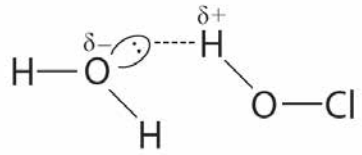
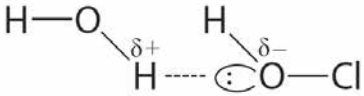
CHEMISTRY AS PAPER 1 MARKSCHEME

Question Number	Answer	Additional Guidance	Mark
1(a)	An answer that makes reference to the following points: • **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)	• calculation of % ^{30}Si and substitution into expression showing sum of abundance x mass number ÷ total abundance (1) • evaluation of correct answer to 3 s.f. (1)	Example of calculation: $\frac{(92.2 \times 28) + (4.67 \times 29) + (3.13 \times 30)}{100}$ (= 28.1093) = 28.1 Correct answer with no working to 3.s.f scores 2 marks Ignore any units	**2**
1(d)	• calculation of number of moles of molecules present (1) • use of Avogadro number to convert to number of molecules (1)	Example of calculation: number of moles of molecules = 5.67 ÷ 170.1 = 0.03333... number of molecules = 0.03333...x 6.02 x 10^{23} = 2.01 x 10^{22} Allow 2 x 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) • 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) • because only carbon dioxide is symmetrical / linear (1) OR bond polarities are vectors / vector quantities • and therefore the bond polarities cancel (1)		**2**

Question Number	Answer	Additional Guidance	Mark
2(c)	 OR  • lone pair of electrons on O of one molecule (1) • δ+ symbol on one relevant H atom AND δ– symbol on one relevant O atom (1) If no representation of a hydrogen bond (by dashed line or similar), then only one of these marks can be awarded	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: • use a fume cupboard (1) • as chlorine is toxic / poisonous (1)		**2**
3(b)(ii)	An explanation that makes reference to the following points: • 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)	• $PCl_3 + Cl_2 \rightarrow PCl_5$ (1)	Ignore state symbols, even if incorrect	**1**

Question Number	Answer	Additional Guidance	Mark
3(c)	• 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)	Allow ecf for steps in calculation, ignore significant figures in final answer except one significant figure Correct answer with no working scores 3 marks Example of calculation Moles PCl_5 = $\frac{4.17}{208.5}$ = 0.02(00) (mol) Moles HCl = 5 x 0.02(00) = 0.1(00) (mol) Volume HCl = 0.1 x 24 = 2.4 (dm^3)	**3**

(Total for Question 3 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	D		**1**
4(b)	• calculation of moles AgCl (1) • total moles of Ag in 500 cm^3 (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 = $\frac{\text{Mass Ag}}{5.00}$ x 100% (1)	allow ecf for steps in calculation; including for final answer dependent on rounding in steps of the calculation. correct answer to 3.s.f with no working scores 4 marks Example of calculation Moles AgCl = $\frac{0.617}{143.4}$ = 0.00430.. (mol) Total moles Ag = 0.00430 x $\frac{500}{50.0}$ = 0.0430... Mass Ag = 0.0430 x 107.9 = 4.6425... = 4.64 (g) % by mass of Ag = $\frac{4.6425...}{5.00}$ x 100% = 92.9 %	**4**

Question Number	Answer	Additional Guidance	Mark
4(c)(i)	An answer that makes reference to the following points: • (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)	$SrCO_3(s) \rightarrow SrO(s) + CO_2(g)$ • species (1) • state symbols (1)		**2**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*5(b)(iii)</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

<table><tr><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr><tr><td>6</td><td>4</td></tr><tr><td>5–4</td><td>3</td></tr><tr><td>3–2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table></td><td>Guidance on how the mark scheme should be applied:
The mark for indicative content should be added to the mark for lines of reasoning.

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).

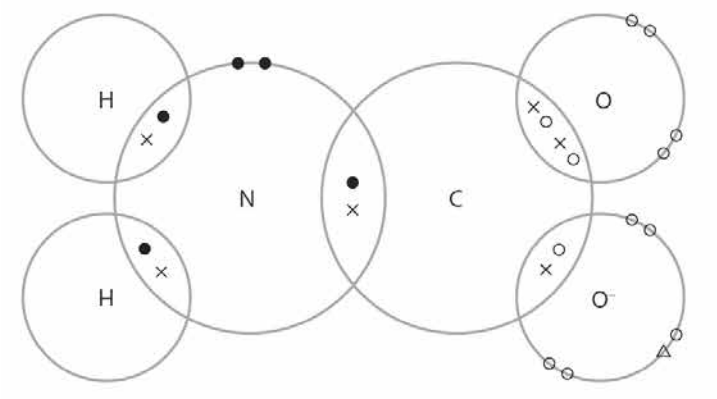
If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td><td>6</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*5(b)(iii) cont.</td><td>The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr>
</table>
Indicative content:

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
</td><td></td><td></td></tr>
</table>

