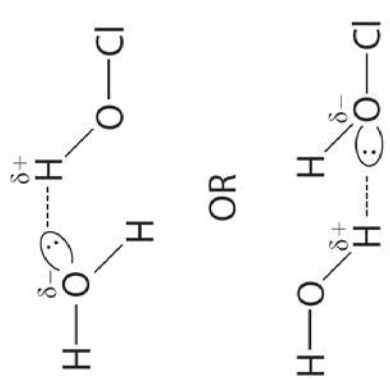


CHEMISTRY AS PAPER 1 MARKSCHEME

Question Number	Answer	Additional Guidance	Mark
1(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • atoms with the same number of protons (1) • with different numbers of neutrons (1) 	<p>Reject 'Elements with the same...'</p> <p>Ignore references to the same number of electrons</p> <p>Ignore 'atoms of the same element that differ only in mass number'</p>	2
1(b)	C		1
1(c)	<ul style="list-style-type: none"> • calculation of % ³⁰Si and substitution into expression showing sum of abundance x mass number ÷ total abundance (1) • evaluation of correct answer to 3 s.f. (1) 	<p><u>Example of calculation:</u></p> $(92.2 \times 28) + \frac{(4.67 \times 29)}{100} + (3.13 \times 30)$ $= 28.1093 = 28.1$ <p>Correct answer with no working to 3.s.f scores 2 marks</p> <p>Ignore any units</p>	2
1(d)	<ul style="list-style-type: none"> • calculation of number of moles of molecules present (1) • use of Avogadro number to convert to number of molecules (1) 	<p><u>Example of calculation:</u></p> <p>number of moles of molecules = $5.67 \div 170.1$ = 0.033333...</p> <p>number of molecules = $0.033333... \times 6.02 \times 10^{23}$ = 2.01×10^{22}</p> <p>Allow 2×10^{22}</p> <p>Correct answer no working scores 2 marks</p>	2

(Total for Question 1 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	<p>An answer that makes reference to the following points:</p> <p>O (atom)</p> <ul style="list-style-type: none"> • has more protons / has greater nuclear charge (1) • has smaller (atomic) radius (than C atom) (1) 	<p>Ignore references to shielding</p> <p>Allow just 'smaller'</p> <p>Allow reverse argument for carbon</p>	2
2(b)	<p>An explanation that makes reference to:</p> <p>(only carbon dioxide is non-polar)</p> <ul style="list-style-type: none"> • because only carbon dioxide is symmetrical / linear (1) <p>OR</p> <p>bond polarities are vectors / vector quantities</p> <ul style="list-style-type: none"> • and therefore the bond polarities cancel (1) 		2

Question Number	Answer	Additional Guidance	Mark
2(c)	 <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • lone pair of electrons on O of one molecule (1) • $\delta+$ symbol on one relevant H atom AND $\delta-$ symbol on one relevant O atom (1) <p>If no representation of a hydrogen bond (by dashed line or similar), then only one of these marks can be awarded</p>	No penalty for showing both possible hydrogen bonds	2

(Total for Question 2 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)	B		1
3(b)(i)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • use a fume cupboard (1) • as chlorine is toxic / poisonous (1) 		2
3(b)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • cool the reaction vessel / surround the flask with cold water (1) • in order to prevent sublimation (of PCl_5) / to prevent the PCl_5 turning into a gas (1) 		2
3(b)(iii)	<ul style="list-style-type: none"> • $\text{PCl}_3 + \text{Cl}_2 \rightarrow \text{PCl}_5$ (1) 	Ignore state symbols, even if incorrect	1

Question Number	Answer	Additional Guidance	Mark
3(c)	<ul style="list-style-type: none"> • calculation of moles PCl_5 (= moles POCl_3) (1) • moles HCl = moles PCl_5 x 5 (1) • volume HCl = moles HCl x 24 dm^3 (1) 	<p>Allow ecf for steps in calculation, ignore significant figures in final answer except one significant figure</p> <p>Correct answer with no working scores 3 marks</p> <p><u>Example of calculation</u></p> <p>Moles $\text{PCl}_5 = \frac{4.17}{208.5} = 0.02(00)$ (mol)</p> <p>Moles $\text{HCl} = 5 \times 0.02(00) = 0.1(00)$ (mol)</p> <p>Volume $\text{HCl} = 0.1 \times 24 = 2.4$ (dm^3)</p>	3

