OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced GCE

Unit **F335:** Chemistry by Design

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

1. **Annotations**

Annotation	Meaning
	Benefit of doubt
	Contradiction
	Cross
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Not good enough
	Rounding error
	Repeat
	Noted but no credit given
	Error in no. of significant figures
	Tick
	Omission mark

2. **Subject-specific Marking Instructions**

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

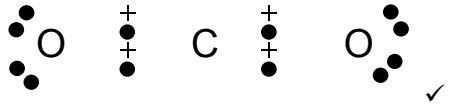
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

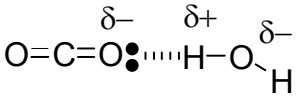
All questions must be annotated with a tick where the mark is given (please refer to Scoris Annotations document from your Team Leader).

Additional objects: You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use a suitable annotation (either ^ or SEEN).

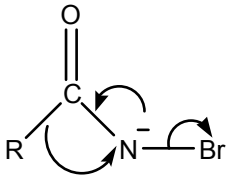
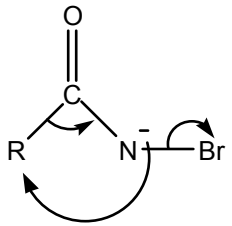
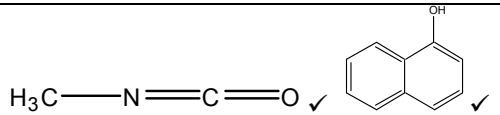
Subject-specific Marking Instructions

• Accept minor mis-spellings where the 'sound' is right (e.g. alcahol), except:
QWC mark
Where it changes a technical term (e.g. alkene/alkane)
• If the answer on the answer line (or in box) differs from a previous answer (copying error), mark the answer on the answer line (or in box).
• If the answer line (or box) is blank, reward the answer elsewhere if possible.
• In calculations, rounding errors should not be rewarded, unless the Mark Scheme indicates otherwise.
• If it says 'mark separately' marks can be awarded even if the answer does not hang together well without the other mark.
However, if the later marking point has words in brackets before it, the mark should only be awarded in the context of those words.
•Formulae must have correct brackets and subscripts to score. Element symbols must have small second letters (e.g. not BA).
These errors and the use of a wrong symbol should, if possible, only result in the loss of ONE mark in a part (rather than more marks).
•Multiples of equations are acceptable (including halves) unless specified otherwise.
•Allow the omission of one plus sign in an equation if the species are still well separated.

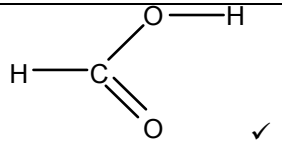
Question			Answer	Marks	Guidance
1	(a)	(i)	 ✓	1	**The additional pages (including pp 9 &24) will precede this part. Please check them and link any answers to the appropriate part. Please ensure that there is some annotation (default: SEEN) on each page, even if blank** Allow '• x' (i.e. electrons in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

Question			Answer	Marks	Guidance
1	(a)	(iv)	 1.hydrogen bond (shown as in diagram or by dashed line), with bond shown straight (less than 20° angle) with H–O ✓ 2.partial charges as shown (for any one hydrogen bond)✓ 3.lone pair on CO_2 oxygen pointing along bond (for any one hydrogen bond)✓	3	**ALLOW** any shapes for molecules (but O-----H-O must be straight for 1.) any incorrect formulae, e.g. HO_2, or bonds (*apart from* O-C-O) or non-linear O-H-O CON the first mark. Apply this rule for multiple hydrogen bonds. Then look for any correct hydrogen bonds (even different ones and even to H of HO_2) to score marks 2. and 3. **IGNORE** other partial charges just 'O: ---- H' needed for last mark perpendicular from centre of lone pair must point along bond
1	(a)	(v)	Hydrogen bonds in water ✓ weaker/ fewer / less hydrogen bonds between CO_2 and water **ORA**✓	2	Do not consider second mark unless the first has been scored 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 CO_2 and water') **IGNORE** references to imb between CO_2 molecules **IGNORE** further explanations
1	(b)	(i)	equilibrium <u>position</u> moves to right/ products ✓ increased H^+ <u>concentration</u> ✓	2	**IGNORE** 'protons' **ALLOW** $[H^+]$ Incorrect pH changes are CON to second mark mark separately (no ecf from mpt 1 to 2)
1	(b)	(ii)	1. pH remains (virtually) unchanged/ resists change to pH (AW) ✓ 2. when small ✓ 3.amounts of <u>acid/H^+ or alkali/OH^-/base</u> added ✓ 4. large hydrogencarbonate concentration **OR** hydrogencarbonate concentration similar to CO_2 concentration ✓	4	**ALLOW** 'resist small changes in pH' 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 **ALLOW** 'acid and alkali' **ALLOW** 'amount'/ 'quantity' for 'concentration' **ALLOW** 'excess' or 'reservoir' for 'large concentration **ALLOW** 'hydrogen carbonate' or HCO_3^- or 'conjugate base' **IGNORE** 'salt' reference to large $[H^+]$ is CON to 4. **IGNORE** 'large $[CO_2]$' and references to $[H_2O]$

