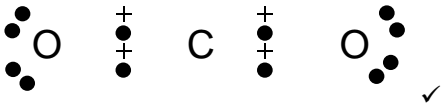
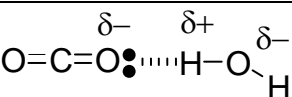
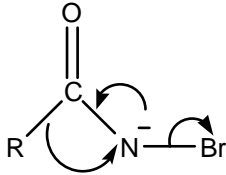
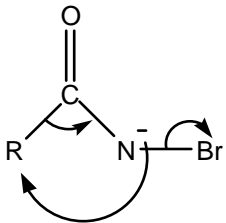
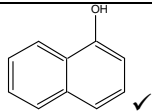


Question			Answer	Marks	Guidance
1	(a)	(i)		1	<p>The additional pages (including pp 9 & 24) will precede this part. Please check them and link any answers to the appropriate part. Please ensure that there is some annotation (default: SEEN) on each page, even if blank</p> <p>Allow '• x' (i.e. electrons in horizontal rather than vertical line)</p> <p>Bond angle is immaterial. Lone pairs can be represented by four electrons anywhere around the oxygens</p>
1	(a)	(ii)	<p>1.(shape is) linear/(bond angle) 180 ✓</p> <p>2. two areas of electron density/ OR two groups/sets of electrons OR two areas of negative charge AND around central atom/ around C ✓</p> <p>3.these OR 'bonding pairs' OR 'electron pairs' repel /repulsion✓</p> <p>4.(electrons) get as far away from each other as possible/ (take up positions to) minimise repulsion ✓</p>	4	<p>IGNORE 'straight', 'planar'</p> <p>IGNORE 'bonds' or 'bonding pairs' in awarding second mark</p> <p>NO ecf from (i) for mpts 1 and 2</p> <p>must be 'around' or 'surrounding' or 'on (the C atom)';</p> <p>ALLOW 'carbon has two electron dense areas'</p> <p>'carbon molecule' is CON</p> <p>3. There must be a clear reference back to the areas/groups etc described in 2. or a restatement</p> <p>4. needs the word 'electron(s)'</p> <p>so: 'electrons repel and get as far away as possible' scores 4. but not 3. 'Bonding pairs repel and get as far away as possible' scores 3. but not 4.</p> <p>ALLOW 'repel as far as possible' for both 3. and 4.</p> <p>NOT 'repel as much as possible' (can score 3. not 4.)</p> <p>IGNORE 'maximise repulsion' for 3.</p>
1	(a)	(iii)	<p>1.oxygen is more <u>electronegative</u> /greater <u>electronegativity</u> (than carbon) ORA✓</p> <p>2.some indication that carbon is slightly/partially positively charged AND oxygen slightly/partially negatively charged ✓</p> <p>3.(no overall dipole since) (bond) <u>polarities</u> /<u>dipoles</u> <u>cancel</u> OR centre of negativity/(negative) charge is on C/ on the middle of molecule/ on the centre of positive charge AW✓</p>	3	<p>1. QWC 'electronegative' (or a derivative, e.g. 'electronegativity') must be spelled correctly to score 1. Must be comparative</p> <p>2. e.g. statement or use of 'delta' terminology</p> <p>'oxygen/carbon <i>molecules</i>' CONs this mark</p> <p>NOT just 'positive' and/or 'negative', must say 'slight' AW for both</p> <p>(unless delta terminology used as well)</p> <p>IGNORE 'negative charges cancel'</p> <p>ALLOW 'polar bonds cancel'</p>

