

18.1 Equilibrium and changing conditions

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS reversible reaction • equilibrium

Objective

Equilibrium and changing conditions. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

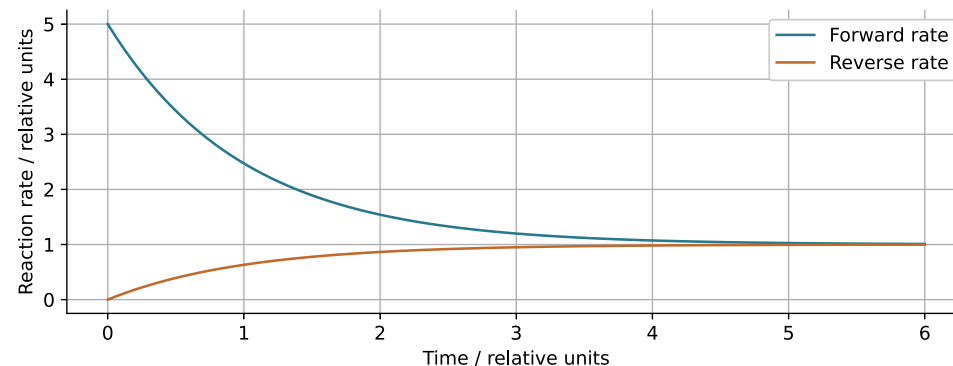
1 Key knowledge and worked examples

■ What would explain this observation?

- A **reversible reaction** can continue in a closed vessel while measured concentrations stay constant. Constant composition does not mean particles have stopped reacting.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Dynamic **equilibrium** occurs in a closed system when forward and reverse rates are equal. Reactant and product concentrations are constant, but they need not be equal.
- equilibrium: A state with equal forward and reverse reaction rates; reversible reaction: A reaction that can proceed in both directions.



■ Choose evidence that can test it

- A concentration or pressure change disturbs the balance. The system responds toward a new equilibrium. Temperature changes can also change the equilibrium constant; a catalyst changes how quickly equilibrium is reached.
- State the balanced equation and whether the forward reaction is exothermic before predicting a temperature effect. Count gas coefficients when considering pressure; pressure has no composition effect when gaseous amounts are equal on both sides.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: in $A \rightleftharpoons B$, equilibrium concentrations are $[A] = 0.20$ and $[B] = 0.60$ in the same concentration unit. For this stated expression, $K = [B]/[A]$. $K = 0.60/0.20 = 3.0$. Equal rates do not imply $K = 1$.

Example:

For $A \rightleftharpoons B$, calculate $[B]/[A]$ when $[B]=0.8$ and $[A]=0.2$. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- Do not use a catalyst to claim a larger equilibrium yield. For heterogeneous equilibria, pure solids are omitted from the usual equilibrium expression.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A catalyst changes the equilibrium constant at a fixed temperature. This claim is false: Do not use a catalyst to claim a larger equilibrium yield. For heterogeneous equilibria, pure solids are omitted from the usual equilibrium expression.

Key:

Equilibrium and changing conditions: A concentration or pressure change disturbs the balance. The system responds toward a new equilibrium. Temperature changes can also change the equilibrium constant; a catalyst changes how quickly equilibrium is reached.

2 Practice

2.1 What is equal at dynamic equilibrium? Choose one answer.

- **A** Concentrations of all species
 - **B** Forward and reverse reaction rates
 - **C** Masses of every reactant and product
- [1]

2.2 For $A \rightleftharpoons B$, calculate $[B]/[A]$ when $[B]=0.8$ and $[A]=0.2$. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: A catalyst changes the equilibrium constant at a fixed temperature.

[2]

2.4 A state with equal forward and reverse reaction rates: write the technical term.

[1]

3 Exam-style questions

3.1 $A \rightleftharpoons B$ has $K=4$ at fixed temperature. Immediately after adding A, the ratio $[B]/[A]=2$. Predict the shift and distinguish reaction rates from equilibrium concentrations.

[4]

Solutions

2.1 B A concentration or pressure change disturbs the balance. The system responds toward a new equilibrium. Temperature changes can also change the equilibrium constant; a catalyst changes how quickly equilibrium is reached.

2.2 For the stated $A \rightleftharpoons B$ expression, $K = [B]/[A] = 0.8/0.2 = 4$.

2.3 False. Do not use a catalyst to claim a larger equilibrium yield. For heterogeneous equilibria, pure solids are omitted from the usual equilibrium expression.

2.4 equilibrium. equilibrium means A state with equal forward and reverse reaction rates.

3.1 $Q < K$, so net forward change raises the ratio toward 4. At equilibrium forward/reverse rates are equal; concentrations need not be equal. Temperature and the stated expression matter.