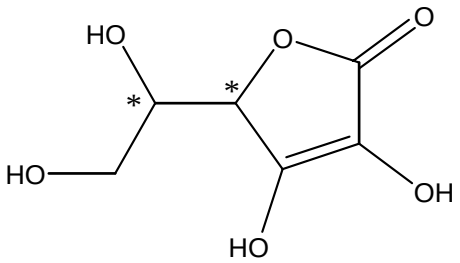
Question Number	Acceptable Answers	Reject	Mark
1 (a)(i)	(vitamin C / ascorbic acid) oxidation / oxidized / oxidised ALLOW oxidisation	Redox / oxidation-reduction / reduction-oxidation	**1**

Question Number	Acceptable Answers	Reject	Mark
1 (a)(ii)	(very) pale yellow / straw coloured **(1)** IGNORE 'just before the end-point' blue-black to colourless (both needed) **(1)** Accept (dark) blue or black ALLOW pale yellow / straw coloured to colourless for 1/2	Just 'yellow' Clear	**2**

Question Number	Acceptable Answers	Reject	Mark
1 (a)(iii)	Moles $S_2O_3^{2-}$ = 27.85 x 10^{-3} x 0.0631 **(1)** (= 1.757335 x 10^{-3}) moles of I_2 remaining = Moles $S_2O_3^{2-}$ ÷ 2 = 27.85 x 10^{-3} x 0.0631 ÷ 2 = 8.786675 x 10^{-4} = 8.79 x 10^{-4} **(1)** Moles ascorbic acid = moles I_2 at start – moles I_2 remaining = 2.00 x 10^{-3} – 8.786675 x 10^{-4} = 1.1213325 x 10^{-3} = 1.12 x 10^{-3} **(1)** M_r (ascorbic acid) = 176 Mass ascorbic acid in 250 cm^3 = 10 x M_r x moles ascorbic acid = 10 x 176 x 1.1213325 x 10^{-3} **(1)** (= 1.97355) Percentage ascorbic acid in tablet 100 x mass ascorbic acid in 250 cm^3 ÷ 2 = 100 x 10 x 176 x 1.1213325 x 10^{-3} ÷ 2 = 98.67726 = 98.7% **(1)** IGNORE SF except 1 SF Premature rounding gives 98.5% (5) Correct answer with no working scores full marks TE at each stage of the calculation.	Answers greater than 100%	**5**

Question Number	Acceptable Answers	Reject	Mark
1(a)(iv)	EITHER Using larger **mass** reduces the percentage error / uncertainty (in weighing) OR Using larger amount reduces the percentage error / uncertainty in **weighing** OR Reverse discussion of two tablets ALLOW using four tablets gives a more representative sample	Just 'reduces the percentage error' Titration value will be larger (with four tablets) so reduces the percentage error (in volume measurement)	**1**

Question Number	Acceptable Answers	Reject	Mark
1 (b)(i)	 **(2)** Mark independently ALLOW any clear indication of chiral centres		**2**

Question Number	Acceptable Answers	Reject	Mark
1 (b)(ii)	**First mark** Use of (plane-)polarized light (mentioned somewhere) **(1)** ALLOW Use a polarimeter **Second mark** Pure optical isomer / enantiomer) **rotates** the **plane** of (plane-) polarized light OR racemic mixture has no effect on the **plane** of (plane-) polarized light **(1)** IGNORE optically active / inactive ALLOW rotates plane-polarized light scores 2		**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(iii)	(Ester group / vitamin C / it) is hydrolysed ALLOW Vitamin C is oxidized Ester / vitamin C is broken down to form carboxylic acid **and** alcohol (groups) IGNORE Just 'breaks down'	C=O is broken Just 'oxidation'	1