Question			Answer	Marks	Guidance
1	(a)	(iv)	 <p>1. hydrogen bond (shown as in diagram or by dashed line), with bond shown straight (less than 20° angle) with H-O ✓</p> <p>2. partial charges as shown (for any one hydrogen bond) ✓</p> <p>3. lone pair on CO₂ oxygen pointing along bond (for any one hydrogen bond) ✓</p>	3	<p>ALLOW any shapes for molecules (but O-----H-O must be straight for 1.)</p> <p>any incorrect formulae, e.g. HO₂, or bonds (<i>apart from</i> O-C-O) or non-linear O-H-O CON the first mark.</p> <p>Apply this rule for multiple hydrogen bonds. Then look for any correct hydrogen bonds (even different ones and even to H of HO₂) to score marks 2. and 3.</p> <p>IGNORE other partial charges just 'O: ---- H' needed for last mark perpendicular from centre of lone pair must point along bond</p>
1	(a)	(v)	<p>Hydrogen bonds in water ✓</p> <p>weaker/ fewer / less hydrogen bonds between CO₂ and water ORA ✓</p>	2	<p>Do not consider second mark unless the first has been scored</p> <p>must be comparative ALLOW in terms of making and breaking of hydrogen bonds (e.g. 'more energy to break hydrogen bonds in water than released when hydrogen bonds forms between CO₂ and water') IGNORE references to imb between CO₂ molecules IGNORE further explanations</p>
1	(b)	(i)	<p>equilibrium <u>position</u> moves to right/ products ✓</p> <p>increased H⁺ <u>concentration</u> ✓</p>	2	<p>IGNORE 'protons'</p> <p>ALLOW [H⁺]</p> <p>Incorrect pH changes are CON to second mark mark separately (no ecf from mpt 1 to 2)</p>
1	(b)	(ii)	<p>1. pH remains (virtually) unchanged/ resists change to pH (AW) ✓</p> <p>2. when small ✓</p> <p>3. amounts of <u>acid/H⁺</u> or <u>alkali/OH⁻/base</u> added ✓</p> <p>4. large hydrogencarbonate concentration OR hydrogencarbonate concentration similar to CO₂ concentration ✓</p>	4	<p>ALLOW 'resist small changes in pH'</p> <p>Can consider 2. and 3. if 1. not scored (e.g. 'solution resists small additions of acid and alkali') second mark depends on one of acid or alkali being mentioned</p> <p>ALLOW 'acid and alkali'</p> <p>ALLOW 'amount'/ 'quantity' for 'concentration'</p> <p>ALLOW 'excess' or 'reservoir' for 'large concentration'</p> <p>ALLOW 'hydrogen carbonate' or HCO₃⁻ or 'conjugate base'</p> <p>IGNORE 'salt'</p> <p>reference to large [H⁺] is CON to 4.</p> <p>IGNORE 'large [CO₂]' and references to [H₂O]</p>

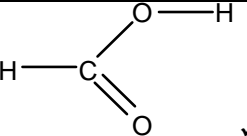
CHERRY HILL TUITION OCR (SALTERS) CHEMISTRY A2 PAPER 31 MARK SCHEME

Question			Answer	Marks	Guidance
1	(c)		CO_3^{2-} /carbonate ✓	1	
1	(d)		<p>($[\text{H}^+]$ concentrations are) 6.62×10^{-9} & $8.53 \times 10^{-9} \text{ (mol dm}^{-3}\text{)}$ OR $10^{-8.179}$ and $10^{-8.069}$ ✓</p> <p>% = '$1.91 \times 100/6.62$' = 29% ✓</p>	2	<p>ALLOW any number of sig figs (including 1sf [30])</p> <p>Correct answer (any number rounding to 29; or 30) without reference to working scores 2 marks</p> <p>Answers based on 8.53 as divisor (numbers rounding to 22 or 20) score 1 without reference to working</p>
1	(e)	(i)	<p>1. equilibrium (position) in equation <u>1.3</u> moves to right/ products ✓</p> <p>2. (equation) <u>1.2</u> moves to the right / products ✓</p> <p>3. CaCO_3/calcium carbonate/shells <u>dissolve</u> ✓</p>	3	<p>Note that here, the word 'position' is not mandatory for the marks</p> <p>must mention equilibrium once to score <i>both</i> 1. and 2., but can score separately without</p> <p>'1.2' and '1.3' must be mentioned to score 1. and 2. respectively mark separately</p> <p>no ecf</p> <p>'concentration of CaCO_3 decreases' is CON of third mark</p> <p>alternatives to 'dissolve' do not score 3.</p>
1	(e)	(ii)	less greenhouse effect (ORA) ✓	1	<p>ALLOW 'less global warming'(ORA)</p> <p>ALLOW e.g. 'less CO_2 in atmosphere that causes the greenhouse effect'</p> <p>IGNORE climate change, greenhouse gases</p> <p>References to ozone depletion are CON</p>
1	(f)		<p>$3.3 \times 10^{-3} \times 10 \times 24000 = 790/792 \text{ cm}^3$ ✓✓</p> <p>answer to 2sf ✓</p>	3	<p>790 scores 3</p> <p>792, 0.79 score 2 ;</p> <p>0.792 scores 1</p> <p>If not one of the above, please annotate where marks scored: <i>Award 1 for either:</i></p> <ul style="list-style-type: none"> • multiplying 3.3×10^{-3} by ten; or • multiplying something by 24000 <p>sf mark can be scored separately for any correct answer to a shown calculation</p>
			Total	29	