(Total for Question 3 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	D		1
4(b)	<ul style="list-style-type: none"> • calculation of moles AgCl (1) • total moles of Ag in 500 cm³ (where moles Ag = moles AgCl) (1) • calculation of total mass of Ag (1) • evaluation of correct answer to 3.s.f using % by mass of Ag = $\frac{\text{Mass Ag}}{5.00} \times 100\%$ (1) 	<p>allow ecf for steps in calculation; including for final answer dependent on rounding in steps of the calculation.</p> <p>correct answer to 3.s.f with no working scores 4 marks</p> <p><u>Example of calculation</u></p> <p>Moles AgCl = $\frac{0.617}{143.4} = 0.00430..$ (mol)</p> <p>Total moles Ag = $0.00430 \times \frac{500}{50.0} = 0.0430...$</p> <p>Mass Ag = $0.0430 \times 107.9 = 4.6425... = 4.64$ (g)</p> <p>% by mass of Ag = $\frac{4.6425...}{5.00} \times 100\%$ = 92.9 %</p>	4

Question Number	Answer	Additional Guidance	Mark
4(c)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none"> • (a reaction in which an) element (in a species) (1) • is simultaneously oxidised and reduced / for which the oxidation number both increases and decreases (in the same reaction) (1) 	Reject 'atom'	2
4(c)(ii)	C		1

(Total for Question 4 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
5(a)	A		1
5(b)(i)	C		1
5(b)(ii)	$\text{SrCO}_3(\text{s}) \rightarrow \text{SrO}(\text{s}) + \text{CO}_2(\text{g})$ <ul style="list-style-type: none"> • species (1) • state symbols (1) 		2

Question Number	Answer	Additional Guidance	Mark																		
*5(b)(iii)	<p>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="667 1070 957 1350"> <thead> <tr> <th data-bbox="667 1070 810 1350">Number of indicative marking points seen in answer</th> <th data-bbox="667 1070 810 1070"></th> <th data-bbox="810 1070 957 1350">Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td data-bbox="810 1070 847 1350">6</td> <td data-bbox="810 1070 847 1070"></td> <td data-bbox="847 1070 957 1350">4</td> </tr> <tr> <td data-bbox="847 1070 884 1350">5-4</td> <td data-bbox="847 1070 884 1070"></td> <td data-bbox="884 1070 957 1350">3</td> </tr> <tr> <td data-bbox="884 1070 920 1350">3-2</td> <td data-bbox="884 1070 920 1070"></td> <td data-bbox="920 1070 957 1350">2</td> </tr> <tr> <td data-bbox="920 1070 957 1350">1</td> <td data-bbox="920 1070 957 1070"></td> <td data-bbox="957 1070 994 1350">1</td> </tr> <tr> <td data-bbox="957 1070 994 1350">0</td> <td data-bbox="957 1070 994 1070"></td> <td data-bbox="994 1070 1031 1350">0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer		Number of marks awarded for indicative marking points	6		4	5-4		3	3-2		2	1		1	0		0	<p>Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning.</p> <p>For example, an answer with five indicative marking points, which is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</p>	6
Number of indicative marking points seen in answer		Number of marks awarded for indicative marking points																			
6		4																			
5-4		3																			
3-2		2																			
1		1																			
0		0																			

Question Number	Answer	Additional Guidance	Mark								
<p>*5(b)(iii) cont.</p>	<p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table border="1" data-bbox="352 1010 895 1877"> <thead> <tr> <th data-bbox="352 1010 536 1361"></th> <th data-bbox="352 1361 536 1877">Number of marks awarded for structure of answer and sustained line of reasoning</th> </tr> </thead> <tbody> <tr> <td data-bbox="536 1010 715 1361">Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td> <td data-bbox="536 1361 715 1877">2</td> </tr> <tr> <td data-bbox="715 1010 823 1361">Answer is partially structured with some linkages and lines of reasoning.</td> <td data-bbox="715 1361 823 1877">1</td> </tr> <tr> <td data-bbox="823 1010 895 1361">Answer has no linkages between points and is unstructured.</td> <td data-bbox="823 1361 895 1877">0</td> </tr> </tbody> </table> <p>Indicative content:</p> <ul data-bbox="970 987 1388 1832" style="list-style-type: none"> • Cloudiness / milkiness / formation of white ppt due to reaction between limewater and carbon dioxide • The shorter the time (for limewater to go cloudy), the faster the rate of decomposition • Rate of decomposition depends on metal ion size and charge / charge density • B faster than A as Mg^{2+} (radius) smaller than Ca^{2+} • B faster than D as charge density of Mg^{2+} greater than Li^+ / higher charge of Mg^{2+} has more effect than smaller radius of Li^+ • C does not decompose as K^+ has (relatively) large radius and small charge 		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2	Answer is partially structured with some linkages and lines of reasoning.	1	Answer has no linkages between points and is unstructured.	0		
	Number of marks awarded for structure of answer and sustained line of reasoning										
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2										
Answer is partially structured with some linkages and lines of reasoning.	1										
Answer has no linkages between points and is unstructured.	0										

