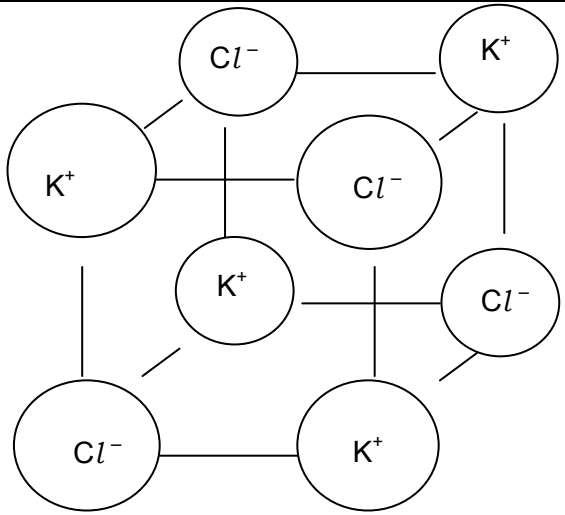
Question			Answer	Marks	Guidance
1	(a)	(i)	**Mass** of the **isotope** compared to 1/12th **OR** **mass** of the **atom** compared to 1/12th ✓ (the mass of an atom of) ^{12}C ✓	2	**ALLOW** for ^{12}C: carbon-12 **OR** C-12 **OR** C 12 **OR** 12C **ALLOW** mass of a **mole** of the isotope **OR** mass of a mole of atoms compared to 1/12th the mass of **mole** or 12 **g** of ^{12}C for two marks **ALLOW** mass of the isotope or mass of the atom compared to ^{12}C which has a mass of 12(.0) for two marks **ALLOW** one mark for responses which have individual atoms compared to one mole of 12C and vice versa eg mass of the isotope or mass of the atom compared to ^{12}C which has a mass of 12(.0) **g** eg mass of an atom compared to 1/12th mass of one mole of ^{12}C eg mass of one mole of atoms compared to 1/12th the mass of an atom of 12C **ALLOW** 2 marks for responses expressed as a fraction eg $\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of } ^{12}C}$ **IGNORE** (weighted) mean **OR** average **DO NOT ALLOW** mass of element or mass of ion
		(ii)	19p and 20n ✓ $^{41}K^{+}$ and 19p ✓	2	Mark by row **ALLOW** 41K+
	(b)		$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ ✓	1	**ALLOW** $1s^2$ repeated **ALLOW** subscripts **AND** upper case etc

Question			Answer	Marks	Guidance
1	(c)	(i)	**First check the answer on the answer line.** **If answer =** 3.01 x 10^{22} award 3 marks 170.1 ✓ (**ALLOW** in working shown as 28.1 + 35.5 x 4) Correctly calculates amount of molecules 8.505 / 170.1 = 0.05(00) mol ✓ Correctly calculates number of molecules 0.05 x 6.02 x 10^{23} = 3.01 x 10^{22} ✓	3	**ALLOW** 0.301 x 10^{23} for three marks If there is an alternative answer, check to see if there is any ECF credit possible using working below. **ALLOW** ECF from incorrect molar mass of $SiCl_4$ **ALLOW** 0.05(00) (mol) for two marks **ALLOW** ECF for incorrect number of mol of $SiCl_4$ **ALLOW** calculator value or rounding to 3 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2. **DO NOT ALLOW** any marks for: 8.505 x 6.02 x 10^{23} = 5.12 x 10^{24}
		(ii)	 4 K and 4 C*l* correctly arranged ✓ 4 K^+ and 4 Cl^- correctly arranged ✓	2	**ALLOW** the structure with **ALL** Cl^- and K^+ transposed **ALLOW** labels if seen outside circles but linked with an arrow eg K^+ → ○
			Total	**10**	

