



EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

2002

XVIII

1583

Time allowed
38 Minutes

Score

/32

Percentage

%

CHEMISTRY

**OCR
AS & A LEVEL**

Mark Scheme

Module 5: Physical chemistry and transition elements

www.exampaperspractice.co.uk



Question		er	Mark	Guidance
1	(a)	<p>process</p> <p>$\text{C}_2\text{H}_5\text{OH}(\text{l}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$ increase decrease ✓</p> <p>$\text{C}_2\text{H}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$ ✓</p> <p>$\text{NH}_4\text{Cl}(\text{s}) + \text{aq} \rightarrow \text{NH}_4\text{Cl}(\text{aq})$ ✓</p> <p>$4\text{Na}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{Na}_2\text{O}(\text{s})$ ✓</p> <p>$2\text{CH}_3\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$ ✓</p> <p>All 5 correct → 2 marks</p> <p>4 correct → 1 mark</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 3×131)</p> <p>ALLOW 1 mark for 594 (sign of 189)</p>



Question	er	Mark	Guidance
(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, $91.2 = 176 - T\Delta S$ ✓ $\Delta S (= \frac{176 - 91.2}{298}) = 0.285 \text{ (kJ K}^{-1} \text{ mol}^{-1})$ OR $\Delta S (= \frac{176000 - 91200}{298}) = 285 \text{ (J K}^{-1} \text{ mol}^{-1})$ ✓ <i>subsumes 1st marking point</i> At 1000 K, $\Delta G = 176 - 1000 \times 0.285$ $= -109 \text{ (kJ mol}^{-1})$ ✓ 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>-----</p> <p>COMMON ERRORS</p> <p>(+)3 (J K⁻¹ mol⁻¹) ✓ (211 + 189) – (192 + 205)</p> <p>– 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:</p> <p>With increasing temperature</p> <p>$\Delta H/T$ is less negative OR $\Delta H/T$ increases</p> <p>OR $-\Delta H/T$ decreases OR $\Delta H/T$ decreases</p> <p>OR magnitude of $\Delta H/T$ decreases ✓</p> <p>ALLOW at high temperatures</p> <p>$\Delta S - \Delta H/T < 0$</p>



EXAM PAPERS PRACTICE

Question	Expected answers	Marks	Additional guidance
			OR ΔS is more negative than $\Delta H/T$ OR ΔS outweighs/ is more significant than $\Delta H/T$
e	(For feasibility,) $\Delta G < 0$ OR $\Delta G = 0$ OR $0 < \Delta H - T\Delta S$ OR $0 = \Delta H - T\Delta S$ OR $0 = 493 - T \times 543/1000 \checkmark$ $T = \frac{\Delta H}{\Delta S} = 493 \times 1000/543 \checkmark$ $= 908 \text{ K} \checkmark$ Units of temperature are required	3	ALLOW total entropy statement: $\Delta S(\text{total}) = 0$ OR $\Delta S(\text{total}) > 0$ 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> Mark temperature given on answer line ALLOW 3 SF up to calculator value 907.9189687 correctly rounded, e.g. 907.9, 907.92 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 IF ΔS has not been converted to kJ, DO NOT ALLOW 2nd mark BUT ... ALLOW calculated answer = $493/543 = 0.91 \text{ K}$ (calculator: 0.907918968) <i>ALLOW 2 marks only for absence of one of the statements required for 1st marking point</i>
		Total	10



Question	Answer	Mark	Guidance
3 (a)	<p>A: forms fewer moles/molecules of gas ✓ B: forms gas from a liquid ✓ C: forms liquid from gases ✓ D: forms more moles/molecules of gas ✓</p>	4	<p>Note: Responses must imply the key difference between the sides of the equation</p> <p>IGNORE comments about C(s)</p>
(b)	<p>$\Delta S = \Sigma S(\text{products}) - \Sigma S(\text{reactants})$ $= 40 + 214 - 89 = 165 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$ $= 0.165 \text{ (kJ K}^{-1} \text{ mol}^{-1}\text{)} \checkmark$</p> <p>At 25 °C, $\Delta G = +178 - 298 \times 0.165 \checkmark$ $= (+)129 \checkmark$ units: $\text{kJ mol}^{-1} \checkmark$ OR $(+)129,000 \checkmark$ units: $\text{J mol}^{-1} \checkmark$</p> <p>As $\Delta G > 0$, reaction is not feasible OR as $\Delta G > 0$, CaCO_3 is stable ✓</p> <p>-----</p> <p>Minimum temperature for feasibility when $0 = \Delta H - T\Delta S$ OR $\Delta H = T\Delta S$ OR $T = \frac{\Delta H}{\Delta S} \checkmark$ $= \frac{178}{0.165} = 1079 \text{ K OR } 806 \text{ }^\circ\text{C} \checkmark$ The units must be with the stated temperature</p>	1	<p>ANNOTATE WITH TICKS AND CROSSES, etc <i>Mark is for the working line:</i> $40 + 214 - 89 = 165$</p> <p>UNITS have a separate mark ALLOW 129 to calculator value of 128.83 DO NOT ALLOW 128 (incorrect rounding) IF 25 °C used rather than 298 K, credit by ECF, calculated $\Delta G = 174$ to calculator value of 173.875</p> <p>ENTROPY APPROACH-----</p> <p>ALLOW At 25 °C, $\Delta S_{\text{total}} = 0.165 - \frac{178}{298} \checkmark$ $= -0.432 \checkmark \text{ kJ K}^{-1} \text{ mol}^{-1} \checkmark$ OR $-432 \checkmark \text{ J K}^{-1} \text{ mol}^{-1} \checkmark$</p> <p>4 As $\Delta S < 0$, reaction is not feasible ✓ ENTROPY APPROACH-----</p> <p>Minimum temperature for feasibility when $0 = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$ OR $\Delta S_{\text{system}} = \frac{\Delta H}{T}$</p> <p>ALLOW 1080 K up to calculator value of 1078.787879, correctly rounded, eg 1078.79 is correct value to 6SF DO NOT ALLOW 1078 (incorrect rounding)</p> <p>2 IF 1079 K is given and additional temperature in °C is incorrect, IGNORE °C temperature (and vice versa)</p>
Total		11	