Question			Answer	Marks	Guidance
1	(c)		CO_3^{2-}/carbonate ✓	1	
1	(d)		($[H^+]$ concentrations are) 6.62×10^{-9} & 8.53×10^{-9} (mol dm^{-3}) **OR** $10^{-8.179}$ and $10^{-8.069}$ ✓ % = '1.91 x 100/6.62' = 29% ✓	2	**ALLOW** any number of sig figs (including 1sf [30]) Correct answer (any number rounding to 29; or 30) without reference to working scores 2 marks Answers based on 8.53 as divisor (numbers rounding to 22 or 20) score 1 without reference to working
1	(e)	(i)	1.equilibrium (position) in equation 1.3 moves to right/ products ✓ 2. (equation) 1.2 moves to the right / products ✓ 3. $CaCO_3$/calcium carbonate/shells dissolve ✓	3	Note that here, the word 'position' is not mandatory for the marks must mention equilibrium once to score *both* 1. and 2., but can score separately without '1.2' and '1.3' must be mentioned to score 1. and 2. respectively mark separately no ecf 'concentration of $CaCO_3$ decreases' is CON of third mark alternatives to 'dissolve' do not score 3.
1	(e)	(ii)	less greenhouse effect (**ORA**) ✓	1	**ALLOW** 'less global warming'(**ORA**) **ALLOW** e.g. 'less CO_2 in atmosphere that causes the greenhouse effect' **IGNORE** climate change, greenhouse gases References to ozone depletion are CON
1	(f)		$3.3 \times 10^{-3} \times 10 \times 24000 =$ 790/ 792 cm^3 ✓✓ answer to 2sf ✓	3	790 scores 3 792, 0.79 score 2 ; 0.792 scores 1 If not one of the above, please annotate where marks scored: *Award 1 for either*: • multiplying 3.3×10^{-3} by ten; or • multiplying something by 24000 sf mark can be scored separately for any correct answer to a shown calculation
			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)	 arrow from R–C bond to N (or pointing to an imaginary line between R and N) ✓ arrow from minus charge or N atom to C–N bond or C atom✓ arrow from N–Br bond to Br atom ✓	3	**ALLOW**  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 **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
2	(b)	(i)	 ✓ ✓	2	**ALLOW** any recognisable structure for naphthol (e.g. Kekule rings) **ALLOW** methyl isocyanate formula '–N=C=O' or CH_3NCO **NOT** R-N=C=O **IGNORE** bond angles in isocyanate **ALLOW** one mark for both structures correct but in wrong boxes
2	(b)	(ii)	100% atom economy ✓ no <u>waste</u> (at all)✓	2	mark separately **IGNORE** 'byproducts' must say or imply 'no waste at all' **NOT** 'no toxic/harmful waste'. **ALLOW** 'no atoms wasted' no ecf
2	(c)	(i)	harmful to <u>humans/mammals/animals</u>	1	**ALLOW** 'toxic/poisonous' for 'harmful', no other words **IGNORE** references to insects

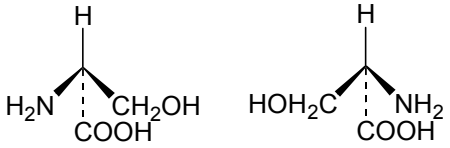
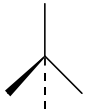
Question			Answer	Marks	Guidance
2	(c)	(ii)	1. shape of carbaryl is: same as/ similar to substrate **OR** complementary to active site/receptor site ✓ 2. carbaryl binds with the active site/receptor site ✓ 3. (carbaryl) blocks the active site/receptor site **OR** (carbaryl) binds with the active/receptor site in place of /better than substrate **OR** (carbaryl) competes with the substrate **OR** substrate cannot bind (as well) /enzyme-substrate complex cannot form (as well) **OR** fewer/less active sites available ✓	3	**ALLOW** 'it' or 'inhibitor' for 'carbaryl' **IGNORE** 'pharmacophore' **ALLOW** 'complimentary' **ALLOW** 'bonds' 'fits' 'forms complex' instead of 'binds' in 2 and 3. **IGNORE** references to binding elsewhere and changing shape of enzyme
2	(d)		addition **AND** forms: no other substance/ no small molecule/ no water ***I***(only) one product **or** two molecules join to form one molecule AW ✓ **OR** copolymerisation **AND** two (different) monomers	1	**ALLOW** 'no loss (of atoms/ molecules)' **IGNORE** references to other specific small molecules (e.g. HCl) **IGNORE** 'no waste product'
2	(e)		$RNCO + H_2O \rightarrow CO_2 + RNH_2$ ✓	1	**IGNORE** state symbols **ALLOW** isocyanate or amine represented as a correct structural formula
2	(f)		1. chloromethane/methyl chloride/CH_3Cl ✓ 2. aluminium chloride/$AlCl_3$/iron(III) chloride/$FeCl_3$ ✓ 3.reflux/anhydrous ✓	3	Mark separately 1. **IGNORE** chloroalkane, benzene 'reflux' only scores 3. if one other mark scored 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.
			Total	**18**	