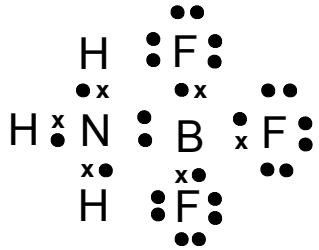
Question			Answer	Marks	Guidance
2	(a)	(i)	Al^{3+} ✓ SO_4^{2-} ✓	2	
		(ii)	$Al_2O_3(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2O(l)$ Correct species **AND** correctly balanced ✓ state symbols on **correct** species ✓	2	**ALLOW** multiples
		(iii)	(The number of) water(s) of crystallisation ✓	1	**IGNORE** hydrated **OR** hydrous **OR** 'contains water'
		(iv)	**First check the answer on the answer line.** **If answer** = 16, award 3 marks Correctly calculates amount of $Al_2(SO_4)_3$: 6.846 / 342.3 = 0.02(00) mol ✓ Correctly calculates amount of H_2O: 5.760 / 18.0 = 0.32(0) mol ✓ Correctly calculates whole number ratio of mol of H_2O: $Al_2(SO_4)_3$ to give ***x*** = 16 ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** as ECF from 12.606/342.3 = 0.0368(273) **AND** 0.32/0.0368(273) To give ***x*** = 9 for two marks **ALLOW** calculator value or rounding to 2 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2. **ALLOW** ECF for calculation of correctly rounded **whole number** value of H_2O from incorrect mol of H_2O and / or incorrect mol of $Al_2(SO_4)_3$ **BUT** ***x*** must be a whole number **ALLOW** alternative method Mol of $Al_2(SO_4)_3$: 6.846 / 342.3 = 0.02(00) mol (first mark) Molar mass of $Al_2(SO_4)_3 \cdot xH_2O$: 12.606 / 0.02(00) = 630.3 g mol^{-1} (second mark) Mass of water per mol = 630.3 – 342.3 = 288 **AND** 288/18 to give ***x*** = 16 (third mark)

Question			Answer	Marks	Guidance
2	(b)	(i)	$Cl_2 + H_2O \rightarrow HCl + HClO$ ✓ H^+ ions are released **OR** HC*l* is acidic **OR** HC*l*O is acidic ✓	2	**ALLOW** HOC*l* **ALLOW** equilibrium sign **IGNORE** state symbols **ALLOW** formulae **OR** names *If correct equation is seen:* **ALLOW** 'product is acidic' **OR** 'acid is produced' **IGNORE** 'the solution is acidic' but **ALLOW** 'the solution formed is acidic' **DO NOT ALLOW** 'chlorine is acidic' ie acidity must be related to the product(s) *If an incorrect equation is seen:* **ALLOW** second mark if H^+ **OR** HC*l* **OR** HC*l*O is given as a product in the equation **AND** is stated as being acidic *If no equation is seen:* **ALLOW** second mark if H^+ **OR** HC*l* **OR** HC*l*O is produced **AND** is stated as being acidic
		(ii)	ClO^- ✓	1	**ALLOW** OCl^-
			Total	**11**	

Question			Answer	Marks	Guidance
3	(a)	(i)	P in P_4 is 0 **AND** in PH_3 is –3 **AND** in NaH_2PO_2 is (+)1 ✓ Phosphorus has been oxidised (from 0) to +1✓ Phosphorus has been reduced (from 0) to –3 ✓	3	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** **ALLOW** oxidation states written above the equation if not seen in the text BUT **IGNORE** oxidation states written above the equation if seen in the text **ALLOW** 3– **AND** 1+ **DO NOT ALLOW ions** **DO NOT ALLOW** P^{3-} in PH_3 **OR** P^{+} in NaH_2PO_2 **DO NOT ALLOW** phosph**ide** or phosph**ine** or phosphate in place of phosphorus **ALLOW** P or P_4 for phosphorus **ALLOW** ECF for the second and third marks if **ONE** incorrect oxidation number is assigned but directional changes are correct eg P = 0 and –3 and +2 instead of 0 and –3 and +1. **IGNORE** references to electron loss / gain If correct oxidation numbers are seen **ALLOW** second **AND** third marking points for: 'Phosphorus is oxidised to form NaH_2PO_2' **AND** 'Phosphorus is reduced to form PH_3' **IF** neither second and third marks have been awarded **ALLOW** for **ONE** mark: Phosphorus has been both oxidised and reduced **OR** Phosphorus's oxidation number has increased and decreased

