



Two changes are described below.

For each change,

- write an equation, including state symbols,
- state and explain how the entropy changes.

(i) The reaction of aqueous barium nitrate with aqueous sodium sulfate.

Full equation with state symbols

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Explanation of entropy change

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..... [2]

(ii) The change that accompanies the standard enthalpy change of atomisation of iodine.

Equation with state symbols

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Explanation of entropy change

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..... [2]



Methanol is formed when carbon dioxide and hydrogen react.

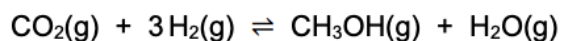


Table 5 contains enthalpy of formation and entropy data for these substances.

Table 5

| | CO₂(g) | H₂(g) | CH₃OH(g) | H₂O(g) |
|---------------------------------------|--------------------------|-------------------------|----------------------------|--------------------------|
| $\Delta_f H / \text{kJ mol}^{-1}$ | -394 | 0 | -201 | -242 |
| $S / \text{J K}^{-1} \text{mol}^{-1}$ | 214 | 131 | 238 | 189 |

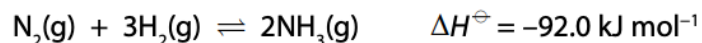
- 1** Use the equation and the data in **Table 5** to calculate the Gibbs free-energy change (ΔG), in kJ mol^{-1} , for this reaction at 890 K

[6 marks]

ΔG _____ kJ mol^{-1}



Ammonia is produced industrially by reacting nitrogen and hydrogen.



A temperature in the range of 673 to 773 K is used.

The standard entropies, S^\ominus , of $\text{N}_2(\text{g})$, $\text{H}_2(\text{g})$ and $\text{NH}_3(\text{g})$ at 298 K are given in the table.

| substance | $\text{N}_2(\text{g})$ | $\text{H}_2(\text{g})$ | $\text{NH}_3(\text{g})$ |
|--|------------------------|------------------------|-------------------------|
| $S^\ominus / \text{JK}^{-1} \text{mol}^{-1}$ | 192 | 131 | 193 |

- (a) Show that this reaction is feasible at 298 K by calculating ΔG^\ominus in kJ mol^{-1} . Give your answer to an appropriate number of significant figures.

(5)

- (b) Explain, in terms of entropy, why this reaction is not feasible at very high temperatures.

(2)

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