How Far? - Entropy
Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Rates, Equilibria & Further Organic Chemistry
Sub Topic	How Far? - Entropy
Booklet	Mark Scheme

Time Allowed: **48 minutes**

Score: **/40**

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	Reject	Mark
1	A		1

Question Number	Correct Answer	Reject	Mark
2	D		1

Question Number	Correct Answer	Reject	Mark
3	B		1

Question Number	Correct Answer	Mark
4(a)	D	

Question Number	Correct Answer	Mark
4(b)	C	

Question Number	Correct Answer	Reject	Mark
5	**C**		**(1)**

Question Number	Correct Answer	Reject	Mark
6	**A**		**(1)**

Question Number	Correct Answer	Reject	Mark
7	**C**		**(1)**

Question Number	Correct Answer	Reject	Mark
8	**B**		**(1)**

Question Number	Correct Answer	Reject	Mark
9	**B**		**(1)**

Question Number	Correct Answer	Reject	Mark
10	**A**		**(1)**

Question Number	Correct Answer	Reject	Mark
11	D		**1**

Question Number	Correct Answer	Reject	Mark
12	C		**1**

Question Number	Acceptable Answers	Reject	Mark
13a(i)	ΔS_{system} = 240.0 - 102.5 - 210.7 = -73.2 J mol^{-1}K^{-1}/ -0.0732 kJ mol^{-1}K^{-1} ALLOW -73 J mol^{-1}K^{-1} Correct data **(1)** Final answer with sign and units (in any order) TE on incorrect data **(1)**		2

Question Number	Acceptable Answers	Reject	Mark
13a(ii)	**First check final answer** +118.1 J mol^{-1}K^{-1} / +0.1181 kJ mol^{-1}K^{-1} ALLOW +120 J mol^{-1}K^{-1} **(2)** OR $\Delta S_{surroundings}$ = $-(-57 \times 1000 /298)$ = (+)191.3 (J mol^{-1}K^{-1}) ALLOW (+)191 (J mol^{-1}K^{-1}) **(1)** ΔS_{total} = (-73.2 + 191.3) = +118.1 J mol^{-1}K^{-1} Use of -73 +191 gives +118 **(1)**		2

Question Number	Acceptable Answers	Reject	Mark
13a(iii)	(it ceases when) ΔS_{total} = 0 **(1)** (this is when TΔS_{system} = ΔH) T = $\dfrac{\Delta H}{\Delta S_{system}}$ = $\dfrac{57 \times 1000}{73.2}$ = 778.69/ 778.7 / 779 / 780 (K) Use of 73 gives 780.1/ 780 (K) **(1)**	 778 -780.1 -780	2

Question Number	Acceptable Answers	Reject	Mark
13b	(Even though thermodynamically feasible) (The reaction is very slow because) the activation energy is high/ there is an activation energy barrier	Reaction is not spontaneous Makes reaction faster Catalyst lowers activation energy Provides an alternative route with a lower activation energy	1

(Total for Question 13 = 7 marks)

Question Number	Acceptable Answers	Mark
14(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 $\quad\quad\quad$ −(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
14(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,** $\Delta S^{\ominus}_{surroundings} = \dfrac{-\Delta H^{\ominus}}{T}$ **(1)** $\quad\quad = -\dfrac{(-5639.7) \times 1000}{298}$ $\quad\quad = +18925.2$ J mol^{-1} K^{-1}/ $\quad\quad\quad +18.9252$ 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
14(a)(iii)	**F t 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
14(a)(iv)	**I** **ORE** 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
14(a)(v)	**Fir t 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
14(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)**		**2**
	IGNORE risk of cancer/ high blood sugar/ stomach ulcers			

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

Question Number	Acceptable Answers	Reject	Mark
14(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
14(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)/ $RCHO + [O] \rightarrow RCOOH$ **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 14 = 20 marks