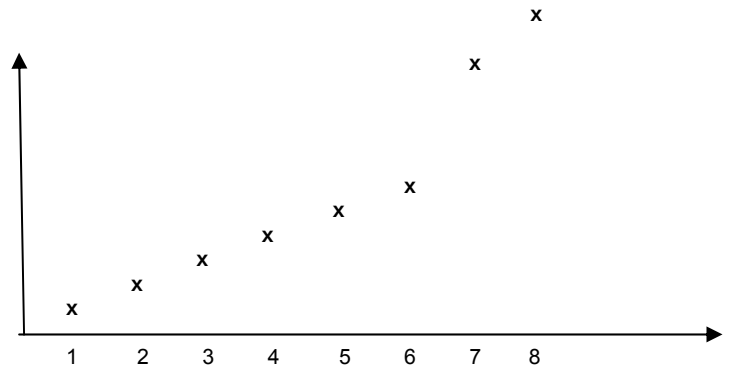
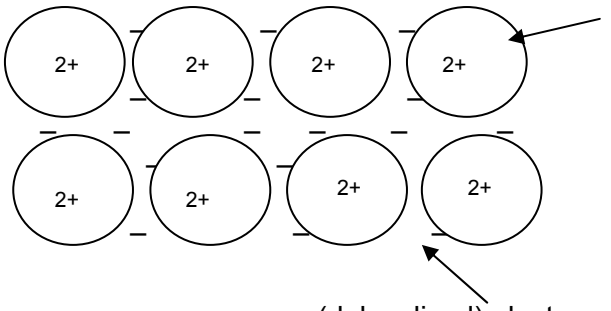
Question			Answer	Marks	Guidance
1	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **IF answer = 3.6(0) (dm^3) award 3 marks** Amount of WO_3 = (11.59 / 231.8 =) 0.05(00) (mol) ✓ Amount of H_2 = 0.0500 x 3 = 0.15(0) (mol) ✓ Volume of H_2 = 0.150 x 24.0 = 3.6(0) (dm^3) ✓	3	**If there is an alternative answer, check to see if there is any ECF credit possible using working below** **ALLOW** calculator value or rounding to 2 significant figures or more BUT **IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2 if wrong M_r produces such numbers throughout. **IF** answer **= 1.2(0)** dm^3 award 2 marks (not multiplying by 3) **ALLOW** use of inexact M_r (eg 232) – if it still gives 0.05 **ALLOW** amount of WO_3 x 3 correctly calculated for 2nd mark **ALLOW** amount of H_2 x 24.0 correctly calculated for 3rd mark **ALLOW** 1 mark for **incorrect** amount of WO_3 x 24.0 (not multiplied by 3 ie scores third mark only)
			Total	**8**	

Question			Answer	Marks	Guidance
2	(a)		A shared pair of electrons ✓	1	**DO NOT ALLOW** 'shared electrons'
	(b)	(i)	**Pairs** of (electrons surrounding a central atom) repel ✓ The shape is determined by the number of bond pairs **AND** the number of lone pairs (of electrons) ✓	2	**ALLOW** alternative phrases/words to repel eg 'push apart' **ALLOW** lone pairs repel **OR** bond(ing) pairs repel **ALLOW** 'the number of bonding pairs and number of lone pairs decides the orientation of the surrounding atoms' **ALLOW** 'how many' for 'number of' **ALLOW** the second mark for a response which has 2 of the following **including at least one** shape involving lone pairs (of electrons) BUT mark incorrect responses first 2 bonding pairs = linear 3 bonding pairs = trigonal planar 4 bonding pairs = tetrahedral 6 bonding pairs = hexagonal 3 bonding pairs and 1 lone pair = pyramidal 2 bonding pairs and 2 lone pairs = non-linear **IGNORE** 'number of electron pairs decides shape of molecule' as this is in the question
		(ii)	O–B–O = 120° ✓ B–O–H = 104.5° ✓	2	**ALLOW** 104–105°
	(c)		SF_6 **OR** sulfur hexafluoride **OR** sulfur(VI) fluoride ✓	1	**ALLOW** XeF_4 **DO NOT ALLOW** SCl_6 **DO NOT ALLOW** stated complexes (simple molecule is asked for)
			Total	**6**	

