# HL Paper 1

Which variable affects the equilibrium constant, $K_c$?

A. Atmospheric pressure

B. Catalyst

C. Concentration of reactants

D. Temperature

# Markscheme

D

# Examiners report

[N/A]

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What is the effect of an increase of temperature on the yield and the equilibrium constant for the following reaction?

$$2H_2(g) + CO(g) \rightleftharpoons CH_3OH(l) \quad \Delta H^{\ominus} = -128\ \text{kJ}$$

| | Yield | Equilibrium constant |
|---|---|---|
| A. | Increases | Increases |
| B. | Increases | Decreases |
| C. | Decreases | Increases |
| D. | Decreases | Decreases |

# Markscheme

D

# Examiners report

[N/A]

Which statements explain why a catalyst is used in the Contact process (shown below)?

$$\mathrm{SO_2(g)} + \frac{1}{2}\mathrm{O_2(g)} \rightleftharpoons \mathrm{SO_3(g)}$$

I. A catalyst lowers the activation energy.

II. A catalyst moves the position of equilibrium towards the product.

III. A catalyst allows the same rate to be achieved at a lower temperature.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

# Markscheme

B

# Examiners report

There were a number of comments suggesting that the sentence “A catalyst creates a new reaction pathway of lower activation energy.” should have been used. The examiners accept the rebuke. Nevertheless, nearly 85% of the candidates saw past the poor wording and gave B as the correct answer.

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What is the effect of increasing the temperature in this reaction?

$$CO_2(g) + H_2O(l) \rightleftharpoons H^+(aq) + HCO_3^-(aq) \quad \Delta H < 0$$

A. The pH will decrease.

B. The pH will increase.

C. $CO_2$ pressure will decrease.

D. The equilibrium position will shift to the right.

# Markscheme

B

# Examiners report

[N/A]

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Which statement is correct for the equilibrium $\mathrm{H_2O(l)} \rightleftharpoons \mathrm{H_2O(g)}$ in a closed system at 100 °C?

A. All the $\mathrm{H_2O(l)}$ molecules have been converted to $\mathrm{H_2O(g)}$.

B. The rate of the forward reaction is greater than the rate of the reverse reaction.

C. The rate of the forward reaction is less than the rate of the reverse reaction.

D. The pressure remains constant.

# Markscheme

D

# Examiners report

One respondent stated that candidates had to assume that equilibrium has been established since the question does not make this clear. It was felt that this is clearly implied in the question by stating that the container was closed and at constant temperature.

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Consider the following reversible reaction.

$$\mathrm{Cr_2O_7^{2-}(aq) + H_2O(l) \rightleftharpoons 2CrO_4^{2-}(aq) + 2H^+(aq)}$$

What will happen to the position of equilibrium and the value of $K_c$ when more $\mathrm{H^+}$ ions are added at constant temperature?

| | Position of equilibrium | Value of $K_c$ |
|---|---|---|
| A. | shifts to the left | decreases |
| B. | shifts to the right | increases |
| C. | shifts to the right | does not change |
| D. | shifts to the left | does not change |

# Markscheme

D

# Examiners report

[N/A]

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The enthalpy change for the dissolution of $NH_4NO_3$ is +26 kJ $mol^{-1}$ at 25 °C. Which statement about this reaction is correct?

A. The reaction is exothermic and the solubility decreases at higher temperature.

B. The reaction is exothermic and the solubility increases at higher temperature.

C. The reaction is endothermic and the solubility decreases at higher temperature.

D. The reaction is endothermic and the solubility increases at higher temperature.

# Markscheme

D

# Examiners report

[N/A]

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What occurs when the pressure on the given equilibrium is increased at constant temperature?

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \quad \Delta H = +180 \text{ kJ}$$

A. $K_c$ increases and the position of equilibrium moves to the right.

B. $K_c$ stays the same and the position of equilibrium is unchanged.

C. $K_c$ stays the same and the position of equilibrium moves to the left.

D. $K_c$ decreases and the position of equilibrium moves to the left.

# Markscheme

B

# Examiners report

[N/A]

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Which of the following will shift the position of equilibrium to the right in the Haber process?

$$\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)} \quad \Delta H^{\ominus} = 92.6\ \mathrm{kJ}$$

I. Decreasing the concentration of $\mathrm{NH_3(g)}$

II. Decreasing the temperature

III. Increasing the pressure

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

# Markscheme

D

# Examiners report

[N/A]