Chemistry

Standard level

Paper 2

Practice paper

Topic: Equilibrium

Chemistry

Standard level

Paper 2

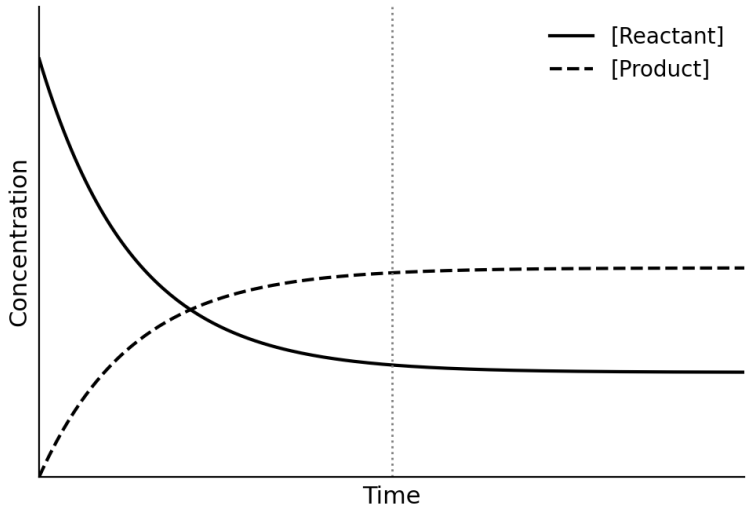
Specimen paper

1 hour 15 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 this examination paper is [40 marks].

1. The following graph shows the concentration of a generic reactant and product over time as they approach dynamic equilibrium.



(a) The vertical dashed line is drawn at t = 25 s. State the significance of this time with respect to the state of the reaction system. **[1]**

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(b) Deduce whether the value of the equilibrium constant K_c for this reaction is greater than 1 or less than 1. Justify your answer using the graphical data. **[2]**

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2. Consider the equilibrium: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ with an equilibrium constant K_c = 280 at a specific temperature.

(a) Determine the value of the equilibrium constant, K_c', for the reverse reaction: $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ at the same temperature. **[1]**

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3. An aqueous equilibrium exists between the yellow chromate ion, CrO_4^{2-}, and the orange dichromate ion, $Cr_2O_7^{2-}$:
$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$

(a) Predict the color change observed when a few drops of concentrated hydrochloric acid, HCl(aq), are added to the equilibrium mixture. Explain your reasoning using Le Chatelier's principle. **[3]**

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(b) Predict the color change observed when aqueous sodium hydroxide, NaOH(aq), is added to the mixture. Explain your reasoning. **[3]**

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4. The Contact process uses vanadium(V) oxide as a solid catalyst for the reaction:
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ ($\Delta H = -196$ kJ mol^{-1}).

(a) Explain why adding the solid catalyst does not increase the equilibrium yield of $SO_3(g)$. **[2]**

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5. A sealed bottle of carbonated water contains dissolved carbon dioxide gas in dynamic equilibrium with gaseous carbon dioxide.

(a) Write the equation for this physical equilibrium, including state symbols. **[2]**

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(b) Explain why opening the bottle causes bubbles to form rapidly throughout the liquid. **[2]**

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