OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Mark Schemes

H034/H434/MS/R/10J

CONTENTS

Advanced GCE Chemistry A (H434)

Advanced Subsidiary GCE Chemistry A (H034)

MARK SCHEME FOR THE UNITS

F321 Atoms, Bonds and Groups

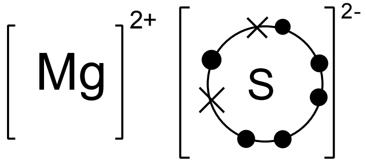
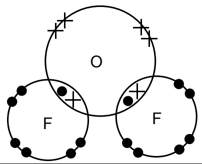
Question			Expected Answers	Marks	Additional Guidance
1	(a)		**Mass** of the **isotope** compared to 1/12th **OR** **mass** of the **atom** compared to 1/12th ✓ (the mass of a) carbon-12 **OR** ^{12}C (atom) ✓	2	**IGNORE** Reference to average **OR** weighted mean (i.e. correct definition of relative atomic mass will score both marks) **ALLOW** mass of a **mole** of the isotope/atom with 1/12th the mass of a **mole OR** 12 **g** of carbon-12 for two marks. **ALLOW 2 marks for:** '**Mass** of the isotope **OR mass** of the atom compared to ^{12}C atom given a mass of 12.0' i.e. 'given a mass of 12' **OR** C12 is 12 communicates the same idea as 1/12th.' **ALLOW** 12C **OR** C12 **ALLOW 2 marks for:** $\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of carbon-12}}$ i.e. fraction is equivalent to 'compared to' **ALLOW 1 mark for** a mix of mass of atom and mass of mole of atoms, i.e. 'mass of the isotope/mass of an atom compared with 1/12th the mass of a **mole OR** 12 g of carbon-12.' **DO NOT ALLOW** mass of 'ions' OR mass of element
	(b)		$\frac{(151 \times 47.77) + (153 \times 52.23)}{100}$ **OR** 72.1327 + 79.9119 **OR** 152.0446 (calculator value) ✓ A_r = 152.04 ✓	2	**ALLOW** Correct answer for two marks **ALLOW** One mark for ECF from transcription error in first sum provided final answer is to 2 decimal points and is to between 151 and 153 and is a correct calculation of the transcription

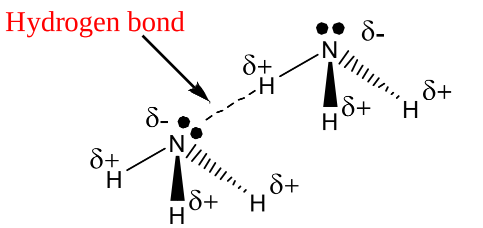
Question			Expected Answers	Marks	Additional Guidance
	(c)	**(i)**	^{153}Eu has (2) more neutrons **OR** ^{153}Eu has 90 neutrons **AND** ^{151}Eu has 88 neutrons ✓	**1**	**ALLOW** There are a different number of neutrons **IGNORE** Correct references to protons / electrons **DO NOT ALLOW** Incorrect references to protons / electrons
		(ii)	(It has the) same number of protons **AND** electrons **OR** Both have 63 protons and 63 electrons ✓	**1**	**ALLOW** Same number of protons **AND** same electron configuration **DO NOT ALLOW** 'Same number of protons' without reference to electrons (and vice versa)

