

Chemistry

Higher level

Paper 1B

Practice paper

Topic: Equilibrium

Chemistry

Higher level

Paper 1B

Specimen paper

45 minutes

Instructions to candidates

- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for paper 1B is [25 marks].

Section B

1. Hydrogen and iodine react to form hydrogen iodide according to the equation: $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$. At 700 K, the value of K_c is 54.0. Exactly 1.00 mol of H_2 and 1.00 mol of I_2 are placed into a completely empty 2.00 dm³ flask.

(a) Determine the equilibrium concentrations of all species in the flask. **[3]**

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(b) Calculate the final equilibrium concentration of hydrogen iodide, HI. **[2]**

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2. The standard Gibbs free energy change, ΔG^\ominus , for the gas-phase reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ is +4.73 kJ mol⁻¹ at 298 K. ($R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$).

(a) Calculate the thermodynamic equilibrium constant, K , for this reaction at 298 K. **[2]**

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(b) Explain the macroscopic significance of K being less than 1 with reference to the composition of the equilibrium mixture. **[1]**

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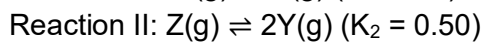
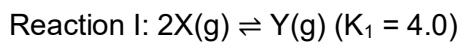
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(c) The reaction is endothermic. Formulate how the value of ΔG^\ominus changes if the temperature is increased to 400 K, explaining your reasoning conceptually.

[2]

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3. Consider the following two equilibrium reactions and their respective K_c values at 500 K:

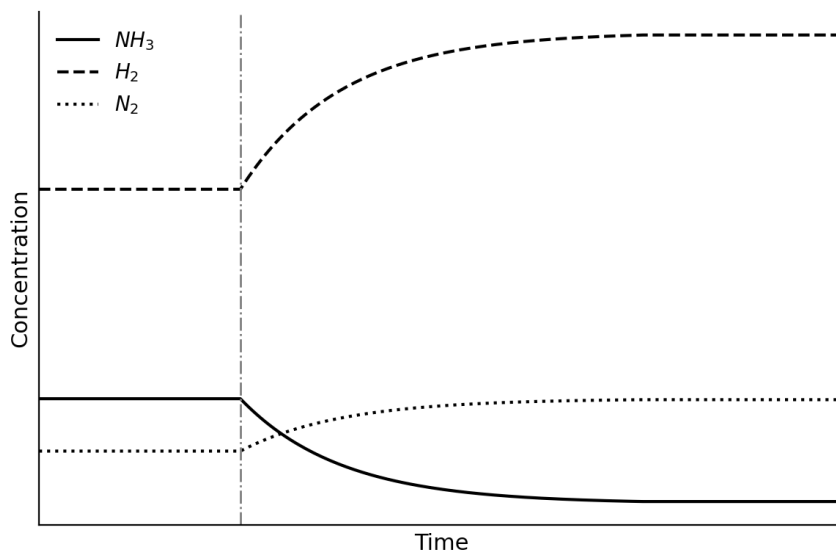


(a) Determine the value of the equilibrium constant K_3 for the reaction: $4X(g) \rightleftharpoons Z(g)$.
Show your mathematical derivation.

[3]

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4. The following concentration-time graph traces the dynamic equilibrium of the Haber process: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ ($\Delta H < 0$). A sudden disturbance is applied to the closed system at $t = 10$ minutes.



(a) Identify the specific disturbance applied at $t = 10$ minutes based on the immediate graphical spikes.

[2]

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(b) Use Le Chatelier's principle in conjunction with the reaction quotient (Q_c) to explain why the concentration of $\text{NH}_3(\text{g})$ decreases gradually after $t = 10$ minutes until a new equilibrium is reached.

[3]

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