(Total for Question 5 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)	• 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)	Example of calculation (% by mass of) O = 41.03(%) C : H : N : O $\frac{15.38}{12.0} : \frac{7.69}{1.0} : \frac{35.90}{14.0} : \frac{41.03}{16.0}$ 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)	• $H_2NCOONH_4 \rightarrow 2NH_3 + CO_2$ (1)	Ignore state symbols, even if incorrect	**1**
6(b)(ii)	A		**1**
6(b)(iii)	 • all electron pairs correctly shown for C=O **and** C—O$^-$ (1) • correct electron pairs for C—N bond **and** the —NH_2 group **and** the lone pair on N (1)		**2**

Question Number	Answer	Additional Guidance	Mark
6(b)(iv)	• 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)	An explanation that makes reference to: • boiling temperatures **increase** from fluorine to iodine (1) • (as) more electrons per (X_2) molecule from fluorine to iodine (1) • (therefore the) strength of London forces increases from fluorine to iodine (1) Plus **one** from: • (so) more energy required to separate molecules (1) • (so) more energy required to break the intermolecular forces (1)	Allow molecules increase in size / mass from fluorine to iodine Allow 'more London forces' from fluorine to iodine Allow 'more heat' needed to separate molecules Allow more energy required to overcome the intermolecular attractions Reject 'more energy required to break covalent bonds' Allow reverse argument	**4**
7(b)	D		**1**
7(c)(i)	• $H_2SO_4 + 2H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ **or** • $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ (1)	Allow multiples Ignore state symbols, even if incorrect	**1**

Question Number	Answer	Additional Guidance	Mark
7(c)(ii)	• $H_2SO_4 + 2H^+ + 2Br^- \rightarrow SO_2 + 2H_2O + Br_2$ **or** • $SO_4^{2-} + 4H^+ + 2Br^- \rightarrow SO_2 + 2H_2O + Br_2$ (1)	No ecf from (c)(i) Allow multiples Ignore state symbols, even if incorrect	**1**
7(c)(iii)	• reducing agent/electron donor/reduces sulfuric acid/reduces H_2SO_4 (1)		**1**
7(d)(i)	• hydrogen chloride / HCl (1)	Ignore state symbols	**1**
7(d)(ii)	Observation: • black solid / grey solid / purple vapour OR pungent gas OR yellow solid OR gas smelling of rotten eggs (1) Equations: • $NaI + H_2SO_4 \rightarrow NaHSO_4 + HI$ (1) • $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$ OR $6HI + H_2SO_4 \rightarrow 3I_2 + S + 4H_2O$ OR $8HI + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$ (1) 2nd equation must match observation made	Allow purple solid Allow $2NaI + H_2SO_4 \rightarrow Na_2SO_4 + 2I$ Allow combinations of both equations for both marks e.g. $2NaI + 3H_2SO_4 \rightarrow 2NaHSO_4 + I_2 + SO_2 + 2H_2O$	**3**

Question Number	Answer	Additional Guidance	Mark
7(d)(iii)	An explanation that makes reference to the following points: • 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)	Allow HI is a better reducing agent (than HCl) Allow reverse argument	**2**

(Total for Question 7 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
8(a)	• 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 (cm^3) (1)	(i.e. those that agree within ±0.20 cm^3)	**2**
8(b)(i)	• 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 Example of calculation moles acid = moles NaOH = $\frac{0.130 \times 25.0}{1000}$ = 3.25×10^{-3} / 0.00325 (mol) concentration of acid = $3.25 \times 10^{-3} \times \frac{1000}{22.25}$ = 0.146… mol dm^{-3} concentration acid in g dm^3 = 0.146… x 163.5 = 23.9 g dm^{-3}	**3**

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	• calculation of number of grams of trichloroethanoic acid in 250 cm^3 (1) • calculation of % purity, showing it is < 99.9% (1) OR • conversion of measured mass into theoretical concentration in g dm^{-3} (1) • calculation of % purity, showing it is < 99.9% (1)	Example of calculation: mass acid in 250 cm^3 = 23.9 x $\frac{250}{1000}$ = 5.975 g purity = $\frac{5.975}{6.2}$ x 100% = 96.4 %, which is <99.9% OR theoretical concentration = 6.2 x $\frac{1000}{250}$ = 24.8 g dm^{-3} purity = $\frac{23.9}{24.8}$ x 100% = 96.4 %, which is < 99.9% Allow ecf on value in (b)(i)	**2**
8(c)(i)	• (each mass reading) = 1.61 % and (each pipette reading) = 0.160 % (1)	Example of calculation Each mass reading: (±) 2 x $\frac{0.05}{6.2}$ x 100% = 1.61% Each pipette volume: ± $\frac{0.04}{25.0}$ x 100% = 0.160%	**1**
8(c)(ii)	An explanation that makes reference to: • 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)	ecf on value obtained in (c)(i)	**2**

Question Number	Answer	Additional Guidance	Mark
8(d)	Maximum **three** marks for issue identified Maximum **three** marks for improvement identified which must be linked with associated issue identified • 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)	Reject use of a 'more **accurate**' balance Allow pipette not rinsed with sodium hydroxide	**6**

(Total for Question 8 = 16 mark)