Question			Expected Answers	Marks	Additional Guidance
	(d)		Xe has a bigger atomic radius **OR** Xe has more shells ✓ Xe has **more** shielding ✓ The nuclear attraction decreases **OR** Outermost electrons of Xe experience less attraction (to nucleus) **OR** Increased shielding / distance outweighs the increased nuclear charge ✓ ORA throughout	**3**	**ALLOW** Xe has more energy levels **ALLOW** Xe has electrons in higher energy level **ALLOW** Xe has electrons further from nucleus **IGNORE** Xe has more orbitals **OR** more sub-shells **DO NOT ALLOW** 'different shell' or 'new shell' **ALLOW More** screening There must be a clear comparison ie **more** shielding **OR** **increased** shielding. i.e. **DO NOT ALLOW** Xe 'has shielding' **ALLOW** Xe has **more** electron repulsion from inner shells **ALLOW** Xe has less nuclear pull **IGNORE** Xe has less effective nuclear charge **DO NOT ALLOW** nuclear charge for nuclear attraction
			Total	**9**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	The H^+ ion in an (nitric) acid has been replaced by a metal ion **OR** by a Ca^{2+} ion ✓	1	**DO NOT ALLOW** it has been produced by the reaction of an acid and a base as this is stated in the question. **IGNORE** references to replacement by NH_4^+ ions or positive ions. **ALLOW** H **OR** Hydrogen for H^+; **DO NOT ALLOW** Hydrogen atoms **ALLOW** Ca **OR** Calcium for Ca^{2+}. **DO NOT ALLOW** Calcium atoms **ALLOW** 'metal' for 'metal ion
		(ii)	$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$ Formulae ✓ Balance **AND** states ✓	2	**ALLOW** multiples **ALLOW** (aq) **OR** (s) for $Ca(OH)_2$
		(iii)	Accepts a **proton OR** accepts $\mathbf{H^+}$ ✓	1	**ALLOW** $\mathbf{H^+}$ + $OH^- \rightarrow H_2O$ **ALLOW** OH^- reacts with $\mathbf{H^+}$ **OR** OH^- takes $\mathbf{H^+}$ **ALLOW** OH^- 'attracts' $\mathbf{H^+}$ if 'to form water' is seen **DO NOT ALLOW** OH^- neutralises H^+ ('neutralises' is in the question)
	(b)	(i)	Calculates correctly $\frac{0.0880 \times 25.0}{1000} = 2.20 \times 10^{-3}$ mol **OR** 0.00220 mol ✓	1	**ALLOW** 0.0022 **OR** 2.2×10^{-3} mol
		(ii)	Calculates correctly $\frac{0.00220}{2} = 1.10 \times 10^{-3}$ mol **OR** 0.00110 mol ✓	1	**ALLOW** 0.0011 **OR** 1.1×10^{-3} mol **ALLOW** ECF for answer **(i)**/2 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
		(iii)	$\frac{0.00110 \times 1000}{17.60} = 0.0625$ mol dm^{-3} **OR** 6.25×10^{-2} mol dm^{-3} ✓	1	**ALLOW** 0.063 **OR** 6.3×10^{-2} mol dm^{-3} **ALLOW** ECF for answer **(ii)** × 1000/17.60 **OR** ECF from **(i)** for answer **(i)**/2 × 1000/17.60 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes

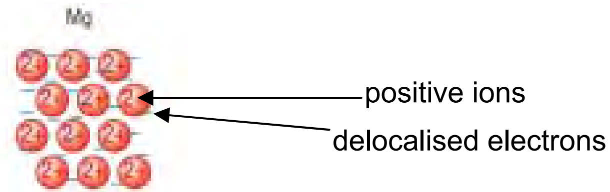
	(c)	**(i)**	(The number of) Water(s) of crystallisation ✓	**1**	**IGNORE** hydrated **OR** hydrous
		(ii)	142.1 ✓ $x = \frac{(322.1 - 142.1)}{18.0} = 10$ ✓	**2**	**ALLOW** 142 **ALLOW** M_r expressed as a sum **ALLOW** ECF from incorrect M_r and x is **calculated correctly** **ALLOW** ECF values of x from nearest whole number to calculator value **ALLOW** 2 marks if final answer is 10 **without any working**
			Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
3	**(a)**	**(i)**	(Electrostatic) **attraction** between oppositely charged **ions**. ✓	**1**	**IGNORE** force **IGNORE** references to transfer of electrons **MUST** be ions, not particles
		(ii)	Mg shown with either 8 of 0 electrons **AND** S shown with 8 electrons **with** 2 crosses and 6 dots (or vice versa) ✓ Correct charges on both ions ✓ 	**2**	Mark charges on ions and electrons independently **For first mark**, if 8 electrons are shown around the Mg then 'extra electrons' around S must match the symbol chosen for electrons around Mg Shell circles not required **IGNORE** inner shell electrons Brackets are not required
	(b)	**(i)**	Electron pairs in covalent bonds shown correctly using dots and crosses in a molecule of the F_2O ✓ Lone pairs correct on O and both F atoms ✓ 	**2**	Must be '*dot-and-cross*' circles for outer shells **NOT** needed **IGNORE** inner shells Non-bonding electrons of O do not need to be shown as pairs Non-bonding electrons of F do not need to be shown as pairs
		(ii)	Predicted bond angle 104–105^{O}. ✓ There are 2 bonded pairs and 2 lone pairs ✓ Lone pairs repel more than bonded pairs ✓	**3**	**ALLOW** 103–105^{O} (103^{O} is the actual bond angle) **ALLOW** responses equivalent to second marking point. e.g. There are 4 pairs of electrons and 2 of these are lone pairs **ALLOW** 'bonds' for 'bonded pairs' **DO NOT ALLOW** 'atoms repel' **DO NOT ALLOW** electrons repel **ALLOW** LP for 'lone pair' **ALLOW** BP for bonded pair **ALLOW** LP repel more if bonded pairs have already been mentioned

