17.1 Equilibrium and changing conditions

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS reversible reaction • equilibrium

Objective

Equilibrium and changing conditions. Original classroom practice for IB SL; not an official IB paper.

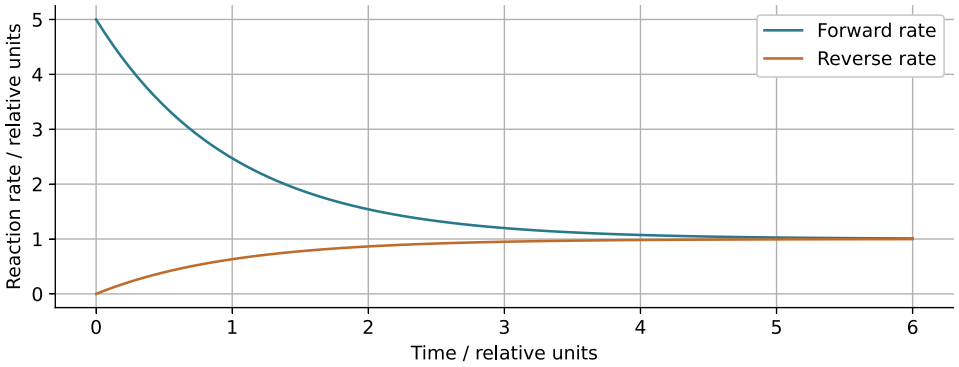
1 Key knowledge and worked examples

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.

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.

In the lab: 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

- 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 $K = 1$.

Your turn: For $A \rightleftharpoons B$, calculate $[B]/[A]$ when $[B]=0.8$ and $[A]=0.2$.

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.

Not true: A catalyst changes the equilibrium constant at a fixed temperature. A catalyst speeds the forward and reverse reactions equally, so equilibrium is reached sooner but the equilibrium constant and final composition at a fixed temperature are unchanged.

Key:

- Dynamic equilibrium occurs in a closed system when forward and reverse rates are equal.
- A concentration or pressure change disturbs the balance.
- Watch for: do not use a catalyst to claim a larger equilibrium yield.

Write from an equilibrium constant of 2.0

- For A in equilibrium with B, the concentration of B is 0.50 and the concentration of A is 0.25, in the same unit.
- Find K for the stated expression $[B]/[A]$. A catalyst does not change K at a fixed temperature.

2 Practice

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

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

2.2 For A ⇌ 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 speeds the forward and reverse reactions equally, so equilibrium is reached sooner but the equilibrium constant and final composition at a fixed temperature are unchanged. [2]

2.4 A state with equal forward and reverse reaction rates: write the technical term. [1]

3 Exam-style questions

3.1 A⇌B hasK=4 at fixed temperature. Immediately after addingA, the ratio[B]/[A]=2. Predict the shift and distinguish reaction rates from equilibrium concentrations. [4]