Question			Answer	Marks	Guidance
2	(a)	(i)	(primary) amide ✓	1	NOT secondary or tertiary
2	(a)	(ii)	acid-base/ acid-alkali ✓	1	ALLOW elimination or neutralisation
2	(a)	(iii)	 <p>arrow from R–C bond to N (or pointing to an imaginary line between R and N) ✓</p> <p>arrow from minus charge or N atom to C–N bond or C atom ✓</p> <p>arrow from N–Br bond to Br atom ✓</p>	3	<p>ALLOW</p>  <p>arrow from minus or N must point to R or an imaginary line between N and R IGNORE any of these arrows if those on left given</p> <p>ALLOW if lone pair shown on nitrogen and arrow starts at lone pair arrows must hit the start and finishing points described if they are extrapolated backwards and forwards IGNORE extra arrows 'half headed arrows' negate one mark only</p>
2	(b)	(i)	$\text{H}_3\text{C}-\text{N}=\text{C}=\text{O}$ ✓  ✓	2	<p>ALLOW any recognisable structure for naphthol (e.g. Kekule rings)</p> <p>ALLOW methyl isocyanate formula '–N=C=O' or CH_3NCO</p> <p>NOT $\text{R}-\text{N}=\text{C}=\text{O}$</p> <p>IGNORE bond angles in isocyanate</p> <p>ALLOW one mark for both structures correct but in wrong boxes</p>
2	(b)	(ii)	100% atom economy ✓ no <u>waste</u> (at all) ✓	2	<p>mark separately</p> <p>IGNORE 'byproducts' must say or imply 'no waste at all'</p> <p>NOT 'no toxic/harmful waste'. ALLOW 'no atoms wasted' no ecf</p>
2	(c)	(i)	harmful to <u>humans/mammals/animals</u>	1	<p>ALLOW 'toxic/poisonous' for 'harmful', no other words</p> <p>IGNORE references to insects</p>

