Chirality

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Rates, Equilibria & Further Organic Chemistry
Sub Topic	Chirality
Booklet	Mark Scheme 1

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Mark
1(a)	C	1

Question Number	Correct Answer	Mark
1(b)	A	1

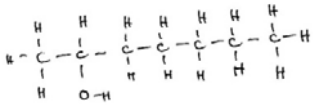
Question Number	Correct Answer	Mark
1(c)	D	1

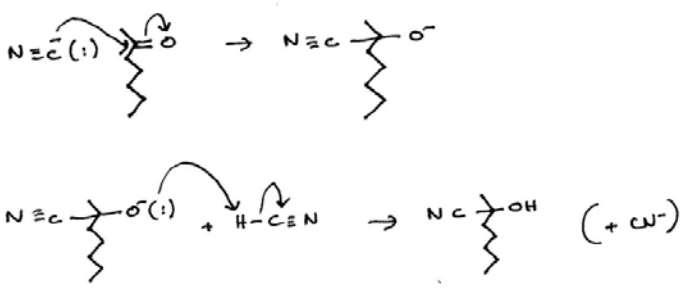
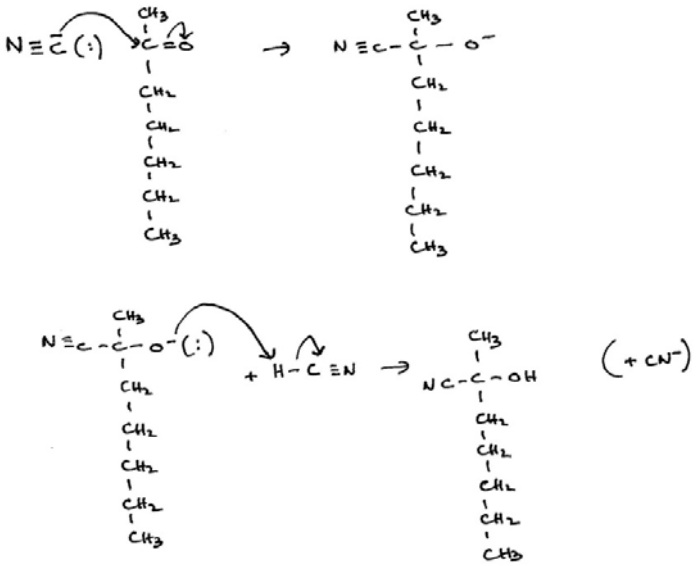
Question Number	Acceptable Answers	Reject	Mark
2a	Heptan-2-one ALLOW Hept-2-one Hepta-2-one Heptane-2-one 2-heptanone	Heptanone	1

Question Number	Acceptable Answers	Reject	Mark
2b	(Warm with) iodine and sodium hydroxide/ iodine in the presence of alkali **(1)** EITHER Yellow **and** precipitate with **A only** OR Yellow **and** precipitate with **A**, no change with **B** ALLOW Antiseptic smell with **A only** ALLOW Correct result following use of just 'iodoform test' for second mark **(1)**	Just 'iodoform test' Measure the melting point of the hydrazone	2

Question Number	Acceptable Answers	Reject	Mark
2c	Test 2 may be given before test 1 Allow a correct result with a nearly correct test eg no acid in dichromate test scores 0 for test but scores 1 for the result remains orange Test 1: (Warm with) Brady's reagent / (2,4-)dinitrophenylhydrazine / (2,4)DNP(H) **(1)** Yellow/ orange/ red **and** precipitate/ solid/ crystals **and** confirms C=O/ carbonyl/ aldehyde or ketone **(1)** Test 2: Any one from (Warm/boil with) Fehling's solution/ Benedict's solution **(1)** No red-brown/ brown/ orange ppt / stays blue, confirms not an aldehyde ALLOW No reaction confirms not an aldehyde/ so it is a ketone **(1)** OR Test 2: (Warm with) Tollens' reagent/ ammoniacal silver nitrate **(1)** No silver mirror/ grey black or silver ppt confirms not an aldehyde ALLOW No reaction confirms not an aldehyde/ so it is a ketone **(1)** OR (Warm with) potassium/sodium dichromate((VI)) **and** sulfuric acid/ $Cr_2O_7^{2-}$ **and** H^+ ALLOW (Warm with) acidified (potassium/ sodium) dichromate((VI)) **(1)** remains orange / does not go green confirms not an aldehyde ALLOW No reaction confirms not an aldehyde/ so it is a ketone **(1)**		4

