c)	(i)	octahedral **OR** octahedron ✓	1	
		(ii)	 Diagram of BF_3 showing three '*dot-and-cross*' bonds between B and F and all F atoms with complete octet of electrons ✓ Diagram of NH_3 showing three '*dot-and-cross*' bonds between N and H and N atom has a lone pair ✓ ***Marking points 3, 4 and 5 may be awarded independently*** electron pairs repel ✓ NH_3 has **one lone** pair and **three bonding** pairs of electrons **AND** lone pair of electrons repels **more** than bonding pairs ✓ BF_3 has **three** (bonding) pairs of electrons (which repel equally) ✓	5	**Use annotations with ticks, crosses ECF etc. for this part** **ALLOW** diagrams without circles Must be '*dot-and-cross*' **IGNORE** 'electrons repel' **DO NOT ALLOW** 'atoms repel' **ALLOW** 'bonds repel' **ALLOW** 'bonds' for 'bonding pairs' **ALLOW** 'four pairs' in place of 'one lone pair and three bonding pairs' The third marking point can be gained from statements seen in fourth or fifth marking points

Question			Answer	Mark	Guidance
3	(c)	(iii)	BF_3 is **symmetrical** ✓ The **dipoles** cancel out ✓	2	**IGNORE** 'polar bonds cancel' **IGNORE** 'charges cancel'
			Total	**11**	

Question			Answer	Mark	Guidance
4	(a)		Used to neutralise **acidic** soils ✓ Excess will result in soils becoming **too** alkaline (to sustain crop growth) ✓	2	**ALLOW** raises the pH of the soil **IGNORE** references to fertilisers **ALLOW** pH becomes **too** high **IGNORE** 'harmful' **IGNORE** 'corrosive'
	(b)	(i)	0.00131 × 40.1 = 0.0525 g **OR** 5.25×10^{-2} ✓	1	**ALLOW** 0.053 **OR** 0.05253 **OR** 0.052531 g **IGNORE** 0.05 **if correct answer seen in working** **DO NOT ALLOW** 0.052 **OR** 0.0524
		(ii)	0 00131 × 24.0 = 0.0314 dm^3 **OR** 3.14×10^{-2} ✓	1	**ALLOW** 0.031 **OR** 0.03144 dm^3 **IGNORE** 0.03 **if correct answer seen in working** **DO NOT ALLOW** 31.4
		(iii)	Mol of OH^- ions = 0.00131 × 2 = 0.00262 **OR** 2.62×10^{-3} ✓ Mol of OH^- ions in 1 dm^3 = 0.00262 × $\frac{1000}{250}$ = 0.0105 mol dm^{-3} ✓	2	**ALLOW** 0.0026 **ALLOW** 0.01048 **OR** 0.01(0) **ALLOW ECF** from incorrect mol of OH^- **DO NOT ALLOW** 2nd mark as **ECF** if 0.0525 is used as no of mol of OH^- ions **DO NOT ALLOW** 2nd mark as **ECF** if 0.0314 is used as no of mol of OH^- ions 0.00524 mol dm^{-3} is a likely **ECF** as a result of not multiplying 0.00131 by 2, but 0.00131 must be seen in working
	(c)	(i)	**Fewer** moles of Ba (in 0.0525 g) **OR Fewer** atoms of Ba (in 0.0525) ✓	1	**ORA** Assume candidate is referring to Ba if not stated **IGNORE** A_r Ba > A_r Ca
		(ii)	Idea of Ba having a quick**er** rate **OR more** vigorous reaction ✓	1	**ALLOW more** exothermic **OR** gets hot**ter OR** fizzes more Assume candidate is referring to Ba if not stated Comparison is essential **IGNORE** 'Ba more reactive' **ORA**
			Total	**8**	