CHERRY HILL TUITION OCR (SALTERS) CHEMISTRY A2 PAPER 31 MARK SCHEME

Question			Answer	Marks	Guidance
2	(c)	(ii)	<p>1. <u>shape</u> of carbaryl is: same as/ similar to <u>substrate</u> OR complementary to <u>active site/receptor site</u> ✓</p> <p>2. carbaryl binds with the <u>active site/receptor site</u> ✓</p> <p>3. (carbaryl) blocks the <u>active site/receptor site</u> OR (carbaryl) binds with the <u>active/receptor site</u> in place of /better than <u>substrate</u> OR (carbaryl) competes with the <u>substrate</u> OR <u>substrate</u> cannot bind (as well) /enzyme-<u>substrate</u> complex cannot form (as well) OR fewer/less <u>active sites</u> available ✓</p>	3	<p>ALLOW 'it' or 'inhibitor' for 'carbaryl'</p> <p>IGNORE 'pharmacophore' ALLOW 'complimentary'</p> <p>ALLOW 'bonds' 'fits' 'forms complex' instead of 'binds' in 2 and 3.</p> <p>IGNORE references to binding elsewhere and changing shape of enzyme</p>
2	(d)		<p>addition AND forms: no other substance/ no small molecule/ no water / (only) one product or two molecules join to form one molecule AW ✓</p> <p>OR copolymerisation AND two (different) monomers</p>	1	<p>ALLOW 'no loss (of atoms/ molecules)'</p> <p>IGNORE references to other specific small molecules (e.g. HCl) IGNORE 'no waste product'</p>
2	(e)		$\text{RNCO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{RNH}_2$ ✓	1	<p>IGNORE state symbols ALLOW isocyanate or amine represented as a correct structural formula</p>
2	(f)		<p>1. chloromethane/methyl chloride/CH_3Cl ✓</p> <p>2. aluminium chloride/AlCl_3/iron(III) chloride/FeCl_3 ✓</p> <p>3. reflux/anhydrous ✓</p>	3	<p>Mark separately</p> <p>1. IGNORE chloroalkane, benzene</p> <p>'reflux' only scores 3. if one other mark scored</p> <p>extra reagents or catalysts (i.e. more than one reactant and one catalyst) negate one of the first two marks IGNORE 'heat', other extra conditions are CON to mark 3.</p>
			Total	18	

Question			Answer	Marks	Guidance
3	(a)			1	O–H must be displayed to gain mark shape is unimportant
3	(b)	(i)	$\text{CH}_2\text{O}_2 \rightleftharpoons \text{CHO}_2^- + \text{H}^+$ ✓	1	ALLOW structural formulae for anion with atoms in any order and 'OO' for 'O ₂ ') Allow negative charge anywhere. ALLOW H ₂ O added on LHS with H ₃ O ⁺ on right IGNORE '(aq)', other state symbols are CON NOT square brackets
3	(b)	(ii)	$[\text{CHO}_2^-] [\text{H}^+][\text{CH}_2\text{O}_2]$ ✓	1	No ecf from (i) All square brackets must be there and no addition signs IGNORE use of 'HA' for acid, etc ALLOW structural formulae for anion (as above) ALLOW [H ₃ O ⁺] for [H ⁺]
3	(b)	(iii)	$10^{-3.77}$ ✓	1	ALLOW 'antilog(–3.77)' or 'inv(erse)log (–3.77)' ALLOW '–log 1.7 x 10 ^{–4} = 3.77' IGNORE 10 ^{–pK_a} and '3.77 = –logK _a '
3	(b)	(iv)	$[\text{H}^+] (= \sqrt{(1.7 \times 10^{-4} \times 0.004)}) = 8.2 \times 10^{-4} (\text{mol dm}^{-3})$ ✓ pH = 3.08/3.09 (depends on rounding) ✓	2	Calculated answer (to at least 2sf) (with 'H ⁺ ' or '[H ⁺]') needed to score first mpt 3.08/3.09 alone scores both marks [3.1 or numbers with more dp rounding to 3.08/3.09 score 1 mark, without reference to working]
3	(b)	(v)	<u>Concentration</u> of acid at start = concentration of acid at equilibrium (AW) ✓ 0.00082 (ecf) not much smaller than 0.004 AW OR 0.004 – 0.00082/ 0.00318 is not a good approximation (AW) for 0.004 ✓	2	ALLOW as symbols, including [HA] Does not score if '[H ⁺] = [A [–]]' given, but second mark can score if there (among other explanations) ALLOW standard form. Both numbers must be mentioned (or used) and compared to score second mark ALLOW ecf for 0.00082 from (iv), provided number is smaller than 0.001
3	(c)		$2\text{CH}_2\text{O}_2 + \text{CaCO}_3 \rightarrow \text{Ca}(\text{CHO}_2)_2 + \text{CO}_2 + \text{H}_2\text{O}$ methanoic acid formula and CaCO ₃ on left, CO ₂ on right ✓ completely correct ✓	2	ALLOW structural formulae for methanoic acid and methanoate. (see b(i) guidance) ALLOW Ca ²⁺ ('methanoate' [–]) ₂ for salt provided both charges are given. IGNORE state symbols H ₂ CO ₃ for 'CO ₂ + H ₂ O' scores 1 if otherwise correct