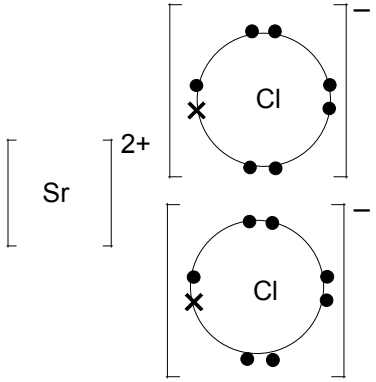
Question			Answer	Marks	Guidance
3	(a)		Energy (needed) to remove an electron ✓ from **each atom** in **one mole** ✓ of **gaseous atoms** ✓	3	**ALLOW** 'energy to remove one mole of electrons from one mole of gaseous atoms' for three marks **IGNORE** 'element' **ALLOW** 'energy needed to remove an electron from one mole of gaseous atoms to form one mole of gaseous 1+ ions' for two marks For third mark: **ALLOW** ECF if wrong particle is used in second marking point but is described as being gaseous eg 'molecule' instead of 'atom' **IGNORE** equations
	(b)	**(i)**	$O^+(g) \rightarrow O^{2+}(g) + e^-$ ✓	1	**ALLOW** $O^+(g) - e^- \rightarrow O^{2+}(g)$ **ALLOW** e for electron (ie charge omitted) **IGNORE** states on the electron
		(ii)	 All eight ionisation energies showing an increase ✓ The biggest increase between the sixth and seventh ionisation energy **AND** 8th ionisation energy is higher than 7th ✓	2	**IGNORE** the 2p/2s true jump **IGNORE** line if seen **IGNORE** 0, if included by candidate **IGNORE missing** 1st IE point BUT **DO NOT ALLOW** first ionisation energy higher than second **DO NOT ALLOW** either mark if ionisations energies 3 to 8 inclusive are not shown Place tick for second mark on the x-axis between 6 and 7

Question			Answer	Marks	Guidance
3	(c)			3	**Use annotations ie ticks crosses ECF ^ etc for this part** Comparison should be used for each mark. Look for ORA from perspective of F throughout. **ALLOW** all three marks applied to 'as you go across the period' BUT assume the response refers to 'as you go across the period' if not stated
			Nuclear charge mark O has (one) less proton(s) **OR** O has smaller nuclear charge **OR** F has (one) more proton(s) **OR** F has greater nuclear charge ✓		**ALLOW** O has lower proton number BUT **IGNORE** O has lower atomic number **IGNORE** O has a smaller nucleus **IGNORE** 'O has a smaller charge' ie must be nuclear charge **IGNORE** 'O has smaller effective nuclear charge'
			Atomic radius/shielding mark (Outermost) electrons are in the same shell **OR** energy level **OR** (Outermost) electrons experience the same shielding **OR** Atomic radius of O is larger **OR** Atomic radius of F is smaller ✓		**ALLOW** sub-shell for shell but **IGNORE** orbitals **ALLOW** shielding is similar **ALLOW** outermost electrons of O are further **DO NOT ALLOW** 'distance is the same' for second mark
			Nuclear attraction mark Less nuclear attraction (on outermost electrons) in O **OR** (outer) electrons are attracted less strongly (to the nucleus) in O **OR** More nuclear attraction (on outermost electrons) in F **OR** (outer) electrons are attracted more strongly (to the nucleus) in F ✓		**ALLOW** 'less nuclear pull' for 'less nuclear attraction' **DO NOT ALLOW** 'less nuclear charge' instead of 'less nuclear attraction' for the third mark **IGNORE** 'not pulled as close' for 'pulled less strongly'