	Additional Comments READ (b) and (c) TOGETHER DNPH test in (b) scores 0 but if DNPH test is given correctly in (b) allow up to 2 marks for this test in in (c)		

Question Number	Acceptable Answers	Reject	Mark
2d	 OR $CH_3CH(OH)(CH_2)_4CH_3$ / $CH_3CH(OH)CH_2CH_2CH_2CH_2CH_3$ **(1)** Lithium tetrahydridoaluminate((III))/ lithium aluminium hydride / $LiAlH_4$ (in dry ether) ALLOW $NaBH_4$ / sodium borohydride H_2 + Ni/Pt/ Pd catalyst **(1)**	Skeletal formula Lack of hydrogens	2

Question Number	Acceptable Answers	Reject	Mark
2e(i)	 ALLOW  Arrow from any part of CN^- (including a lone pair on either the carbon or nitrogen)to **carbon** of C=O **and** Arrow from part of C=O double bond to oxygen ALLOW CN^- can approach from LHS or RHS of A Two steps via charged canonical form **(1)** Negatively charged intermediate with C-CN bond **(1)** Arrow from resulting O^- to hydrogen of HCN/ H^+/ H_2O Do not penalise incorrect or absent arrow between H and CN **(1)** IGNORE Dipoles on C=O	CN without negative charge C-N-C Penalise once only	3

Question Number	Acceptable Answers	Reject	Mark
2e(ii)	Forms a racemic mixture / racemate **(1)** Cyanide can attack (equally) from either side/ above or below **(1)** Because bonds round C=O are (trigonal) planar / \ C=O is planar / OR Carbonyl group / C=O **group** / reaction site is planar OR Bonds around carbonyl carbon are planar **(1)**	Ketone/ the molecule is planar C=O is planar carbocation / intermediate is planar	3

(Total for Question 2 = 15 marks)

Question Number	Acceptable Answers	Reject	Mark
3(a)	ethyl dodecanoate **Allow** ethyldodecanoate ethyl dodecan-1-oate	ethyl decanoate / ethyl dodecanal/ ethyl dodecate / ethanoyl dodecanoate	**1**

Question Number	Acceptable Answers	Mark
3(b)	Reducing (agent) **Allow** (source of) nucleophile **Ignore** source of hydride ions	**1**

Question Number	Acceptable Answers	Mark
3(c)	Prevent further reduction / reduction of the aldehyde (to an alcohol) **Allow** to prevent further reaction of dodecanal /aldehyde **Ignore** reference to rates **Ignore** higher yield/ prevent side reactions **Ignore** exothermic / optimum temperature **Ignore** volatility	**1**

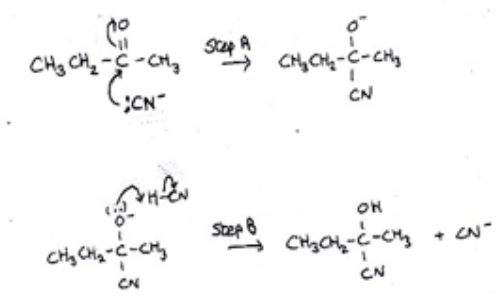
Question Number	Acceptable Answers	Mark
3(d)	**If final answer is 3.74 (g), with or without working, award 3 marks** Moles ester = 5.26 / 228 = 0.02307 mol **NOTE**: Do not allow this rounded to 0.02 **(1)** **EITHER** So mass of aldehyde at 100% = 0.02307 x 184 = 4.2449 (g) **(1)** But yield is 88%, so actual mass = 4.245 x 0.88 = 3.7355 / 3.74 (g) Allow 3.73 g if 4.24 g of aldehyde used **(1)** **OR** But yield is 88%, so actual moles = 0.02307 x 0.88 = 0.02(03) **(1)** So mass of aldehyde formed = 0.0203 x 184 = 3.7355 / 3.74 /3.7 (g) **(1)** **Allow** TE for 2nd and 3rd marks Ignore SF in final answer except 1SF	**3**