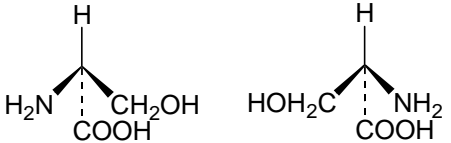
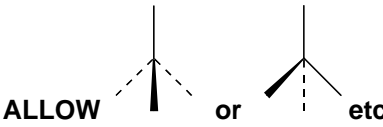
CHERRY HILL TUITION OCR (SALTERS) CHEMISTRY A2 PAPER 31 MARK SCHEME

Question			Answer	Marks	Guidance
3	(d)	(i)	3.77 ✓	1	ALLOW 3.8 or more decimal places that round to 3.77 (Do not allow rounding errors, e.g. 3.76)
3	(d)	(ii)	statement that ratio of $[A^-]/[HA]$ is 3:1 (ORA) ✓ pH = 4.25 ✓	2	ALLOW 4.3 or any more decimal places that round to 4.25 NO ecf Correct pH scores two marks without reference to working ALLOW one mark for 4.07/4.1 (from a 2:1 ratio)
3	(e)	(i)	methanal/structural formula ✓ (only) one proton/H/hydrogen <u>environment</u> ✓	2	ALLOW CH ₂ O if aldehyde mentioned Mark separately IGNORE 'H' IGNORE '(non-)equivalent'
3	(e)	(ii)	1720 – 1740 (cm ⁻¹) AND C=O ✓ 2850 – 2950 (cm ⁻¹) AND C–H ✓ <i>ecf methanoic acid or COOH group</i> 1700 – 1725 (cm ⁻¹) AND C=O 2850 – 2950 (cm ⁻¹) AND C–H 2500 – 3200 (cm ⁻¹) AND O–H <i>all 3 – 2 marks; any 2 – 1 mark</i> <i>ecf methanol</i> 2850 – 2950 (cm ⁻¹) AND C–H ✓ 3600 – 3640 (cm ⁻¹)/3200 – 3600 AND O–H ✓	2	ALLOW these answers even if wrong/no product identified in (i) (apart from those below) ALLOW 3000 – 3100 or 'ca.3300' IGNORE 'in alkanes/ alkenes/alkynes' (for C-H bond) ALLOW one mark for all correct ranges without bonds, but not vice versa no other ecf
3	(f)	(i)	making ammonia/ Haber process /as a fuel/ for hydrogenating oils/ hydrogenation of unsaturated fats/ making margarine/ making HC/ ✓	1	NOT 'biofuel', IGNORE hydrogenation of alkenes ALLOW 'fuel cell' Haber process does not have to be spelled correctly
3	(f)	(ii)	$CH_2O_2 \rightleftharpoons CO_2 + H_2$ AND ($K_c =$) $[CO_2] [H_2]/[CH_2O_2]$ ✓	1	Check for equilibrium sign (accept if over-written over arrow) ALLOW structural formulae ALLOW '(g)' as state symbols – others are CON