Question			Answer	Marks	Guidance
3	(d)		$1s^2\ 2s^2\ 2p^4$ **AND** $1s^2\ 2s^2\ 2p^6$ ✓ (In the reaction) oxygen has formed a **negative ion** (by gaining (two) electrons) ✓	2	**ALLOW** subscripts, capitals **ALLOW** oxidation number of oxygen has decreased **ALLOW** non metals form negative ions **IGNORE** oxygen has gained electrons (this is shown in the electron configurations)
	(e)	(i)	SO_3^{2-} ✓ ClO_2^- ✓	2	
		(ii)	$Al(NO_3)_3$ ✓	1	
		(iii)	Aluminium oxide **OR** aluminium hydroxide ✓ HNO_3 ✓	2	**IGNORE** correct formula (ie Al_2O_3 or $Al(OH)_3$) **DO NOT ALLOW** correct name with incorrect formula **IGNORE** correct name (ie nitric acid or nitric(V) acid) **DO NOT ALLOW** correct formula with incorrect name **ALLOW** one mark for Al_2O_3 or $Al(OH)_3$) **AND** nitric acid or nitric(V) acid (ie name answer and formulae answer has been transposed)
			Total	**16**	

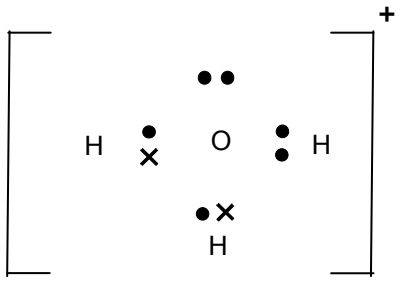
Question			Answer	Marks	Guidance
4	(a)		 Diagram showing a regular arrangement of **labelled** '**Ba^{2+} ions**' or '**2+ ions**' and some attempt to show electrons ✓ Scattering of labelled electrons between other species **AND** statement anywhere of **delocalised** electrons (can be in text or in diagram) ✓ The attraction between (positive) ions and (delocalised) electrons is strong ✓	3	Regular arrangement must have at least two rows of correctly charged ions and a minimum of two ions per row **ALLOW** as label: positive ions, cations if correct charge is seen within circle **ALLOW** for labelled Ba^{2+} ions: circles with **Ba^{2+}** inside **DO NOT ALLOW** incorrect charge for ions eg + , 3+ etc **DO NOT ALLOW** for label of ions: nuclei **OR** positive atom **OR** protons **ALLOW** e^- or 'e' or – as symbol for electron within the lattice for first marking point if not labelled as 'electrons'. **ALLOW** mobile or 'sea of' for delocalised *Quality of written communication:* 'electron(s)' spelled correctly and used in context for the **third** marking point **ALLOW** a lot of energy is needed to break **OR** overcome the attraction between (positive) ions and (delocalised) electrons **IGNORE** 'heat' but **ALLOW** 'heat energy' **DO NOT ALLOW** references to incorrect particles or incorrect attractions eg 'intermolecular attraction' **OR** 'nuclear attraction' **IGNORE** 'strong metallic bonds' without seeing correct description of metallic bonding

Question			Answer	Marks	Guidance
4	(b)	(i)	$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$ $Ba(OH)_2$ as product ✓ Rest of equation + state symbols ✓	2	**ALLOW** multiples
		(ii)	Any value or the range $7 < pH \leq 14$ ✓	1	**DO NOT ALLOW** if pH 7 is in a quoted range
		(iii)	OH^- **OR** HO^- ✓	1	**DO NOT ALLOW** Ba^{2+} **DO NOT ALLOW** any reference to electrons
	(c)		Magnesium hydroxide **OR** magnesium oxide ✓	1	**ALLOW** magnesium carbonate **ALLOW** correct formulae: $Mg(OH)_2$, MgO, $MgCO_3$ **IGNORE** 'milk of magnesia'
	(d)	(i)	Effervescence **OR** fizzing **OR** bubbling **OR** gas produced **AND** Strontium carbonate **OR** solid dissolves **OR** disappears **OR** a colourless solution is formed ✓ $SrCO_3 + 2HCl \rightarrow SrCl_2 + H_2O + CO_2$ ✓	2	**DO NOT ALLOW** 'carbon dioxide produced' without 'gas' **DO NOT ALLOW** 'hydrogen gas produced' **OR** any other named gas **ALLOW** 'it' for strontium carbonate **ALLOW** strontium for strontium carbonate if $SrCO_3$ seen in equation **IGNORE** 'reacts' **IGNORE** references to temperature change **IGNORE** 'steam produced' **IGNORE** state symbols