Question			Answer	Marks	Guidance
3	(a)	(ii)	**First check the answer on the answer line.** **If answer** = 360 (cm^3) award 2 marks Correctly calculates amount of P_4 = 1.86/124.0 = 0.015(0) mol ✓ Correctly calculates volume of PH_3 = 0.015(0) x 24000 = 360 (cm^3) ✓	2	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** ECF for wrong amount of P_4 x 24000 for second mark **ALLOW** one mark for (1.86/31.0) x 24000 = 1440 **DO NOT ALLOW** 2nd mark for 1.86 x 24000 = 44640 **ALLOW** calculator value or rounding to 2 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2.
	(b)		$4PH_3 + 8O_2 \rightarrow P_4O_{10} + 6H_2O$ ✓	1	**ALLOW** correct multiples **IGNORE** state symbols
	(c)	(i)	The hydrogen **ions OR** H^+ **OR** protons (of phosphoric acid) are replaced by sodium **ions OR** Na^+ ✓	1	**ALLOW** Na ions **OR** positive ions replace H ions **OR** metal ions have replaced hydrogen ions **OR** protons **DO NOT ALLOW** Na replaces H. Ions are key in either word or symbol form. **DO NOT ALLOW** incorrect charge on Na ions (eg Na^{2+})
		(ii)	Correctly calculates 0.100 x 15 / 1000 = 1.5(0) x 10^{-3} **OR** 0.0015(0) ✓	1	
		(iii)	22.5 ✓	1	**ALLOW** ECF from (ii) Answer from (ii) x (3/0.2) x 1000
	(d)	(i)	hydrogen bonding ✓ Permanent dipole(–dipole interactions) ✓	2	

Question			Answer	Marks	Guidance
3	(d)	(ii)	the intermolecular forces are weaker in PH_3 ✓	1	**ALLOW** the energy needed to overcome the intermolecular forces in NH_3 is greater Check table in part (i) **IF** NH_3 = hydrogen bonds **AND** PH_3 = permanent dipoles **OR** van der Waal's forces; **ALLOW** 'Hydrogen Bonds are stronger' **ORA** **IF** NH_3 = permanent dipoles **AND** PH_3 = van der Waal's forces; **ALLOW** 'permanent dipoles are stronger' **ORA** **IF** NH_3 = permanent dipoles **AND** PH_3 = permanent dipoles; **ALLOW** 'permanent dipoles are stronger **in NH_3**' **ORA** **DO NOT ALLOW** PH_3 has weaker vdW's than NH_3 **DO NOT ALLOW** NH_3 has stronger hydrogen bonds than PH_3 **DO NOT ALLOW** implication that covalent bonds are broken
	(e)	(i)	Both electrons have been donated by one atom ✓	1	**ALLOW** 'they' for electrons **IGNORE** elements for atom **DO NOT ALLOW** 'transfer' in place of 'donated' **DO NOT ALLOW** more than one electron pair is donated

Question			Answer	Marks	Guidance
3	(e)	(ii)	 Correct '*dot-and-cross*' arrangement of B covalently '*dot-and-cross*' bonded to three F atoms, including full octet on F atoms **AND** Correct '*dot-and-cross*' arrangement of N covalently '*dot-and-cross*' bonded to three H atoms ✓ Dative covalent shown between N and B atoms ✓	2	Must be '*dot-and-cross*', but **ALLOW** other symbols for electrons of third and fourth atoms eg ∆, +, o, etc Circles for outer shells are not needed **IGNORE** inner shells **IGNORE** use of charges Non-bonding electrons of F do not need to be seen as pairs **IGNORE** dative-covalent arrows from N to B, but **DO NOT ALLOW** arrow from B to N **DO NOT ALLOW** two separate molecules for first mark **DO NOT ALLOW** dative covalent bond mark if electron pair matches the B electrons ie to be correct the dative pair must be the same symbol as non-bonding electrons on F atoms if only two symbols are used **DO NOT ALLOW** dative covalent bond mark if F atoms have no non-bonding electrons **UNLESS** B has different electron symbol to N or H atoms
		(iii)	BF_3 = 120(◦) ✓ H_3NBF_3 = 109.5(◦) ✓	2	**ALLOW** 109–110(◦) for H_3NBF_3

Question			Answer	Marks	Guidance
3	(e)	(iv)	(N in) NH_3 has three bonding pairs and one lone pair of electrons ✓ (N in) H_3NBF_3 has **four** bonding pairs (and no lone pairs) of electrons **OR** Lone pair on N now becomes bonding pair ✓ Lone pair of electrons repels **more** than bonding pairs ✓	3	**ALLOW** 'bonds' for 'bonding pairs' **IGNORE** 'electrons repel' **DO NOT ALLOW** 'atoms repel'
			Total	**20**	