Question			Answer	Marks	Guidance
3	(a)		 ✓	1	O–H must be displayed to gain mark shape is unimportant
3	(b)	(i)	$CH_2O_2 \rightleftharpoons CHO_2^- + H^+$ ✓	1	**ALLOW** structural formulae for anion with atoms in any order and 'OO' for 'O_2') Allow negative charge anywhere. **ALLOW** H_2O added on LHS with H_3O^+ on right **IGNORE** '(aq)', other state symbols are CON **NOT** square brackets
3	(b)	(ii)	$[CHO_2^-]\,[H^+]/[CH_2O_2]$ ✓	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** $[H_3O^+]$ for $[H^+]$
3	(b)	(iii)	$10^{-3.77}$ ✓	1	**ALLOW** 'antilog(–3.77)' or 'inv(erse)log (–3.77)' **ALLOW** '–log $1.7 \times 10^{-4} = 3.77$' **IGNORE** 10^{-pKa} and '$3.77 = -\log K_a$'
3	(b)	(iv)	$[H^+]$ (= $\sqrt{(1.7 \times 10^{-4} \times 0.004)} = 8.2 \times 10^{-4}$ (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)	Concentration of acid at start = concentration of acid at equilbrium (**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)		$2CH_2O_2 + CaCO_3 \rightarrow Ca(CHO_2)_2 + CO_2 + H_2O$ 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_2CO_3 for '$CO_2 + H_2O$' scores 1 if otherwise correct

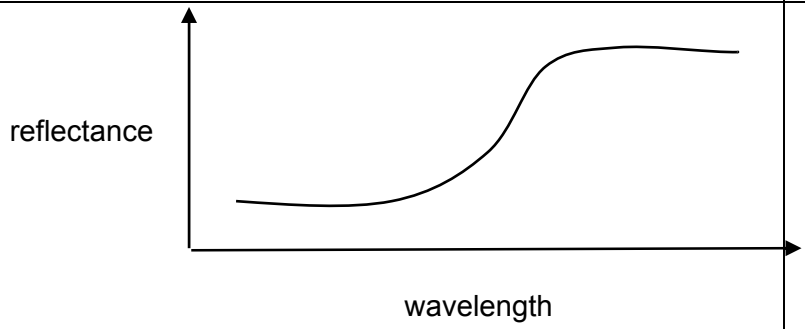
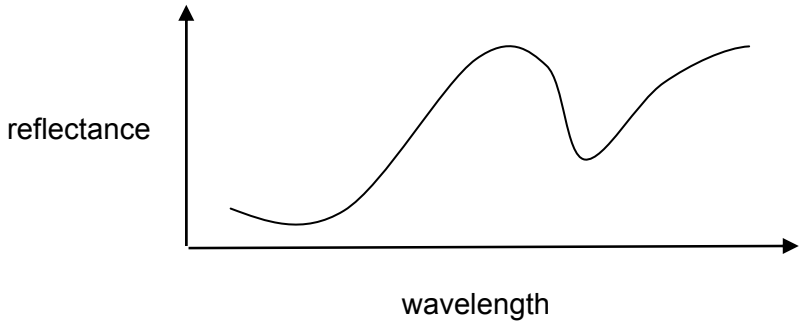
Question			Answer	Marks	Guidance
3	(d)	(i)	3.77 ✓	1	**ALLOW** 3.8 or more decimal places that round to 3.77 (Do not allow rounding errors, e.g. 3.76)
3	(d)	(ii)	statement that ratio of $[A^-]/[HA]$ is 3:1 (**ORA**) ✓ pH = 4.25 ✓	2	**ALLOW** 4.3 or any more decimal places that round to 4.25 **NO** ecf 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 environment ✓	2	**ALLOW** CH_2O 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 ✓ *ecf methanoic acid or COOH group* 1700 – 1725 (cm^{-1}) **AND** C=O 2850 – 2950 (cm^{-1}) **AND** C–H 2500 – 3200 (cm^{-1}) **AND** O–H *all 3 – 2 marks; any 2 – 1 mark* *ecf methanol* 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/akynes' (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*l* ✓	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

