

Question		er	Mark	Guidance	
1	(a)	<p>process</p> <p>$C_2H_5OH(l) \rightarrow C_2H_5OH(g)$ ✓</p> <p>$C_2H_2(g) + 2H_2(g) \rightarrow C_2H_6(g)$ ✓</p> <p>$NH_4Cl(s) + aq \rightarrow NH_4Cl(aq)$ ✓</p> <p>$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ ✓</p> <p>$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$ ✓</p> <p>All 5 correct → 2 marks</p> <p>4 correct → 1 mark</p>	<p>increase decrease</p>	2	
	(b)	<p>ΔH: + AND bonds broken ✓</p> <p>ΔS: + AND more random/more disorder/more ways of arranging energy ✓</p>	2	<p>Sign and reason required for each mark</p> <p>ALLOW forces of attraction/hydrogen bonds are overcome</p> <p>DO NOT ALLOW response in terms of bonds breaking AND bond making (for melting bonds are just broken)</p> <p>DO NOT ALLOW responses implying that bonds within H_2O molecules are broken</p> <p>IGNORE comments related to ΔG</p> <p>IGNORE comments related to ΔG</p>	
	(c) (i)	<p>$\Delta S = (3 \times 131 + 198) - (186 + 189)$ ✓</p> <p>$\Delta S = (+)216 \text{ (J K}^{-1} \text{ mol}^{-1})$ ✓</p>	2	<p>ALLOW 1 mark for -216 (wrong sign)</p> <p>ALLOW 1 mark for -46 (131 instead of 3 x 131)</p> <p>ALLOW 1 mark for 594 (sign of 189)</p>	

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(c)	Two from points below: 1. fuel OR fuel cells 2. manufacture of margarine OR hydrogenation of alkenes/unsaturated fats 3. manufacture of ammonia OR 'Haber process' ✓ 4. manufacture of HCl/hydrochloric acid 5. reduction of metal ores/metal oxides	1	2 uses for one mark IGNORE hydrogenation of margarine
(d)	FIRST, CHECK THE ANSWER ON ANSWER LINE IF answer = -109, award first 3 marks for calculation ----- At 298 K, $91.2 = 176 - T\Delta S$ ✓ $\Delta S (= \frac{176 - 91.2}{298}) = 0.285 \text{ (kJ K}^{-1} \text{ mol}^{-1}\text{)}$ OR $\Delta S (= \frac{176000 - 91200}{298}) = 285 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$ ✓ <i>subsumes 1st marking point</i> At 1000 K, $\Delta G = 176 - 1000 \times 0.285$ $= -109 \text{ (kJ mol}^{-1}\text{)}$ ✓ Reaction does take place (spontaneously) because $\Delta G < 0$ OR ΔG is -ve ✓ Note: If no value of ΔG , this mark cannot be awarded.	4	IF there is an alternative answer, check to see if there is any ECF credit possible using working below ----- ANNOTATE WITH TICKS AND CROSSES, etc ALLOW 0.285 (3 SF) up to calculator value of 0.284563758 ALLOW 285 (3 SF) up to calculator value of 284.563758 ALLOW -109 up to calculator value correctly rounded, i.e. -108.6, -108.56, etc ALLOW ECF from incorrect ΔS , ie calculated value of ΔG from $\Delta G = 176 - 1000 \times$ calculated value of ΔS Answer and reason BOTH needed for mark ALLOW reaction is feasible for 'reaction does take place' Note: If candidate has a + ΔG value, mark ECF , ie reaction does not take place because $\Delta G > 0$ OR ΔG is +ve
Total		11	

Question	Expected answers	Marks	Additional guidance
2	a	1	
	b	2	
	c	2	<p>ALLOW ECF from working line above from a single error -----</p> <p>COMMON ERRORS (+)3 (J K⁻¹ mol⁻¹) ✓ (211 + 189) – (192 + 205) – 185 (J K⁻¹ mol⁻¹) ✓ <i>incorrect sign</i></p>
	d	2	<p>ANNOTATIONS MUST BE USED</p> <p>DO NOT ALLOW just $T\Delta S$ increases</p> <p>DO NOT ALLOW At high T, '$-T\Delta S$ is greater (than ΔH)'</p> <p>APPROACH BASED ON TOTAL ENTROPY: With increasing temperature $\Delta H/T$ is less negative OR $\Delta H/T$ increases OR $-\Delta H/T$ decreases OR $\Delta H/T$ decreases OR magnitude of $\Delta H/T$ decreases ✓</p> <p>ALLOW at high temperatures $\Delta S - \Delta H/T < 0$</p>

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			<p>OR ΔS is more negative than $\Delta H/T$ OR ΔS outweighs/ is more significant than $\Delta H/T$</p>
e	<p>(For feasibility, $\Delta G < 0$ OR $\Delta G = 0$ OR $0 < \Delta H - T\Delta S$ OR $0 = \Delta H - T\Delta S$ OR $0 = 493 - T \times 543/1000 \checkmark$</p> <p>$T = \frac{\Delta H}{\Delta S} = 493 \times 1000/543 \checkmark$</p> <p>= 908 K \checkmark Units of temperature are required</p>	3	<p>ALLOW total entropy statement: $\Delta S(\text{total}) = 0$ OR $\Delta S(\text{total}) > 0$</p> <p>ALLOW $0 = 493 - T \times 543 \checkmark$ <i>i.e. This mark focuses on ΔG OR $\Delta H - T\Delta S$ being = 0 and NOT on conversion of ΔS value into $\text{kJ K}^{-1} \text{mol}^{-1}$</i></p> <p>Mark temperature given on answer line ALLOW 3 SF up to calculator value 907.9189687 correctly rounded, e.g. 907.9, 907.92</p> <p>ALLOW temperature in $^{\circ}\text{C}$: i.e. ALLOW by subtraction of 273: 635, 634.9, 634.91 $^{\circ}\text{C}$ ALLOW by subtraction of 273.15: 635, 634.8, 634.77 $^{\circ}\text{C}$ up to calculator value correctly rounded ALLOW C for $^{\circ}\text{C}$; $^{\circ}\text{K}$ for K</p> <p>IF ΔS has not been converted to kJ, DO NOT ALLOW 2nd mark BUT ... ALLOW calculated answer = $493/543 = 0.91$ K (calculator: 0.907918968)</p> <p><i>ALLOW 2 marks only for absence of one of the statements required for 1st marking point</i></p>
	Total	10	