(Total for Question 5 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)	<ul style="list-style-type: none"> • calculation of % by mass of oxygen (1) • evaluation of number of moles of C, H, N and O (1) • confirmation of ratio 1 : 6 : 2 : 2 (1) 	<p>Example of calculation</p> <p>(% by mass of) O = 41.03(%)</p> <p>C : H : N : O</p> $\frac{15.38}{12.0} : \frac{7.69}{1.0} : \frac{35.90}{14.0} : \frac{41.03}{16.0}$ $1.28 : 7.69 : 2.56 : 2.56$ $\frac{1.28}{1.28} : \frac{7.69}{1.28} : \frac{2.56}{1.28} : \frac{2.56}{1.28}$ $= 1 : 6 : 2 : 2$	3

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	<ul style="list-style-type: none"> $\text{H}_2\text{NCOONH}_4 \rightarrow 2\text{NH}_3 + \text{CO}_2$ 	Ignore state symbols, even if incorrect	1
6(b)(ii)	A		1
6(b)(iii)		<ul style="list-style-type: none"> all electron pairs correctly shown for C=O and C—O⁻ (1) correct electron pairs for C—N bond and the —NH₂ group and the lone pair on N (1) 	2

Question Number	Answer	Additional Guidance	Mark
6(b)(iv)	<ul style="list-style-type: none"> • shape: trigonal planar (1) • justification: C=O treated as a single bond pair of electrons/(shape of ion) based on three bond pairs of electrons (around central C atom)/(shape of ion based on) three areas of electron density (around central C atom)/(shape of ion based on) three volumes of electron density (around central C atom) (1) <p>electron pairs/electron regions repel to positions of maximum separation/minimum repulsion (1)</p>	Reject `atoms repel`/`bonds repel`/ Just `electrons repel`	3

(Total for Question 6 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)	<p>An explanation that makes reference to:</p> <ul style="list-style-type: none"> boiling temperatures increase from fluorine to iodine (1) (as) more electrons per (X₂) molecule from fluorine to iodine (1) (therefore the) strength of London forces increases from fluorine to iodine (1) <p>Plus one from:</p> <ul style="list-style-type: none"> (so) more energy required to separate molecules (1) (so) more energy required to break the intermolecular forces (1) 	<p>Allow molecules increase in size / mass from fluorine to iodine</p> <p>Allow 'more London forces' from fluorine to iodine</p> <p>Allow 'more heat' needed to separate molecules</p> <p>Allow more energy required to overcome the intermolecular attractions</p> <p>Reject 'more energy required to break covalent bonds'</p> <p>Allow reverse argument</p>	4
7(b)	D	Allow reverse argument	1
7(c)(i)	<ul style="list-style-type: none"> $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ <p>or</p> <ul style="list-style-type: none"> $\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ (1) 	<p>Allow multiples</p> <p>Ignore state symbols, even if incorrect</p>	1

Question Number	Answer	Additional Guidance	Mark
7(c)(ii)	<ul style="list-style-type: none"> $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O} + \text{Br}_2$ <p>or</p> <ul style="list-style-type: none"> $\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O} + \text{Br}_2$ (1) reducing agent/electron donor/reduces sulfuric acid/reduces H_2SO_4 (1) 	No ecf from (c)(i) Allow multiples Ignore state symbols, even if incorrect	1
7(c)(iii)	<ul style="list-style-type: none"> hydrogen chloride / HCl (1) 		1
7(d)(i)	<p>Observation:</p> <ul style="list-style-type: none"> black solid / grey solid / purple vapour OR pungent gas OR yellow solid OR gas smelling of rotten eggs (1) <p>Equations:</p> <ul style="list-style-type: none"> $\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$ (1) $2\text{HI} + \text{H}_2\text{SO}_4 \rightarrow \text{I}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$ OR $6\text{HI} + \text{H}_2\text{SO}_4 \rightarrow 3\text{I}_2 + \text{S} + 4\text{H}_2\text{O}$ OR $8\text{HI} + \text{H}_2\text{SO}_4 \rightarrow 4\text{I}_2 + \text{H}_2\text{S} + 4\text{H}_2\text{O}$ (1) <p>2nd equation must match observation made</p>	Allow purple solid Allow $2\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{I}$ Allow combinations of both equations for both marks e.g. $2\text{NaI} + 3\text{H}_2\text{SO}_4 \rightarrow 2\text{NaHSO}_4 + \text{I}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$	3
7(d)(ii)		Ignore state symbols	1