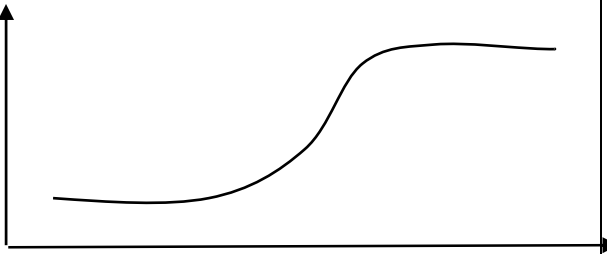
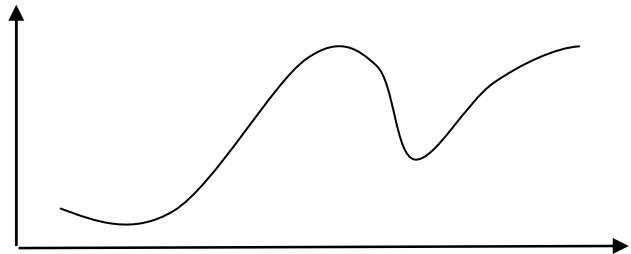
Question			Answer	Marks	Guidance
3	(f)	(iii)	Positive /+ AND more mols/ molecules (of gas) (on right) ORA (AW) OR mixture formed from single substance AW; ✓ more disorder/more ways of arrangement (of particles) (on right) ORA ✓	2	ALLOW 'more products (than reactants)' ALLOW ecf from equation in (ii) (e.g. reversed) NOT just 'two moles on right' for qualifications of 'ways of arrangement': IGNORE products NOT (disorder/ ways of arrangement of) 'a molecule' Mark separately
3	(f)	(iv)	Either of the concentrations given as 0.11 ✓ Concentrations equal ✓	2	ALLOW 0.1 or any number rounding to 0.11 ALLOW ecf <i>only</i> from inverted K_c (gives $5.2(083...) \times 10^{-16}$)
3	(f)	(v)	<i>for low pressure:</i> (can be assumed if not otherwise stated) <u>Equilibrium</u> (position) moves to right/ products (AW) OR greater yield ✓ (accept reverse for high pressure, if stated) Fewer/less molecules/ moles on left/in reactants (ORA) AW ✓	2	Mark separately No ecf from equation in (ii) can deduce which side has fewer molecules from first mark IGNORE 'more products'/ 'less reactants' IGNORE comments about temperature or rates


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Question			Answer	Marks	Guidance
3	(f)	(vi)	<p>1.(Forward) reaction is endothermic (ORA)✓</p> <p>2.<u>equilibrium</u> (position) moves to right AW OR greater (AW) yield (at high temperatures) (ORA)✓</p> <p>3.small ΔH (value)/not very endothermic, hence not much effect /very high temperatures needed AW OR large/good/sufficient yield at 298K OR K_c large ✓</p> <p>4.<u>energy/electricity/fuel</u> (to create high temperatures) is expensive AW ✓</p>	4	<p>No reference to (f)(ii) is needed IGNORE references to rate. 1. this can be implied from the equm movement in 2.</p> <p>2. ALLOW 'more products' etc for 'greater yield' ALLOW 'moves in forward direction' or 'moves in endothermic direction' ALLOW ΔS_{tot} more (positive) at higher T</p> <p>3. ALLOW 'room temp'/'lower temp' for '298K' ALLOW $\Delta H(T)$ small, so small effect on ΔS_{tot}</p> <p>4. NOT just 'uneconomic' as this is in q</p> <p>Mark separately, except: QWC only award 2nd mpt if 1st scored</p>
			Total	29	

Question			Answer	Marks	Guidance
4	(a)	(i)	inert/unreactive/non-reactive ✓	1	
4	(a)	(ii)	high boiling/involatile liquid (on solid/porous support) ✓	1	ALLOW non-volatile ALLOW 'stationary phase' IGNORE sample and carrier gas
4	(a)	(iii)	retention time(s) OR time taken for (compounds) to pass through column ✓	1	ALLOW M_r /molecular mass
4	(b)	(i)	32 ✓ peak of highest mass (or m/z) OR peak furthest to right ✓	2	mark separately IGNORE 'g mol ⁻¹ ' NOT 'g' NOT 'last' or 'highest' peak ALLOW second mpt indicated on diagram – check for this (peak must be labelled 'molecular ion' or 'M ⁺ ') IGNORE references to M+1 peak, C ¹³ etc as peak is too tall
4	(b)	(ii)	CH ₃ ✓ + charge on CH ₃ ✓	2	second mark depends on first IGNORE brackets around CH ₃
4	(b)	(iii)	CH ₃ OH/CH ₄ O ✓	1	IGNORE 'methanol' No ecf from (i) and (ii)
4	(c)	(i)	 <p>one 3-d diagram correct (either side) ✓</p> <p>second 3-d diagram correct and mirror image of first ✓</p>	2	 <p>ALLOW or etc (in diagram with two lines (—), the lines must be adjacent)</p> <p>must have correct connections to atoms for first mark (and for second if first scored) 'fat' wedge can point to several atoms including correct one</p> <p>ALLOW for second mark (if first not scored) 'correct' 3d diagram of mirror image with:</p> <ul style="list-style-type: none"> two lines (—) not adjacent and/or incorrect (but matching) connections to atoms <p>A molecule with incorrect groups does not score either mark</p>
4	(c)	(ii)	(precursors of) life ✓	1	ALLOW any mention of 'life' or 'living things', except that incorrect chemistry CONs, e.g. NOT 'proteins/ amino acids make up DNA' or 'amino acids are produced from DNA' but 'proteins are formed by DNA' is OK