Question			Answer	Marks	Guidance
4	(a)			5	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** 'Down the group' is not required **ORA** throughout
			Reactivity increases (down the group) ✓		**ALLOW** alternative phrases for 'reactivity increases'
			Increasing size mark Atomic radius increases **OR** There are more shells ✓		**ALLOW** 'there are more energy levels' **ALLOW** 'electrons are in higher energy levels' **ALLOW** 'electrons are further from the nucleus' **IGNORE** there are more orbitals **OR** more sub-shells **ALLOW** 'different shell' **OR** 'new shell'
			Increased shielding mark There is **more** shielding ✓		There must be clear comparison ie 'more shielding' **OR** 'increased shielding' **ALLOW** there is **more** electron repulsion from inner shells **DO NOT ALLOW** responses which have no comparative eg 'there is shielding'
			Nuclear attraction (to electron) mark Nuclear attraction (to electron) decreases **OR** (outermost) electrons experience less attraction (to nucleus) **OR** Increased nuclear charge is outweighed by increased shielding/distance ✓		**ALLOW** 'there is less nuclear pull' **OR** 'electrons less tightly held' **IGNORE** there is less effective nuclear charge **IGNORE** 'nuclear charge' for 'nuclear attraction' If question is answered in terms of only Group 7, then **ONLY** marks 2, 3 and 4 can be awarded
			Ease of electron loss mark Easier to remove (outer) electron(s) **OR** Ionisation energy decreases ✓		**ALLOW** easier to oxidise
			Quality of written communication *electron(s)* ***OR*** *ionisation* ***OR*** *ionization* ***OR*** *oxidise* ***OR*** *oxidize spelled correctly at least once for last marking point*		

Question			Answer	Marks	Guidance
4	(b)	(i)	$AgNO_3$(aq) **OR** silver nitrate **OR** $AgNO_3$ ✓	1	**ALLOW** Ag^+(aq)
		(ii)	Yellow **AND** precipitate ✓	1	**ALLOW** shades of yellow but not creamy yellow **ALLOW** ppt or solid for precipitate
		(iii)	Ag^+ (aq) + I^-(aq) ➔ AgI(s) ✓	1	**ALLOW** correct multiples
		(iv)	**concentrated** (aqueous) NH_3 ✓	1	
			Total	**9**	

Question			Answer	Marks	Guidance
5	(a)	(i)	*Nuclear charge mark* (Across the period) number of protons increases **OR** greater nuclear charge ✓ ***Quality of written communication*** *– nuclear* ***OR*** *proton(s)* ***OR*** *nucleus spelled correctly ONCE for the first marking point* *Distance / shielding mark* (Outermost) electrons are in the same shell **OR** (Outermost) electrons experience the same shielding **OR** Atomic radius decreases ✓ *Nuclear attraction (to electron) mark* Greater nuclear attraction (on outermost electrons) **OR** (outer) electrons are attracted more strongly (to the nucleus) ✓	3	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** Comparison should be used for each mark **IGNORE** atomic number increases, but **ALLOW** proton number increases **IGNORE** nucleus gets bigger **IGNORE** 'effective nuclear charge increases' **DO NOT ALLOW** 'charge' increases without reference to nuclear **ALLOW** shielding is similar BUT **IGNORE** 'there is shielding' **DO NOT ALLOW** sub-shells **OR** orbitals **ALLOW** greater nuclear pull for greater nuclear attraction **DO NOT ALLOW** use of greater nuclear charge for greater nuclear attraction for third mark
		(ii)	(Diamond and graphite form) **gaseous atoms** (of carbon when they are ionised) ✓	1	**ALLOW** the **atoms** are in the **gaseous** state

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th></th><th>Lithium</th><th>Carbon (diamond)</th><th>Fluorine</th></tr>
<tr><td>Structure</td><td>Giant</td><td>Giant ✓</td><td>Simple</td></tr>
<tr><td>Force or bond overcome on melting</td><td>Metallic bond</td><td>Covalent (bond) ✓</td><td>van der Waals' (forces) OR induced dipoles ✓</td></tr>
<tr><td>Particles between which the force or bond is acting</td><td>Li^+ ions and (delocalised) electrons ✓</td><td>Atoms ✓</td><td>Molecules ✓</td></tr>
</table>
</td><td>6</td><td>ALLOW shared pair of electrons for covalent (bond)

ALLOW vdw for van der Waals'
ALLOW temporary–induced or instantaneous–induced for van der Waals'

ALLOW Positive ions for Li^+ ions
IGNORE 'Lithium ions' but ALLOW 'Positive lithium ions'
DO NOT ALLOW Li^{2+}

IGNORE C and IGNORE F_2
IGNORE diagrams but ALLOW names of particles if seen as a label on a diagram

DO NOT ALLOW implication that covalent bonds are broken in fluorine for the particles mark of fluorine as this implies the particles are atoms</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>10</td><td></td></tr>
</table>

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

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