Question Number	Answer	Additional Guidance	Mark
7(d)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> iodide ions are better reducing agents (than chloride ions) (1) because iodide ions lose electrons more readily / electrons in iodide ions are less strongly held by the nucleus (1) 	<p>Allow HI is a better reducing agent (than HCl)</p> <p>Allow reverse argument</p>	2

(Total for Question 7 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
8(a)	<ul style="list-style-type: none"> correct calculation of all mean titres (23.15 and 22.25 and 22.30 and 22.70 and 22.20) (1) concordant titres ticked (2, 3 and 5) and calculation of mean titre = 22.25 (cm³) (1) 	(i.e. those that agree within ± 0.20 cm ³)	2
8(b)(i)	<ul style="list-style-type: none"> calculation of number of moles trichloroethanoic acid (= number of moles of NaOH) (1) rearrangement and evaluation of trichloroethanoic acid concentration in mol dm⁻³ (1) evaluation of M_r of trichloroethanoic acid and conversion to concentration in g dm⁻³, to 1 dp (1) 	<p>Allow ecf for steps in calculation; including for final answer dependent on rounding in steps of the calculation.</p> <p>Correct answer with no working to 1dp scores 3 marks</p> <p><u>Example of calculation</u></p> $\text{moles acid} = \text{moles NaOH} = \frac{(0.130 \times 25.0)}{1000}$ $= 3.25 \times 10^{-3} / 0.00325 \text{ (mol)}$ $\text{concentration of acid} = 3.25 \times 10^{-3} \times \frac{1000}{22.25}$ $= 0.146... \text{ mol dm}^{-3}$ $\text{concentration acid in g dm}^{-3} = 0.146... \times 163.5$ $= 23.9 \text{ g dm}^{-3}$	3

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	<ul style="list-style-type: none"> • calculation of number of grams of trichloroethanoic acid in 250 cm³ (1) • calculation of % purity, showing it is < 99.9% (1) <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • conversion of measured mass into theoretical concentration in g dm⁻³ (1) • calculation of % purity, showing it is < 99.9% (1) 	<p><u>Example of calculation:</u></p> <p>mass acid in 250 cm³ = $23.9 \times \frac{250}{1000} = 5.975 \text{ g}$</p> <p>purity = $\frac{5.975}{6.2} \times 100\% = 96.4\%$, which is < 99.9%</p> <p>OR</p> <p>theoretical concentration = $6.2 \times \frac{1000}{250} = 24.8 \text{ g dm}^{-3}$</p> <p>purity = $\frac{23.9}{24.8} \times 100\% = 96.4\%$, which is < 99.9%</p>	2
8(c)(i)	<ul style="list-style-type: none"> • (each mass reading) = 1.61 % and (each pipette reading) = 0.160 % (1) 	<p>Allow ecf on value in (b)(i)</p> <p><u>Example of calculation</u></p> <p>Each mass reading: $(\pm) 2 \times \frac{0.05}{6.2} \times 100\% = 1.61\%$</p> <p>Each pipette volume: $\pm \frac{0.04}{25.0} \times 100\% = 0.160\%$</p>	1
8(c)(ii)	<p>An explanation that makes reference to:</p> <ul style="list-style-type: none"> • Total % error = 2.42% (1) • claim is not correct because 96.4 ± 2.42% is still lower than the manufacturer's value of 99.9% (1) 	<p>ecf on value obtained in (c)(i)</p>	2

Question Number	Answer	Additional Guidance	Mark
8(d)	<p>Maximum three marks for issue identified Maximum three marks for improvement identified which must be linked with associated issue identified</p> <ul style="list-style-type: none"> • issue: mass of (solid) acid not accurately weighed out (1) • improvement: weigh mass of acid by difference/rinse out the weighing bottle/use a balance reading to 2 d.p./use a more precise balance (1) • issue: some acid will be left in the beaker/some acid will not be transferred to the volumetric flask (1) • improvement: rinse out the beaker (in which the solid acid was dissolved) and add the washings to the volumetric flask (1) • issue: insufficient mixing of the solution/concentration of the solution will not be uniform (1) • improvement: invert the volumetric flask (several times) (1) • issue: burette not rinsed (1) • improvement: burette should be rinsed with acid solution before use (1) 	<p>Reject use of a 'more accurate' balance</p> <p>Allow pipette not rinsed with sodium hydroxide</p>	6

(Total for Question 8 = 16 mark)