Question		on	Answer	Marks	AO element	Guidance
17	(a)		High pressure AND low temperature ✓ Right-hand side has fewer (gaseous) moles/molecules OR	3	1.2×1	Marks are independent ORA throughout
			Ieft-hand side has more (gaseous) moles/molecules ✓ (Forward) reaction is exothermic/gives out heat OR reverse reaction is endothermic/takes in heat ✓		1.1×2	ALLOW RHS ALLOW suitable alternatives for RHS e.g. product side
	(b)		(Reaction can be carried out at) lower temperatures / lower energy demand ✓ Less (fossil) fuels burnt / less CO₂ emissions ✓	2	1.1×2	 ALLOW lower pressures as alternative to lower temperature ALLOW reduced carbon footprint as alternative to less fuels burnt ALLOW different reactions can be used with greater atom economy / less waste ALLOW can reduce use of toxic substances

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Question	Answer	Marks	AO element	Guidance
(c)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 25.55 kJ mol ⁻¹ OR 25550 J mol ⁻¹ award first 4 marks	5	2.2×4	
	$\Delta S = 238 - (198 + 2 \times 131) \checkmark$ = -222 (J K ⁻¹ mol ⁻¹) OR -0.222 (kJ K ⁻¹ mol ⁻¹)			ALLOW ECF IGNORE units at this stage
	OR $\Delta G = -91 - (525 \times -0.222)$ OR $\Delta G = -91000 - (525 \times -222)$		3.2×1	
	= 25.55 <u>kJ mol⁻¹</u> OR 25550 <u>J mol⁻¹</u> ∕			Onits for ΔG required ALLOW 26 kJ mol ⁻¹ OR 26000 J mol ⁻¹ up to calculator value.
	(Reaction is) not feasible AND $\Delta G > 0 \checkmark$			

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Question	Answer	Marks	AO element	Guidance
(d)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.22×10^4 award first 2 marksIn $K_p = -\Delta G/RT = \frac{2.48 \times 10^4}{8.314 \times 298} = 10.01 \checkmark$ $K_p = 2.22 \times 10^4$ (3SF required) ✓Units = atm ⁻² ✓	3	3.1×2 1.2×1	ALLOW ECF for transcription errors in first sum ALLOW 10 up to calculator value of 10.00979992 ALLOW 22200 ALLOW 2.20 × 10 ⁴ OR 22000 (use of 10) ALLOW alternatives (k)Pa ⁻² OR N ⁻² m ⁴ OR mmHg ⁻² OR PSI ⁻² OR bar ⁻² Common errors for 1 mark: 22400 (use of 8.31)
	Total	14		4.50 x 10 ⁻⁵ (use of -10.01)