

Class 10 Chemistry - Chapter 9 Notes

Chemical Equilibrium | Reversible reactions, Le Chatelier principle | Punjab Boards (PCTB)

Reversible Reactions

- A reversible reaction goes in both directions: reactants form products (forward) and products change back into reactants (reverse). It is shown by a double arrow.
- Example: $\text{N}_2 + 3\text{H}_2$ (reversible) 2NH_3 - the Haber process for ammonia.
- Such reactions never complete; some reactants always remain unreacted.

Dynamic Equilibrium

- Equilibrium is reached when the rate of forward reaction = rate of reverse reaction.
- At equilibrium the concentrations of reactants and products stay constant (but not necessarily equal).
- It is dynamic: both reactions keep running at equal rates, so there is no visible change.
- Equilibrium can only be established in a closed system.

Law of Mass Action and K_c

- For $a\text{A} + b\text{B} \rightleftharpoons c\text{C} + d\text{D}$: $K_c = \frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$ (concentrations in mol/dm^3).
- K_c has no unit when moles of products = moles of reactants; otherwise it carries units.
- Large K_c means the reaction goes almost to completion; small K_c means very little product at equilibrium.

Le Chatelier's Principle

- If a system at equilibrium is disturbed (concentration, pressure or temperature), it shifts to cancel the change.
- Increasing pressure shifts equilibrium towards the side with fewer gas moles.
- Increasing temperature favours the endothermic direction; decreasing temperature favours exothermic.
- A catalyst does NOT shift equilibrium - it only makes equilibrium arrive faster (lowers activation energy for both directions equally).

Industrial Application - Haber Process

- Conditions: temperature about 450 C, pressure about 200 atm, iron catalyst.
- These are compromise conditions: low temperature gives more NH_3 but a very slow rate.

Exam Tips

- Practise K_c numericals with the ICE method (Initial, Change, Equilibrium).
- Questions on Haber process conditions are repeated every year.
- Never write that reactions 'stop' at equilibrium - write that rates become equal.

Quick Revision Table

Change	Shift
Add reactant	Towards products (right)
Remove product	Towards products (right)

Change	Shift
Increase pressure	Side with fewer gas moles
Add catalyst	No shift - equilibrium reached faster
Increase temperature	Endothermic direction

Practice MCQs (answers at the end)

Q1. At equilibrium, the rate of forward reaction is:

A. Zero **B.** Equal to reverse rate **C.** Maximum **D.** Minimum

Q2. A catalyst at equilibrium:

A. Shifts right **B.** Shifts left **C.** Speeds up both rates equally **D.** Stops the reaction

Q3. Equilibrium needs a:

A. Open system **B.** Closed system **C.** Vacuum **D.** Catalyst

Q4. For $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$, increasing pressure shifts equilibrium:

A. Left **B.** Right **C.** No change **D.** Stops

Q5. K_c is expressed using concentrations in:

A. g/dm^3 **B.** mol/dm^3 **C.** cm^3 **D.** atm only