Total for Question 3 = 6 marks

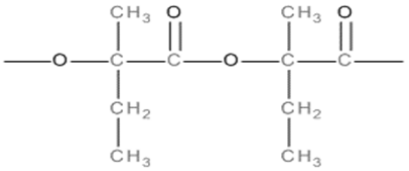
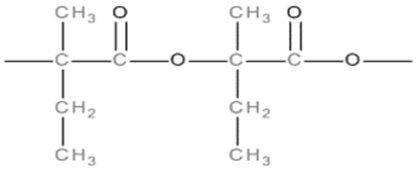
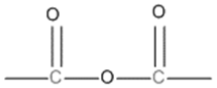
Question Number	Acceptable Answers	Reject	Mark
4(a)	**First mark** mix/add the reagents **and** filter **OR** react butanone/ketone with Brady's reagent/2,4-dinitrophenylhydrazine **and** filter **OR** filter the (yellow/orange) precipitate formed **(1)** **Second mark** recrystallize **OR** description of recrystallization **ALLOW** this mark even if the ppt is not filtered **(1)** **Third mark** measure the melting temperature (of derivative of butanone) **and** compare with data book /reference / literature value **(1)** **Stand alone marks**	 Just 'crystallisation' if the precipitate has not been filtered Just 'characteristic melting temperature'	**(3)**

Question Number	Acceptable Answers	Reject	Mark
4(b)(i)	nucleophilic **(1)** addition **(1)** answers can be in any order **IGNORE** heterolytic	hydrolysis/ reduction S_N1 or S_N2	**(2)**

Question Number	Acceptable Answers	Reject	Mark
4(b)(ii)	**Method 1** acid hydrolysis Name or formula of any strong acid eg (dilute) hydrochloric acid/ (dilute) sulfuric acid **(1)** **IGNORE** dilute acid / $H^+(aq)$/ just 'H^+' Boil/heat /reflux **Conditional** on acid as the **only** reagent **ALLOW** high temperature **(1)** **Method 2** alkaline hydrolysis Sodium hydroxide solution/ dilute sodium hydroxide/ NaOH(aq) **and** boil/heat /reflux **(1)** then add dilute acid / $H^+(aq)$/dilute hydrochloric acid/ dilute sulfuric acid **(1)**	Just 'concentrated sulfuric acid ' Potassium dichromate(VI) and dilute sulfuric acid Just 'warm'	**(2)**

Question Number	Acceptable Answers	Reject	Mark
4(b)(iii)	 **First mark** **both** curly arrows on the first diagram arrow from C of CN^- to C of carbonyl **and** arrow from double bond to O **ALLOW** curly arrow from the - sign but not from the N **(1)** **IGNORE** correct dipoles **Second mark** lone pair on C of CN^- correct **(1)** **IGNORE** other lone pairs, even if incorrect **Third mark** **both** curly arrows on the third diagram arrow from O to H **and** from bond to **C** of CN **ALLOW** curly arrow to gap between C and N **(1)**	full charges on C / O incorrect dipole on C=O arrow directly to N of CN	**(3)**

Question Number	Acceptable Answers	Reject	Mark
4(b)(iv)	**First mark** a racemic mixture/racemate forms **OR** equal amounts of the two optical isomers /enantiomers / D-L isomers / (+) and (-) isomers /R-S isomers **(1)** **Second mark** the molecule is (trigonal) planar **around** C=O /carbonyl group /reaction site **(1)** **Third mark** (equal probability of) the CN^- ion/nucleophile attacking (the C of C=O) from above or below/either side/both sides of (the plane) **(1)**	For second mark only: mention of carbocation OR C=O/carbonyl carbon atom is planar OR intermediate is planar OR the molecule /butanone / ketone is planar	**(3)**