Question			Answer	Marks	Guidance
4	(d)	(ii)	 Strontium ion with eight (or no) outermost electrons **AND** 2 x chloride (ions) with '*dot-and-cross*' outermost octet ✓ correct charges ✓	2	**For first mark**, if eight 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 Circles **not** essential **ALLOW** One mark if both electron arrangement and charges are correct but only one Cl is drawn **ALLOW** $2[Cl^-]$ $2[Cl]^-$ $[Cl^-]_2$ (brackets not required) **DO NOT ALLOW** $[Cl_2]^-$ $[Cl_2]^{2-}$ $[2Cl]^{2-}$ $[Cl]_2^-$
	(e)	(i)	The mixture would turn orange ✓	1	**ALLOW** shades and colours containing (eg dark orange, yellow-orange) **ALLOW** the following: yellow, yellow-brown, brown, brown-red BUT **DO NOT ALLOW** red alone **IGNORE** initial colours **DO NOT ALLOW** any response that includes 'precipitate' **OR** solid
		(ii)	$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓	1	**ALLOW** multiples **IGNORE** state symbols

Question			Answer	Marks	Guidance
4	e	(iii)	*The electron* GAIN *mark* Chlorine will form a negative ion more easily than bromine **OR** Chlorine will gain an electron more easily than bromine ✓ *Atomic size mark* (An atom of) chlorine is smaller (than bromine) ✓ *Shielding mark* (Outermost shell of) chlorine is less shielded (than bromine) ✓ *Stronger nuclear attraction mark* Nuclear attraction (on the electron to be gained) by chlorine is greater (than bromine) **OR** the electron (to be gained) is attracted more strongly (to the nucleus) in chlorine ✓	4	**Use annotations ie ticks crosses ECF ^ etc for this part** Look for ORA from perspective of Br throughout. **ALLOW** all four marks applied to 'as you go up **OR** as you down the group' **ALLOW** C*l* for chlorine **AND** Br for bromine **ALLOW** ORA **DO NOT ALLOW** the use of 'ide' BUT **ALLOW** use of 'ide' as an ECF **ALLOW** chlorine is better at electron capture **ALLOW** chlorine has greater electron affinity **IGNORE** chlorine is more electronegative **IGNORE** chlorine has more oxidising power than bromine **IGNORE** explanations given in terms of displacement **ALLOW** chlorine has fewer shells **ALLOW** the electron is added to the (outer) shell closer to the nucleus **IGNORE** 'easily' for 'greater' or for 'stronger' **ALLOW** 'chlorine has greater nuclear attraction (on its outermost electrons)' **OR** '(the outermost) electrons in chlorine are more attracted (to the nucleus)'
			Total	**18**	

Question			Answer	Marks	Guidance
5	(a)		*F_2 forces mark* F_2 has van der Waals' (forces) **OR** F_2 has induced dipole attractions **OR** interactions **OR** F_2 has temporary **OR** instantaneous dipole(–dipole) attraction **OR** interactions ✓ *HCl forces mark* HCl has **permanent** dipole(–dipole) attractions **OR** interactions ✓ *Comparison of strength of forces between molecules mark* intermolecular force in HCl is stronger than that in F_2 **OR** permanent dipoles are stronger (than induced dipoles) ✓ *Boiling point mark* more energy is required to break stronger (intermolecular) forces ✓	4	**Use annotations ie ticks crosses ECF ^ etc for this part** **ALLOW** vdWs for van der Waals' **IGNORE** F_2 has covalent bond for this mark **IGNORE** F_2 has 'intermolecular forces' *Quality of written communication:* 'dipole(s)' spelled correctly and used in context for the **second** marking point **IGNORE** HCl has 'intermolecular forces' **IGNORE** van der Waals' forces in HC*l* **DO NOT ALLOW** hydrogen bonding **DO NOT ALLOW** ionic bonding Look for strength of force comparison anywhere in the answer **ALLOW** ECF for hydrogen bonding in HCl being stronger than the stated intermolecular forces in F_2 BUT **DO NOT ALLOW** this mark if HCl or F_2 has covalent bonds broken **OR** if HCl has ionic bonds broken (the question asks for forces between molecules) **IGNORE** HC*l* has stronger van der Waals' (forces) than F_2 (as they both have the same number of electrons) **DO NOT ALLOW** fourth mark if covalent bonds are broken in HC*l* or F_2 **OR** if ionic bonds are broken in HCl **IGNORE** 'heat' but **ALLOW** 'heat energy'

