Le Chatelier’s Principle: Effect of Changing Concentration and Temperature (Higher Tier) Worksheet

Combined Science - Chemistry - Key Stage 4

The Rate and Extent of Chemical Change

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Effect of changing concentration on equilibrium

What happens to the equilibrium if we increase the concentration of B?

$$A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)} + D_{(l)}$$

Effect of changing concentration on equilibrium

What happens to the equilibrium if we increase the concentration of B?

$$A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)} + D_{(l)}$$

<u>Equilibrium shifts to the right</u>, away from $B_{(aq)}$ in the equation, increasing the concentration of C.

Effect of changing concentration on equilibrium

What happens to the equilibrium if we increase the concentration of C?

$$A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)} + D_{(l)}$$

Effect of changing concentration on equilibrium

What happens to the equilibrium if we increase the concentration of C?

$$A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)} + D_{(l)}$$

Equilibrium shifts to the left, away from $C_{(aq)}$ in the equation, decreasing the yield.

Effect of changing temperature on equilibrium

The forward reaction is exothermic. What happens to the equilibrium and yield when temperature is increased?

$$CO(g) + H_2(g) \underset{\textit{endothermic}}{\overset{\textit{exothermic}}{\rightleftharpoons}} CH_3OH(g)$$

Effect of changing temperature on equilibrium

The forward reaction is exothermic. What happens to the equilibrium and yield when temperature is increased?

$$CO(g) + H_2(g) \underset{\textbf{\textit{endothermic}}}{\overset{\textbf{\textit{exothermic}}}{\rightleftharpoons}} CH_3OH(g)$$

Equilibrium shifts to the left, increasing temperature favours endothermic reaction (reverse reaction), decreasing the yield.

Effect of changing temperature on equilibrium

The forward reaction is exothermic. What can we do to the temperature to increase the yield?

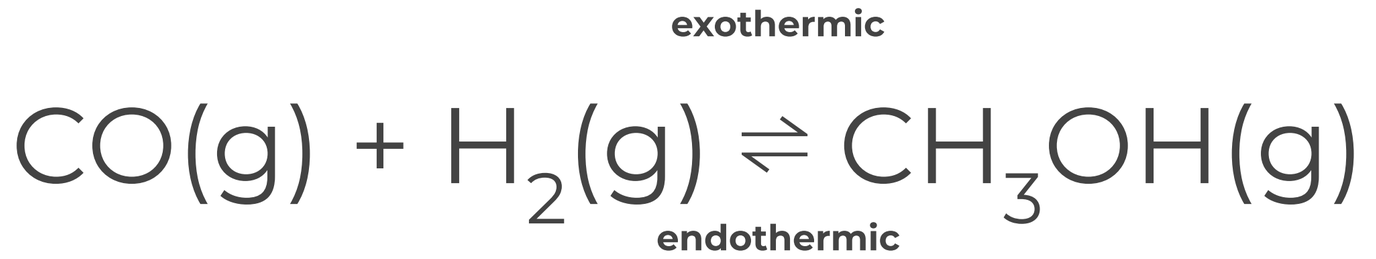
$$CO(g) + H_2(g) \rightleftharpoons CH_3OH(g)$$

exothermic

endothermic

Effect of changing temperature on equilibrium

The forward reaction is exothermic. What can we do to the temperature to increase the yield?



Decreasing temperature favours exothermic reaction in the forward direction, equilibrium shifts to the right, increasing yield.

Multiple choice quiz

Which of the following condition(s) can be changed in a system that is in equilibrium?

A

Pressure

B

Concentration

C

Temperature

D

All of the above

Which of the following condition(s) can be changed in a system that is in equilibrium?

D

All of the above

In a reaction, what will happen to the equilibrium if the concentration of one of the reactants is increased?

A

Increase

B

Decrease

C

Shift to the left

D

Shift to the right

In a reaction, what will happen to the equilibrium if the concentration of one of the reactants is increased?

D

Shift to the right

In a reaction involving solutions, if the concentration of a solute is increased, in which direction will equilibrium shift to?

A

Increase

B

Decrease

C

Away from the solute

D

Towards the solute

In a reaction involving solutions, if the concentration of a solute is increased, in which direction will equilibrium shift to?

C

Away from the solute

In a reaction that is endothermic in the forward reaction, what will happen to the equilibrium if the temperature is increased?

A

Shift to the left

B

Shift to the right

C

Increase

D

Decrease

In a reaction that is endothermic in the forward reaction, what will happen to the equilibrium if the temperature is increased?

B

Shift to the right

In a reaction that is exothermic in the forward reaction, what will happen to the yield if the temperature is increased?

A

Shift to the left

B

Shift to the right

C

Increase

D

Decrease

In a reaction that is exothermic in the forward reaction, what will happen to the yield if the temperature is increased?

D

Decrease

Independent practice

Exam style question 1

In the Haber process, ammonia is produced by a reversible reaction:

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

1) Reversible reactions can reach equilibrium in a closed system. What does a closed system mean? (1)
2) The overall energy change for the reaction is $\Delta H = -92.4$ kJ/mol. Is this reaction endothermic or exothermic in the forward direction? (1)
3) Using your answer from question 2, explain how would increasing the temperature change the yield of ammonia at equilibrium. (2)

Exam style question 2

Cobalt is a transition metal that forms coloured compounds. The following reaction is endothermic in the forward direction:

pink cobalt compound + hydrochloric acid ⇌ blue cobalt compound + water

1) When both compounds are present in solution at equilibrium, the equilibrium mixture is purple. What does ‘equilibrium’ mean? (3)
2) Explain what happens to the concentration of blue cobalt compound when the temperature is increased. (2)
3) Explain what happens to the colour of the equilibrium mixture when the concentration of hydrochloric acid is increased. (2)

Exam style question 1 answers

In the Haber process, ammonia is produced by a reversible reaction:

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

1) *A closed system is a system where none of the reactants or products can enter or escape.*
2) *The overall energy change for the reaction is ΔH = -92.4 kJ/mol. This reaction is exothermic in the forward direction.*
3) *Increasing the temperature will shift the equilibrium to the left in the reverse direction, increasing temperature favours endothermic reaction, decreasing the yield of ammonia.*

Exam style question 2 answers

Cobalt is a transition metal that forms coloured compounds. The following reaction is endothermic in the forward direction:

pink cobalt compound + hydrochloric acid ⇌ blue cobalt compound + water

1) *Equilibrium is the point where the forward and reverse reactions occur at exactly the same rate in a closed system.*
2) *The equilibrium shifts to the right, increasing temperature favours endothermic reaction. The concentration of blue cobalt compound increases.*
3) *When the concentration of hydrochloric acid is increased, equilibrium shifts to the right, away from hydrochloric acid. The equilibrium mixture will become blue as the concentration of blue cobalt compound increases.*