Question Number	Acceptable Answers	Reject	Mark
4(c)	 **OR**  **ALLOW** any combination of displayed structure/ structural formula /skeletal formulae ester group correct **ALLOW** –COOC- **(1)** rest of polymer correct **ALLOW** C_2H_5 **ALLOW** more than 2 repeat units **Conditional** on ester group correct **(1)** **IGNORE** n and square brackets	 in polymer scores **(0)** more than 1 H missing from a bond	**(2)**

(Total for Question 4 = 15 marks)

Question Number	Acceptable Answers	Mark
5(a)(i)	**Penalise lack of + sign once only in (a)(i) or (ii) in each final answer** **IGNORE** sf in (a)(i), (ii), and (iii) in each final answer, except 1 sf **FIRST, CHECK THE FINAL ANSWER** +479.7 J mol^{-1} K^{-1} scores **3** marks 479.7 J mol^{-1} K^{-1} scores **2** marks (+ sign missing) +479.7/ 479.7 scores **2** marks (units and/or + missing) +1709.7 J mol^{-1} K^{-1} scores **2** marks – multiple of 12 used for oxygen 1709.7 J mol^{-1} K^{-1}/ +1709.7/ 1709.7 score **1** mark – multiple of 12 used for oxygen and positive sign and/or units If these answers are not given, award marks as follows: **First mark** correct data for CO_2 (213.6) **and** H_2O (69.9) **(1)** **Second mark** correct multiples (12, 11, 1 and 24) **and** Hess's Law applied $\Delta S^{\ominus}_{system}$ = 12 x 213.6 + 11 x 69.9 −(392.4 + 24 x 102.5) **ALLOW** ecf from incorrect data for CO_2 and/or H_2O **(1)** **Third mark** correct answer with sign and units = +479.7 J mol^{-1} K^{-1} **ALLOW** ecf from incorrect data for CO_2 and/or H_2O and incorrect multiples **(1)**	**3**

Question Number	Acceptable Answers	Reject	Mark
5(a)(ii)	**If answer is +18925.2 J mol^{-1} K^{-1}/ +18.9252 kJ mol^{-1} K^{-1}, then award 2 marks** **If not,** $\Delta S^{\ominus}_{surroundings} = \frac{-\Delta H^{\ominus}}{T}$ **(1)** $= -\frac{(-5639.7) \times 1000}{298}$ = + 18925.2 J mol^{-1} K^{-1} / +18.9252 kJ mol^{-1} K^{-1} **(1)**	+18925.1 J mol^{-1} K^{-1}/ +18.9251 kJ mol^{-1} K^{-1}	**2**

Question Number	Acceptable Answers	Mark
5(a)(iii)	**First mark** ($\Delta S^{\ominus}_{total} = \Delta S^{\ominus}_{surroundings} + \Delta S^{\ominus}_{system} = 18925.2 + 479.7$) = (+)19404.9 (J mol^{-1} K^{-1})/ (+)19.4049 (kJ mol^{-1} K^{-1}) if units given they must be correct **ALLOW** (+)19500 (J mol^{-1} K^{-1})/ (+)19.5 (kJ mol^{-1} K^{-1}) (from 19.0 + 0.480) **ALLOW** ecf on adding answers to (a)(i) and (a)(ii) in the same units (1) **Note** If answer to (a)(i) was +1709.7, $\Delta S^{\ominus}_{total}$ = +20634.9 (J mol^{-1} K^{-1}) / +20.6349 (kJ mol^{-1} K^{-1}) **Second mark** ($\Delta S^{\ominus}_{total}$ is positive so) reaction is (thermodynamically) spontaneous/ feasible/ goes to completion **ALLOW** thermodynamically unstable If their sign for $\Delta S^{\ominus}_{total}$ is negative, then **ALLOW** reaction is not spontaneous/ not feasible/ does not go to completion **(1)**	**2**