Question			Answer	Mark	Guidance
5	(a)	(i)	***Creating the dipole mark*** uneven distribution of electrons ✓ ***Type of dipole mark*** creates an instantaneous dipole **OR** temporary dipole ✓ ***Induction of a second dipole mark*** causes induced dipole(s) in neighbouring molecules ✓	3	**Use annotations with ticks, crosses ECF etc. for this part** **ALLOW** movement of electrons **ALLOW** changing electron density **ALLOW** 'transient', 'oscillating', 'momentary', 'changing' **ALLOW** 'induces a dipole in neighbouring molecules' **ALLOW** 'causes a resultant dipole in neighbouring molecules' **ALLOW** 'atoms' for 'molecules'
		(ii)	boiling points increase down the group ✓ greater number of electrons **OR** stronger intermolecular forces **OR** stronger van der Waals' forces ✓ more energy needed to break intermolecular **OR** van der Waals' forces ✓	3	**Use annotations with ticks, crosses ECF etc. for this part** **ALLOW** Bpt of iodine is high**est OR** Bpt of chlorine is low**est** **ALLOW** Cl for chlorine etc. For 'down the group' **ALLOW** 'as molecules get bigger' **ALLOW** number of **electron** shells increases **IGNORE** 'more shells' (if no reference to electrons) **ALLOW** 'more' for 'stronger' **ALLOW** iodine has most electrons **ALLOW** chlorine has fewest electrons **DO NOT ALLOW** any implication that the attraction is between atoms not molecules for third mark
	(b)		Same number of **outer(most)** electrons **OR** same **outer(most)** electron structure ✓	1	**ALLOW** same number of electrons in outer shell **ALLOW** It has seven outer electrons **IGNORE** same group **DO NOT ALLOW** 'same number of electrons'

Question			Answer	Mark	Guidance
5	(c)	(i)	***Colours:***	6	**Use annotations with ticks, crosses ECF etc. for this part**
			(Add Br_2 to NaCl,) (Cyclohexane layer) turns orange **OR** yellow ✓		**ALLOW** any combination of these but no others
			(Add Br_2 to NaI,) (Cyclohexane layer) turns purple **OR** lilac **OR** violet **OR** pink **OR** mauve ✓		**ALLOW** any combination of these but no others **DO NOT ALLOW** 'precipitate' with either colour
			Equation:		**DO NOT ALLOW** equation mark if incorrect equation(s) also seen
			$Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ ✓		**IGNORE** $Br_2 + 2Cl^- \rightarrow Br_2 + 2Cl^-$ **IGNORE correct** non-ionic version of equation **IGNORE** state symbols
			Reactivity:		
			Reactivity decreases down the group **OR** Oxidising power decreases down the group ✓		**ALLOW** Chlorine is the most reactive **ALLOW** Cl for chlorine etc. **ALLOW** Iodine is the least reactive
			Explanations:		
			Chlorine will gain electron easiest **OR** form negative ion easiest ✓		**ALLOW** chlorine is best at electron capture **ALLOW** chlorine has 'greatest' electron affinity **IGNORE** chlorine is most electronegative **DO NOT ALLOW** explanations in terms of displacement ***Quality of Written Communication –*** *Electron(s)* ***OR*** *negative spelled correctly at least* ***ONCE*** *for marking point 5*
			Because chlorine (atom) is smallest **OR** Outer(most) shell of chlorine least shielded **OR** Nuclear attraction on electrons of chlorine is greatest ✓		**ALLOW** Chlorine atom has fewest shells **ALLOW** outer(most) shell closest to the nucleus **ALLOW** Chlorine atom has lowest shielding **ORA** for marking points 4, 5 and 6

Question			Answer	Mark	Guidance
5	(c)	(ii)	Bromine is toxic ✓	1	**ALLOW** cyclohexane is toxic **ALLOW** bromine irritates the lungs **DO NOT ALLOW** Cl_2 is toxic **IGNORE** 'strong smelling' **IGNORE** 'halogens' are toxic
	(d)	(i)	$2F_2 + 2H_2O \rightarrow 4HF + O_2$ ✓	1	**ALLOW** correct multiples, including use of ½ O_2 **ALLOW** 4FH **IGNORE** state symbols
		(ii)	Oxygen has been oxidised as (oxidation number has increased from) O = –2 to O = 0 ✓ Fluorine has been reduced as (oxidation number has decreased from) F = 0 to F = –1 ✓	2	**IGNORE** references to oxygen in any incorrect products **DO NOT ALLOW** O_2 = –2 → O = 0 but **ALLOW** F_2 = 0 → F = –1 **ALLOW** 'F is reduced from 0 to –1' regardless of product (or no product) in **5d(i)** except **ALLOW ECF** for F = –2 **if** H_2F is seen **ALLOW** one mark for O = –2 and O_2 = 0 **AND** F_2 = 0 and F = –1 if **no reference OR incorrect reference** to oxidation / reduction is seen Look at equation in **5d(i)** for oxidation numbers **if not seen in 5d(ii)** **IGNORE** reference to electron loss / gain if correct **DO NOT ALLOW** incorrect reference to electron loss / gain
	(e)	(i)	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$ ✓	1	**IGNORE** $1s^2$ twice **ALLOW** $4s^2$ before $3d^{10}$ **ALLOW** '3D'
		(ii)	GaF_3 ✓	1	
			Total	**19**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553