Question			Answer	Marks	Guidance
4	(d)	(i)	$\text{CH}_4 \rightarrow \text{CH}_3 + \text{H} \checkmark$ Initiation \checkmark $\text{CH}_3 + \text{CH}_3 \rightarrow \text{C}_2\text{H}_6 \checkmark$ Termination \checkmark	4	NOT '+uv' or '+hv' or '+hf' in equation (though allow 'initiation' mark here), but these over the over arrow are fine ALLOW doubled IGNORE dots on radicals IGNORE state symbols Each classification mark (e.g. 'initiation') depends on the correct reaction being shown ALLOW structural formulae IGNORE other correctly balanced equations. If the two equation marks are scored, extra incorrect equations CON one of the marks
4	(d)	(ii)	$\text{NC}-\text{CH}_2-\text{CH}_2-\text{CN} \checkmark$ $\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{COOH} \checkmark$	2	ALLOW any <u>structural</u> formulae Mark separately No ecf IGNORE incorrect connections to atoms
			Total	17	

Question			Answer	Marks	Guidance
5	(a)		$3p^6 4s^2 3d^2 / 3p^6 3d^2 4s^2$ ✓ $3p^6 (4s^0 3d^0)$ ✓	2	ALLOW capital letters NOT subscripts for first mark (only) No other ecf
5	(b)		+5 ✓ antimony(V) oxide ✓	2	NOT 5+ IGNORE gaps/lack of gap mark separately but ALLOW ecf for name from a wrong positive oxidation state. 'antimony' must be spelled correctly for second mark NOT 'antimony(V) pentoxide' or 'diantimony(V) oxide' NOT 'oxide(II)'
5	(c)		$\% = 20 \times 47.9 \times 100 / 1996 = 47.996$ ✓✓ One mark for $47.9 \times 100 / 1996$, second mark for multiplying this by 20 and evaluating	2	ALLOW use of 48 for Ar of Ti 47.996 or 2 or more sf rounding to 48, scores 2 without reference to working. (47.9 is a rounding error and scores 1 only, as does 50) 4.8, 2.4, or more sf rounding to these values score one mark without reference to working ALLOW ecf if wrong A _r value used in first marking point
5	(d)		 <p>reflectance</p> <p>wavelength</p> <p>y-axis labelled 'reflectance' ✓ x-axis labelled 'wavelength' / λ (or 'frequency')* ✓ graph starts low (bottom quarter of max reflectance or below), then rises and stays high (top quarter of max reflectance or above) ✓</p>	3	 <p>reflectance</p> <p>wavelength</p> <p>ALLOW as above (i.e. dip below green and red) IGNORE 'intensity' IGNORE units of length for wavelength or 'hz' or 's⁻¹ (allow cm⁻¹)' for frequency, other units are CON colours given that are not consistent with x-axis label (e.g. red...blue for 'wavelength') CON that mark. The curve should in this case be matched to colours, not the label. *Graph must be reversed if x-axis labelled 'frequency' If no label, assume wavelength</p>