Question Number	Acceptable Answers	Reject	Mark
5(a)(iv)	**IGNORE** comments on $\Delta S^{\ominus}_{system}$ **First mark** ($\Delta S^{\ominus}_{surroundings} = -\Delta H^{\ominus}/T$ so increase in T makes) $\Delta S^{\ominus}_{surroundings}$ less positive/ decreases **ALLOW** more negative **(1)** **Second mark** ($\Delta S^{\ominus}_{total} = \Delta S^{\ominus}_{surroundings} + \Delta S^{\ominus}_{system}$ so increase in T makes) $\Delta S^{\ominus}_{total}$ less positive/ decreases **ALLOW** more negative **NOTE no ecf** on $\Delta S^{\ominus}_{surroundings}$ increases **(1)** **Third mark** (because $\Delta S^{\ominus}_{total}$ is so large and positive to start with) there is an insignificant effect on the extent of the reaction **ALLOW** $\Delta S^{\ominus}_{total}$ is still positive so reaction still goes to completion/is spontaneous **ALLOW** ecf on $\Delta S^{\ominus}_{total}$ increases **(1)**	more exothermic	**3**

Question Number	Acceptable Answers	Reject	Mark
5(a)(v)	**First mark** (stable because) high activation energy/ E_a (for combustion of sucrose) **ALLOW** sucrose is kinetically stable/ inert **(1)** **Second mark** (hazardous because small particles/ powder have/ has) larger surface area **and** react faster **(1)** **IGNORE** any reference to temperature If answers are not linked to stability and hazardous, still award both marks even if the points are written in the wrong order		**2**

Question Number	Acceptable Answers	Reject	Mark
5(a)(vi)	Any two of: obesity/ weight gain/ stored as fat/ get fat **(1)** tooth decay/ cavities/ toothache **(1)** diabetes/ glycosuria **(1)** heart/ cardiovascular condition/ disease/ attack **(1)** strokes **(1)** damage to the immune system **(1)** high insulin levels **(1)** high blood pressure **(1)** kidney damage **(1)** liver disease **(1)** headaches/ migraines **(1)** arthritis **(1)** high cholesterol **(1)** **IGNORE** risk of cancer/ high blood sugar/ stomach ulcers		**2**

Question Number	Acceptable Answers	Reject	Mark
5(b)(i)	circles or asterisks on carbons 2-5 all four correct **(2)** 3 or 2 correct **(1)** 1 or 0 correct **(0)** **ALLOW** 5 carbons circled **(1)**	all 6 carbons circled (0)	**2**

Question Number	Acceptable Answers	Reject	Mark
5(b)(ii)	rotate the plane of (plane-) polarized light **ALLOW** rotate plane-polarized light **IGNORE** optically active/ optical activity/ non-superimposable	just 'rotate light'	**1**

Question Number	Acceptable Answers	Reject	Mark
5(b)(iii)	**First mark – colour change** from a **blue** (solution) to a **red / orange / brown / yellow precipitate** **ALLOW** solid or (s) for precipitate which could be shown in formula or equation **(1)** **Second mark – functional group** (glucose/it is) an aldehyde / (has) a CHO group **(1)** **Third mark – oxidation / reduction** copper(II)/Cu^{2+} is **reduced** (to copper(I)/Cu^{+} oxide by the aldehyde group) /$Cu^{2+} + e^{(-)} \rightarrow Cu^{+}$ **OR** the aldehyde/ glucose is **oxidized** (to the carboxylate/carboxylic acid)/ RCHO + [O] → RCOOH **OR** Benedict's and Fehling's (solutions) are oxidizing agents **ALLOW** equation showing oxidation of aldehyde and reduction of Cu^{2+} even if not balanced **(1)**	incorrect observation for one of the reagents for first mark only, eg. silver mirror formed	**3**

Total for Question 5 = 20 marks