Question			Expected Answers	Marks	Additional Guidance
	(c)	(i)	(At least) two **NH_3** molecules with correct dipole shown with at least one H with δ^+ and one N with δ^- ✓ (Only) one hydrogen bond from N atom on one molecule to a H atom on another molecule ✓ Lone pair shown on the N atom and hydrogen bond must hit the lone pair ✓ 	3	**DO NOT ALLOW** first mark for ammonia molecules with incorrect lone pairs **DO NOT ALLOW** first mark if H_2O, NH_2 or NH is shown **ALLOW** hydrogen bond need not be labelled as long as it clear the bond type is different from the covalent N–H bond **ALLOW** a line (i.e. looks like a covalent bond) as long as it is labelled 'hydrogen bond) **ALLOW** 2-D diagrams **ALLOW** two marks if water molecules are used. One awarded for a correct hydrogen bond and one for the involvement of lone pair
		(ii)	Liquid H_2O is denser than solid ✓ In solid state H_2O molecules are held apart by hydrogen bonds **OR** ice has an open lattice ✓ **OR** H_2O has a relatively high boiling point **OR** melting point ✓ (relatively strong) hydrogen bonds need to be broken **OR** a lot of energy is needed to overcome hydrogen bonds **OR** hydrogen bonds are strong ✓	2	ORA **ALLOW** ice floats for first mark **ALLOW** higher melting **OR** boiling point than expected **DO NOT ALLOW** H_2O has a high melting / boiling point **ALLOW** other properties caused by hydrogen bonding not mentioned within the specification E.g. high surface tension – strong hydrogen bonds on the surface
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)		*Advantage* removes or kills bacteria **OR** kills germs **OR** kills micro-organisms **OR** make it safe to drink **OR** sterilises water **OR** disinfects water ✓ *Disadvantage* it is toxic **OR** poisonous **OR** could form chlorinated hydrocarbons ✓	2	**ALLOW** to make water potable **IGNORE** virus **IGNORE** 'purifies water' **DO NOT ALLOW** 'antiseptic' **ALLOW forms** carcinogens **OR** forms toxins **IGNORE** harmful **DO NOT ALLOW** 'it causes cancer' **DO NOT ALLOW** "It kills you"
	(b)		$3d^{10}\ 4s^2\ 4p^5$ ✓	1	**ALLOW** $4s^2\ 3d^{10}\ 4p^5$ **ALLOW** subscripts or $3D^{10}$ **ALLOW** answers with $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ appearing twice
	(c)	(i)	$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓	1	**IGNORE** state symbols **ALLOW** any correct multiple including fractions
		(ii)	Yellow / orange / red / brown ✓	1	**ALLOW** any combination of these, but no others
	(d)	(i)	Disproportionation ✓	1	**ALLOW** versions which sound the same **DO NOT ALLOW** disproportional **OR** disproportionate **OR** disproportion
		(ii)	$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$ ✓ $3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$ Cl_2 and NaOH as reactants **AND** $NaClO_3$ and NaCl as products✓ Rest of the equation ✓	3	**ALLOW** multiples for either equation **ALLOW** $3Cl_2 + 6NaOH \rightarrow 2NaClO_3 + 4NaCl + 3H_2$
		(iii)	$NaClO_4$ ✓	1	**ALLOW** Na_3ClO_5 etc
			Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)	(i)	Potassium **AND** argon ✓	1	**ALLOW** K and Ar
		(ii)	They are arranged in increasing atomic number **OR** Neither would show properties **OR** trends of rest of group **OR** Neither would show properties **OR** trends of rest of period **OR** They are arranged by electron configuration ✓	1	**ALLOW** any correct property difference e.g. This would place a reactive metal in the same group as noble gases **ALLOW** they do not fit in with the rest of the group
	(b)	(i)	$2Mg + O_2 \rightarrow 2MgO$ ✓	1	**ALLOW** multiples. Correct species must be seen **IGNORE** state symbols
		(ii)	Fizzes **OR** bubbles **OR** gas produced **OR** effervescing ✓ Mg dissolves **OR** Mg disappears **OR** a solution is formed ✓	2	**DO NOT ALLOW** 'carbon dioxide gas produced' **DO NOT ALLOW** 'hydrogen produced' without 'gas' **ALLOW** 'it for Mg' **IGNORE** Mg reacts **IGNORE** temperature change **IGNORE** steam produced
		(iii)	Quicker **OR** more vigorous **OR** gets hotter	1	**MUST** be a comparison of a reaction observation, not just 'more reactive' **ALLOW** any comparison of greater rate including more bubbles etc. **DO NOT ALLOW** more gas produced