Question Number	Acceptable Answers	Reject	Mark
2(a)(i)	(Amount CO_2 = 0.0584 dm^3 ÷ 24 dm^3 mol^{-1}) = 0.0024333/2.4333 x 10^{-3} (mol) IGNORE sf except 1 No working needed Mark final answer	 0.002/2 x 10^{-3} or any other value WRONG units with correct numerical answer scores (0)	**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	**First mark:** amount CO_2 = amount $NaHCO_3$ **OR** use of candidate's answer to (a)(i) stated (or implied by final answer given) **(1)** **Second mark:** ∴ mass $NaHCO_3$ = 0.0024333 (mol) **x 84** (g mol^{-1}) = 0.2044 (g) ALLOW **0.2 (g)** This mark is for evidence of multiplying their moles of $NaHCO_3$ **by 84** **(1)** IGNORE sf including 1 sf Correct answer with no working scores **(2)** ALLOW consequentially from (i).		**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)(iii)	**%** purity **=** (0.2044 g x 100) ÷ 0.227g = 90.04 **%** **(1)** = 90% **(1) (2 sf only)** ALLLOW consequentially from (i) and (ii) NOTE: The second mark to be awarded for 2sf answers less than a 100% (e.g. 10% scores **(1).** This is the percentage **impurity**) Correct answer with no working scores **(2)** Can score both marks via moles rather than masses	Answers not to 2 sf or answers incorrectly rounded up do not score 2nd mark Answers > 100% score **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	0.4 / 58.4 x 100 = (±) 0.68493(%) IGNORE sf (including 1 sf so (±) 0.7 (%) **is** OK here)	(±) 1.37 (%) etc., as the uncertainty should NOT be doubled Answers incorrectly rounded (e.g. 0.684 / 0.67 / 0.68492)	**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	Any one of:- CO_2 dissolves /soluble (in water) CO_2 reacts (with water) / CO_2 forms carbonic acid / $CO_2 + H_2O \rightarrow H_2CO_3$ ALLOW CO_2 absorbed (by water) IGNORE suggestions to use a gas syringe	"CO_2 not the only gas given off" CO_2 diffuses/is lost/mixes with water "Water is also a product of the experiment" "Suck-back"	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(i)	Throughout 20 (a): IGNORE sf except 1 sf (penalise once) correct answer with no working scores full marks mark consequentially IGNORE units unless incorrect $0.109 \times 27.35 \times 10^{-3}$ **(1)** $= 2.98115 \times 10^{-3}$ (mol) $= 2.98 \times 10^{-3}$ / 0.00298(mol) **(1)** cq only on some concentration x some volume	 0.003	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	Moles I_2 = 0.5 x moles thiosulfate **= 0.5 x answer to (a)(i)** $= 1.490575 \times 10^{-3} = 1.49 \times 10^{-3}$ /0.00149(mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(iii)	Moles of Cl_2 = moles of I_2 **= answer to (a)(ii)** $= 1.49 \times 10^{-3}$ /0.00149(mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(iv)	**Mark consequentially on answer in (a)(iii)** Amount in volumetric flask = 25 x answer to (a)(iii) (= 25 x $1.490575 \times 10^{-3} = 3.72644 \times 10^{-2}$) OR ($25 \times 1.49 \times 10^{-3} = 3.725 \times 10^{-2}$) **(1)** (= amount in 10 cm^3 of disinfectant) Concentration = 100 x previous value ($= 1000 \times 3.73 \times 10^{-2}/10 = 3.73$ (mol dm^{-3})) **(1)** Concentration = 100 x answer to (a)(iii) scores **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
3(b)	(Atoms of) the same element (in the same species) are oxidized and reduced **(1)** ALLOW chlorine for 'element' Chlorine ON 0 oxidized to (+)1 in ClO^- **(1)** and reduced to −1 in Cl^- **(1)** Only penalise once if oxidized and reduced omitted Just 'Chlorine ON 0 oxidized to (+)1 and reduced to −1' or 'Chlorine oxidized to chlorate(I) and reduced to chloride'(1 mark only) Only penalise once if oxidized and reduced reversed	Molecule/substance/ reactant /species Just Cl oxidized & reduced	**3**

Question Number	Acceptable Answers	Reject	Mark
3(c)	Colour just before adding the starch: (very) pale yellow/straw coloured **(1)** Colour after adding the starch: Blue-black (ALLOW black or (dark) blue) Colour at the end point: colourless **(1)** **Both** colours required IGNORE 'Clear'	Just 'yellow', brown, gold purple	**2**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (i)	Pestle (and mortar) / mortar and pestle Allow any recognisable spelling eg pessl, morta	Anything else, including hammer, mallet, heavy metal object, spatula, glass rod, crusher, grinder	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (a) (ii)	Methyl /methly orange **(1)** Red to orange / peach (allow yellow) **(1)** Accept other acid–base indicators eg phenolphthalein **(1)** Accept recognisable spelling for all acid-base indicators Correct colour change, the correct way round, to end point or beyond **(1)**	Litmus, Universal Indicator score 0/2	**2**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (i)	(11.20 and 11.40 give) 11.3(0) (cm^3)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (ii)	$\frac{11.3 \times 0.300}{1000} = 3.39 \times 10^{-3}$ / 0.00339 (mol) If mean titre value is 11.47 then 3.44×10^{-3}	Ignore SF unless only one, in which case penalise this only once.	**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (iii)	3.39×10^{-3} (mol) Or answer to (ii)		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (iv)	3.39×10^{-2} (mol) answer (iii) x 10		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (v)	0.05 – 0.0339 = 0.0161 (mol) Or 0.05 – (answer to (iv)) If mean titre value is 11.47 then 0.0156		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (vi)	0.00805 (mol) Or answer to (v) divided by 2 If mean titre value is 11.47 then 0.0078		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (vii)	0.00805 x 100 = 0.805 (g) / 805 **mg** Or answer to (vi) x 100 If mean titre value is 11.47 then 0.780		**1**

Question Number	Acceptable Answers	Reject	Mark
4 (b) (viii)	Reason – there must be some other ant acid present / substance/chemical which reacts with acid	Experimental / calculation error	**1**