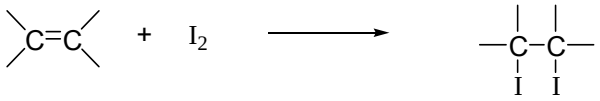
Question			Answer	Marks	Guidance
3	(f)	(iii)	Positive /+ **AND** more mols/ molecules (of gas) (on right) **ORA** (AW) **OR** mixture formed from single substance AW; ✓ more disorder/more ways of arrangement (of particles) (on right) **ORA** ✓	2	**ALLOW '**more products (than reactants)' **ALLOW** ecf 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 *only* from inverted *Kc* (gives 5.2(083...) x 10^{-16})
3	(f)	(v)	*for low pressure*: (can be assumed if not otherwise stated) Equilibrium (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

Question			Answer	Marks	Guidance
3	(f)	(vi)	1.(Forward) reaction is endothermic (**ORA**)✓ 2.<u>equilibrium</u> (position) moves to right AW **OR** greater (AW) yield (at high temperatures) (**ORA**)✓ 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 ✓ 4.<u>energy/electricity/fuel</u> (to create high temperatures) is expensive AW ✓	4	No reference to (f)(ii) is needed **IGNORE** references to rate. 1. this can be implied from the equm movement in 2. 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 3. **ALLOW** 'room temp'/ 'lower temp' for '298K' **ALLOW** ΔH(/T)small, so small effect on ΔS_{tot} 4. **NOT** just 'uneconomic' as this is in q Mark separately, except: **QWC** only award 2nd mpt if 1st scored
			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_3OH/CH_4O✓	1	**IGNORE '**methanol' No ecf from (i) and (ii)
4	(c)	(i)	 one 3-d diagram correct (either side) ✓ second 3-d diagram correct and mirror image of first ✓	2	**ALLOW**  **or**  **etc** (in diagram with two lines (—), the lines must be adjacent) 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 **ALLOW** for second mark (if first not scored) 'correct' 3d diagram of mirror image with: • two lines (—) not adjacent and/or • incorrect (but matching) connections to atoms A molecule with incorrect groups does not score either mark
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)	$CH_4 \rightarrow CH_3 + H$ ✓ Initiation ✓ $CH_3 + CH_3 \rightarrow C_2H_6$ ✓ Termination ✓	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)	$NC–CH_2–CH_2–CN$ ✓ $HOOC–CH_2–CH_2–COOH$ ✓	2	**ALLOW** any structural formulae Mark separately No ecf **IGNORE** incorrect connections to atoms
			Total	**17**	

Question			Answer	Marks	Guidance
5	(a)		$3p^6\ 4s^2\ 3d^2 / 3p^6\ 3d^2\ 4s^2$ ✓ $3p^6\ (4s^o\ 3d^o)$ ✓	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 x 47.9 x 100/1996 = 47.996 ✓✓ One mark for 47.9 x 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)		 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) ✓	3	 **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

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.ΔE=hv **OR** frequency/wavelength depends on energy gap(AW) ✓ 5.<u>complementary</u> 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=hv 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 *fall,* 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</u>/<u>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)	 ✓ ✓	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)	1.moles thiosulfate = 28 x 0.02/1000 = 0.00056 ✓ 2.moles I_2 left = 0.00028 ✓ 3.moles I_2 used = (0.00170 – answer to 2)) evaluated (= 0.00142) ✓ 4.mass iodine = (answer to 3) x 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)** ✓ 5.iodine number (= (ans to 4) x 100/0.2) evaluated (= 180/181 [depending on Mr value and rounding]) ✓ **5a OR (= ans to 4a x 253.8) evaluated (180/181)**	5	**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. 2**. ALLOW ECF** from (i**)** 3**.** Allow this mark for subtracting *mass*es of iodine (0.431 – 0.0711) 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 5. Allow this mark for a recognisable scaling (x500) at any stage. 180 /181/ a number rounding to 181 or 180 scores all 5 marks without reference to working. **IGNORE** 'g' 90 and 0.36 and 0.71 score 4 without reference to working.
			Total	**27**	

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