GCE

Chemistry A

Mark Scheme

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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** $\dfrac{\text{mass of } \textbf{one mole} \text{ of atoms}}{\text{1/12th mass of } \textbf{one mole} \text{ OR } 12\textbf{g} \text{ of carbon-12}}$
	(c)		$\dfrac{(85.00 \times 72.15) + (87.00 \times 27.85)}{100}$ = **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

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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 ✓ (Outermost) electrons are in the same shell **OR** (outermost) electrons experience same shielding **OR** Atomic radius of Sr is small**er** ✓ Sr has great**er** nuclear attraction (on outer electrons / outer shell/s) **OR** the (outer) electrons are attracted more strongly (to the nucleus) ✓	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* **ALLOW** shielding is similar **ALLOW** screening for shielding **IGNORE** sub-shells **DO NOT ALLOW** 'distance is similar' **ALLOW** 'greater nuclear pull' for 'greater nuclear attraction' **DO NOT ALLOW** 'nuclear charge' for nuclear attraction **ORA** throughout

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1	**(e)**	**(iii)**	2nd IE of Rb involves removing electron from shell closer to nucleus ✓ Strong**er** nuclear attraction on (outermost electron) of Rb **OR** (outermost electron) of Rb experiences **less** shielding ✓	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. **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**	

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2	**(a)**	**(i)**	mol of H_xA = $\frac{\underline{25.00 \times 0.0500}}{1000}$ = 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 = $\frac{\underline{12.50 \times 0.200}}{1000}$ = $2.5(0) \times 10^{-3}$ **OR** 0.0025(0) mol ✓	1	**ALLOW** correct answer without working
		(iii)	$\frac{\text{Answer } \mathbf{2a(ii)}}{\text{Answer } \mathbf{2a(i)}}$ rounded to nearest whole number ✓ If **2a(i)** and **2a(ii)** are correct this will be $\boldsymbol{x} = \frac{2.50 \times 10^{-3} \text{ mol}}{1.25 \times 10^{-3} \text{ mol}} = 2$ **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

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2	**(c)**		$Cu(NO_3)_2{\bullet}6H_2O$ ✓	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** $CuN_2O_6{\bullet}6H_2O$
			Total	**9**	

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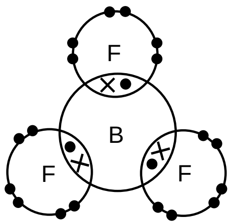
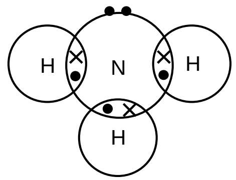
3	**(a)**		The ability of an **atom** to attract electrons ✓ in a covalent bond ✓	2	**ALLOW** 'attraction of an **atom** for electrons' **ALLOW** 'pull' for 'attract' **DO NOT ALLOW** 'element' for 'atom' **ALLOW** 'shared pair' or 'bond(ing) pair' for 'covalent bond'
	(b)		δ^{+}N–Fδ^{-} **AND** δ^{-}N–Brδ^{+} ✓	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

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3	**(c)**	**(iii)**	BF_3 is **symmetrical** ✓ The **dipoles** cancel out ✓	2	**IGNORE** ‘polar bonds cancel’ **IGNORE** ‘charges cancel’
			Total	**11**	

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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 = $0.00262 \times \frac{1000}{250}$ = 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**	

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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'

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5	(c)	(i)	***Colours:*** (Add Br_2 to NaCl,) (Cyclohexane layer) turns orange **OR** yellow ✓ (Add Br_2 to NaI,) (Cyclohexane layer) turns purple **OR** lilac **OR** violet **OR** pink **OR** mauve ✓ ***Equation:*** $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ ✓ ***Reactivity:*** Reactivity decreases down the group **OR** Oxidising power decreases down the group ✓ ***Explanations:*** Chlorine will gain electron easiest **OR** form negative ion easiest ✓ Because chlorine (atom) is smallest **OR** Outer(most) shell of chlorine least shielded **OR** Nuclear attraction on electrons of chlorine is greatest ✓	6	**Use annotations with ticks, crosses ECF etc. for this part** **ALLOW** any combination of these but no others **ALLOW** any combination of these but no others **DO NOT ALLOW** 'precipitate' with either colour **DO NOT ALLOW** equation mark if incorrect equation(s) also seen **IGNORE** $Br_2 + 2Cl^- \rightarrow Br_2 + 2Cl^-$ **IGNORE correct** non-ionic version of equation **IGNORE** state symbols **ALLOW** Chlorine is the most reactive **ALLOW** Cl for chlorine etc. **ALLOW** Iodine is the least reactive **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* **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

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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**	