Question			Answer	Marks	Guidance
5	(b)	(i)	 Two *dot-and-cross* bonding pairs of electrons and one dative covalent bond pair of electrons consisting of either two dots or two crosses ✓ **One** non-bonding pair of electrons **AND** which match the dative covalent bond pair of electrons ✓	2	Must be '*dot-and-cross*' Must be H_3O for either mark Circles for shells **not** needed **IGNORE** inner shells **IGNORE** lack of positive charge and square brackets **DO NOT ALLOW** second marking point if negative charge is shown on the ion Non-bonding electrons do **not** have to be seen as a pair **ALLOW** second mark for one non-bonding pair of electrons and three *dot-and-cross* bonding pairs of electrons

Question			Answer	Marks	Guidance
5	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 7.624 OR 7.62 (g) award 3 marks Molar mass of borax = 381.2 (g mol^{-1}) ✓ Correctly calculates the mass of borax in 1000 cm^3 = 0.0800 x 381.2 = 30.496 g **OR** 30.50 g **OR** 30.5g ✓ Correctly calculates the mass of borax in 250 cm^3 = 30.496/4 = 7.624 g **OR** 7.62 g ✓ **OR** Molar mass of borax = 381.2 (g mol^{-1}) ✓ Amount of borax in 250 cm^3 of solution = 0.0800 x 250 /1000 = 0.02(00) mol ✓ Mass of borax = 0.02(00) x 381.2 of borax = 7.624 g **OR** 7.62 g ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** 381 **DO NOT ALLOW** 380 **ALLOW** 0.0800 x [molar mass of borax] correctly calculated for 2nd mark (ie mass of borax in 1000 cm^3) **ALLOW** [mass of borax in 1000 cm^3] / 4 correctly calculated for 3rd mark **ALLOW** calculator value or rounding to **three** significant figures or more **IGNORE** (if seen) a second rounding error **ALLOW** 381 **DO NOT ALLOW** 380 **ALLOW** [incorrect amount of borax] x 381.2 **OR** [incorrect amount of borax] x [incorrect molar mass of borax] **OR** 0.02(00) x [incorrect molar mass of borax] correctly calculated for this mark **ALLOW** calculator value or rounding to **three** significant figures or more **IGNORE** (if seen) a second rounding error

Question			Answer	Marks	Guidance
5	(d)	(i)	Correctly calculates the amount of borax used = 0.0800 x 22.5/1000 = 1.8(0) x 10^{-3} mol **OR** 0.0018(0) mol ✓	1	
		(ii)	Correctly calculates the amount of HC*l* used = 1.8(0) x 10^{-3} x 2 mol = 3.6(0) x 10^{-3} mol **OR** 0.0036(0) mol ✓	1	**ALLOW** [incorrect amount of borax] x 2 correctly calculated for the 2nd mark. **ALLOW** calculator value or rounding to 3 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2
		(iii)	Correctly calculates the concentration of HC*l* = 3.6(0) x 10^{-3} / (25 / 1000) = 0.144 (mol dm^{-3}) ✓	1	**ALLOW** [incorrect amount of HC*l*] / (25/1000) correctly calculated for the 3rd mark given to 3 SF
			Total	**12**	

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

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553