Question			Answer	Marks	Guidance
5	(e)		1.d energy level / (3)d subshell /orbitals is split ✓ 2.electrons excited/move up to higher energy levels ✓ 3..... absorb light/ visible photon ✓ 4. $\Delta E = h\nu$ OR frequency/wavelength depends on energy gap(AW) ✓ 5.complementary colour reflected/transmitted ✓	5	IGNORE references to dyes and delocalisation, etc. Splitting due to absorbing light is CON to mark 1. 3. QWC third mark depends on second being scored (reference to d electrons not required) 4. Allow $E = h\nu$ only if it is connected to 'energy change' ALLOW 'colour(s) not absorbed' for 'complementary colour' ALLOW 'complimentary' 5. IGNORE 'emitted' but if light is described as being given out when electrons <i>fall</i> , the only marks that can be awarded are for 1. and 4.)
5	(f)	(i)	(tri)ester ✓	1	IGNORE 'bond'
5	(f)	(ii)	'cis' AND both groups/hydrogens/connections to chain on the same side (of the C=C) ✓	1	
5	(f)	(iii)	1.straight <u>chains/chains</u> not bent/kinked ✓ 2.closer ✓ 3 instantaneous (dipole)-induced dipole bonding (between molecules) is greater/stronger/more AW✓ 4.more energy required to separate (molecules)/ break (AW) (im) bonds ✓	4	ORA in any marking point for cis Assume answers refer to trans unless otherwise stated 1. ALLOW 'linear <u>chains</u> ' 2. ALLOW 'fit more tightly' or 'better packing', 'align better', 'more points of contact' 3. IGNORE abbreviations ALLOW 'Van der Waals' (any spelling) 4. ALLOW '...separate the oils' 2., 3. and 4. (but not necessarily 1.) must be comparative (or appropriate descriptions for cis and trans, e.g. 'cis weak.....trans strong')
5	(g)	(i)	 <div style="display: flex; justify-content: space-around; width: 100%;"> ✓ ✓ </div>	2	mark separately: one mark for I ₂ . one mark for balanced equation with compound showing two I atoms on the two different C atoms with bonds as shown. ALLOW H atoms on bonds (if balanced on reactant and product) and any bond angles.

Question			Answer	Marks	Guidance
5	(g)	(ii)	<p>1. moles thiosulfate = $28 \times 0.02/1000 = 0.00056$ ✓</p> <p>2. moles I_2 left = 0.00028 ✓</p> <p>3. moles I_2 used = $(0.00170 - \text{answer to 2})$ evaluated (= 0.00142) ✓</p> <p>4. mass iodine = $(\text{answer to 3}) \times 253.8$ or evaluated (= 0.360(g)) 4a OR moles I_2 (per 100g) = ans to 3 x 100/0.2 or evaluated (= 0.71) ✓</p> <p>5. iodine number = $(\text{ans to 4}) \times 100/0.2$ evaluated (= 180/181 [depending on Mr value and rounding]) ✓ 5a OR (= ans to 4a x 253.8) evaluated (180/181)</p>	5	<p>If fewer than 5 marks awarded, please annotate and show ticks where marks scored ALLOW standard form ALLOW ecf throughout a correct answer to a later stage scores all marks for the stages before without working (e.g. '0.00142 mol I_2 used' scores 3) ALLOW 2 or more sf for all evaluated values, 1 sf is rounding error.</p> <p>2. ALLOW ECF from (i)</p> <p>3. Allow this mark for subtracting <i>masses</i> of iodine ($0.431 - 0.0711$)</p> <p>4/4a. Either the expression or its evaluation scores Award mpt 4 (if 3 not scored) for any calculated moles (described as such) multiplied by 253.8 or 254 and correctly evaluated. ALLOW 254 for 253.8, in 4 or 5a</p> <p>5. Allow this mark for a recognisable scaling (x500) at any stage.</p> <p>180 /181/ a number rounding to 181 or 180 scores all 5 marks without reference to working. IGNORE 'g'</p> <p>90 and 0.36 and 0.71 score 4 without reference to working.</p>
			Total	27	