Question			Expected Answers	Marks	Additional Guidance
	(c)		Mg has a **giant** structure ✓	6	
			Mg has **metallic** bonding OR description of metallic bonding as positive ions and **delocalised** electrons ✓		**Metallic OR delocalised** seen spelt correctly at least **ONCE**
			(There is electrostatic attraction between) positive ions and electrons ✓		**DO NOT ALLOW** as label nuclei **OR** protons for positive ions **ALLOW labelled** diagram of metallic bonding for second and third marks  Lattice must have at least two rows of positive ions. If a Mg ion is shown it must correct charge **ALLOW** for labels:+ ions, positive ions, cations **DO NOT ALLOW** as label nuclei **OR** protons for positive ions **ALLOW** e^- or e as label for electron **DO NOT ALLOW** '–' without label for electron
			Cl has a simple molecular **OR** simple covalent (lattice) ✓		**Covalent OR molecule OR molecular** seen spelt correctly at least **ONCE** **ALLOW** Cl is a (covalent) **molecule**
			Cl has van der Waals' forces (between molecules) **OR** Cl has instantaneous dipole–induced dipoles **OR** temporary dipole–temporary dipole ✓		**IGNORE** Cl has intermolecular bonding

			van der Waals' forces are weak **and** metallic bonds are strong **OR** van der Waals' forces are weak**er** than metallic bonds **OR** Less energy is needed to overcome van der Waals' than metallic bonds ✓		**ALLOW** ECF from incorrect descriptions of giant structure with strong bonds; e.g. Mg has giant ionic structure **ALLOW** ECF from any incorrect intermolecular forces e.g. permanent dipole –dipole from marking point 5 **ALLOW** vdW easi**er** to break ORA
	(d)	**(i)**	O goes from –2 to 0 ✓ N goes from +5 to +4 ✓ N is reduced **AND** O is oxidised ✓	**3**	Oxidation numbers may be seen with equation Third mark is dependent upon seeing a reduction in oxidation number of N and an increase in oxidation number of O **ALLOW** ECF for third mark for N is oxidised **and** O is reduced if incorrect oxidation numbers support this **IGNORE** references to strontium **IGNORE** references to electron loss **OR** gain **DO NOT ALLOW** 'One increases and one decreases'

	(d)	**(ii)**	Calculates correctly: Mol of $Sr(NO_3)_2 = \frac{5.29}{211.6} = 0.0250$ ✓ Calculates correctly: Mol of gas = 5/2 × 0.0250 = 0.0625 ✓ Calculates correctly: Volume of gas = 24.0 × 0.0625 = 1.50 dm^3 ✓	**3**	**ALLOW** 0.025 **ALLOW** ECF for first answer × 2.5 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **ALLOW** ECF for second answer × 24(.0) as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **DO NOT ALLOW** ECF of first answer × 24(.0) (which gives 0.6(0) dm^3) as this has not measured the volume of any gas, simply 0.0250 mol of solid $Sr(NO_3)_2$ converted into a gas i.e. This answer would give **one** mark **ALLOW** 1.5 dm^3 **ALLOW** ECF producing correct volume of NO_2 only i.e. 1.2(0) dm^3 would give **two** marks **OR** **ALLOW** ECF producing correct volume of O_2 only i.e. 0.3(0) dm^3 would give **two** marks
			Total	**18**	