**Chemistry**

**Standard level**

**Paper 1B**

Practice paper

**Topic: Equilibrium**

**Chemistry**

**Standard level**

**Paper 1B**

Specimen paper

45 minutes

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## 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 [20 marks].

## Section B

**1.** The Haber process for the synthesis of ammonia involves the dynamic equilibrium: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ with $\Delta H = -92$ kJ $mol^{-1}$. The following data table shows the percentage yield of ammonia at equilibrium under various industrial conditions.

| Pressure / atm | Yield at 300 K / % | Yield at 500 K / % | Yield at 700 K / % |
|---|---|---|---|
| 100 | 98 | 52 | 16 |
| 200 | 99 | 74 | 35 |
| 400 | 99.5 | 85 | 55 |

(a) State and explain the effect on the equilibrium yield of ammonia when the pressure is increased from 100 atm to 200 atm. **[2]**

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(b) Use Le Chatelier's principle and the data table to verify that the forward reaction is exothermic. **[3]**

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(c) Despite a 99% yield at 300 K, industrial plants typically operate at 700 K. Explain this compromise. **[2]**

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**2.** A reversible reaction $X(g) \rightleftharpoons 2Y(g)$ reaches equilibrium in a sealed container.

(a) Formulate the equilibrium constant expression, $K_c$, for this reaction. **[1]**

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(b) More X(g) is suddenly injected into the sealed container. State the immediate effect on the value of the reaction quotient $Q_c$ and deduce the direction the reaction shifts to re-establish equilibrium. **[2]**

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