

**CHEMISTRY AS PAPER 1 MARKSCHEME**

Question Number	Answer	Additional Guidance	Mark
1(a)	An answer that makes reference to the following points: <ul style="list-style-type: none">• atoms with the same number of protons (1)• with different numbers of neutrons (1)	Reject ' Elements with the same...' Ignore references to the same number of electrons Ignore 'atoms of the same element that differ only in mass number'	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)	<u>Example of calculation:</u> $\frac{(92.2 \times 28) + (4.67 \times 29) + (3.13 \times 30)}{100}$ $= 28.1093 = 28.1$ Correct answer with no working to 3.s.f scores 2 marks Ignore any units	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)	<u>Example of calculation:</u> number of moles of molecules = $5.67 \div 170.1 = 0.03333\dots$ number of molecules = $0.03333\dots \times 6.02 \times 10^{23} = 2.01 \times 10^{22}$ Allow 2×10^{22} Correct answer no working scores 2 marks	2

(Total for Question 1 = 7 marks)



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



Question Number	Answer	Additional Guidance	Mark
2(c)	<p>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)	An explanation that makes reference to the following points: <ul style="list-style-type: none">• use a fume cupboard (1)• as chlorine is toxic / poisonous (1)		2
3(b)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none">• cool the reaction vessel / surround the flask with cold water (1)• in order to prevent sublimation (of PCl₅) / to prevent the PCl₅ turning into a gas (1)		2
3(b)(iii)	<ul style="list-style-type: none">• PCl₃ + Cl₂ → PCl₅ (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 PCl_5 = $\frac{4.17}{208.5}$ = 0.02(00) (mol)</p> <p>Moles HCl = 5 x 0.02(00) = 0.1(00) (mol)</p> <p>Volume HCl = 0.1 x 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 = $\frac{4.6425...}{5.00} \times 100\%$</p> <p>= 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="398 667 1200 957"><thead><tr><th data-bbox="398 667 801 775">Number of indicative marking points seen in answer</th><th data-bbox="801 667 1200 775">Number of marks awarded for indicative marking points</th></tr></thead><tbody><tr><td data-bbox="398 775 801 810">6</td><td data-bbox="801 775 1200 810">4</td></tr><tr><td data-bbox="398 810 801 845">5-4</td><td data-bbox="801 810 1200 845">3</td></tr><tr><td data-bbox="398 845 801 880">3-2</td><td data-bbox="801 845 1200 880">2</td></tr><tr><td data-bbox="398 880 801 916">1</td><td data-bbox="801 880 1200 916">1</td></tr><tr><td data-bbox="398 916 801 951">0</td><td data-bbox="801 916 1200 951">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								
*5(b)(iii) cont.	<p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table border="1" data-bbox="394 352 1263 895"><thead><tr><th data-bbox="394 352 909 533"></th><th data-bbox="909 352 1263 533">Number of marks awarded for structure of answer and sustained line of reasoning</th></tr></thead><tbody><tr><td data-bbox="394 533 909 713">Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td data-bbox="909 533 1263 713">2</td></tr><tr><td data-bbox="394 713 909 823">Answer is partially structured with some linkages and lines of reasoning.</td><td data-bbox="909 713 1263 823">1</td></tr><tr><td data-bbox="394 823 909 895">Answer has no linkages between points and is unstructured.</td><td data-bbox="909 823 1263 895">0</td></tr></tbody></table> <p>Indicative content:</p> <ul data-bbox="443 970 1285 1390" style="list-style-type: none">• Cloudiness / milkiness / formation of white ppte 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><u>Example of calculation</u></p> <p>(% by mass of) O = 41.03(%)</p> <p>C : H : N : O</p> <p>$\frac{15.38}{12.0} : \frac{7.69}{1.0} : \frac{35.90}{14.0} : \frac{41.03}{16.0}$</p> <p>1.28 : 7.69 : 2.56 : 2.56</p> <p>$\frac{1.28}{1.28} : \frac{7.69}{1.28} : \frac{2.56}{1.28} : \frac{2.56}{1.28}$</p> <p>= 1 : 6 : 2 : 2</p>	3



Question Number	Answer	Additional Guidance	Mark
6(b)(i)	<ul style="list-style-type: none"> $\text{H}_2\text{NCOONH}_4 \rightarrow 2\text{NH}_3 + \text{CO}_2$ (1) 	Ignore state symbols, even if incorrect	1
6(b)(ii)	A		1
6(b)(iii)	<div style="text-align: center;"> </div> <ul style="list-style-type: none"> all electron pairs correctly shown for $\text{C}=\text{O}$ and $\text{C}-\text{O}^-$ (1) correct electron pairs for $\text{C}-\text{N}$ bond and the $-\text{NH}_2$ 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) electron pairs/electron regions repel to positions of maximum separation/minimum repulsion (1)	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 Reject 'more energy required to break covalent bonds'</p> <p>Allow reverse argument</p>	4
7(b)	D		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) 	No ecf from (c)(i) Allow multiples Ignore state symbols, even if incorrect	1
7(c)(iii)	<ul style="list-style-type: none"> reducing agent/electron donor/reduces sulfuric acid/reduces H_2SO_4 (1) 		1
7(d)(i)	<ul style="list-style-type: none"> hydrogen chloride / HCl (1) 	Ignore state symbols	1
7(d)(ii)	Observation: <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) Equations: <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) 2 nd equation must match observation made	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



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"><li data-bbox="450 379 1256 448">• iodide ions are better reducing agents (than chloride ions) (1)<li data-bbox="450 488 1256 587">• 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)	Allow ecf for steps in calculation; including for final answer dependent on rounding in steps of the calculation. Correct answer with no working to 1dp scores 3 marks <u>Example of calculation</u> $\text{moles acid} = \text{moles NaOH} = \frac{(0.130 \times 25.0)}{1000}$ $= 3.25 \times 10^{-3} / 0.00325 \text{ (mol)}$ $\text{concentration of acid} = 3.25 \times 10^{-3} \times \frac{1000}{22.25}$ $= 0.146... \text{ mol dm}^{-3}$ $\text{concentration acid in g dm}^3 = 0.146... \times 163.5$ $= 23.9 \text{ g dm}^{-3}$	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>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> <p>Allow ecf on value in (b)(i)</p>	2
8(c)(i)	<ul style="list-style-type: none"> (each mass reading) = 1.61 % and (each pipette reading) = 0.160 % (1) 	<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 $96.4 \pm 2.42\%$ is still lower than the manufacturer's value of 99.9% (1) 	ecf on value obtained in (c)(i)	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)

