CONCEPT MAP
CLASS XI

Le Chatelier's Principle

If a system in dynamic equilibrium is disturbed, the position of equilibrium will shift so as to cancel out the effect of change and a new equilibrium can be established again.

Effect of Concentration Change

- Increase in conc. of reactants or decrease in conc. of products shifts the equilibrium to forward direction.
- Increase in conc. of products or decrease in conc. of reactants shifts the equilibrium to backward direction.

$$2CrO_4^{2-} + 2H^+ \leftrightarrow Cr_2O_7^{2-} + H_2O$$
(yellow) (orange)

Increase H^+ conc.	Decrease H^+ conc.
• By adding H^+ • Equilibrium shift towards right. • Formation of $Cr_2O_7^{2-}$ (orange)	• By adding OH^- • Equilibrium shift towards left. • Formation of CrO_4^{2-} (yellow)

Effect of Pressure Change

- Applicable only in case of gaseous reactions and reactions which proceed with a change in number of moles of gaseous reactants and products.
- Increase in pressure shifts the equilibrium towards lesser number of gaseous molecules.
- Decrease in pressure shifts the equilibrium towards larger number of gaseous molecules.

Pressure-volume changes do not change the value of equilibrium constant as long as the temperature remains constant.

Effect of Volume Change

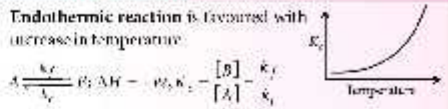
- The effect of change of volume will be exactly reverse to that of pressure.
- Decrease in volume shifts the equilibrium towards lesser number of gaseous molecules.
- Increase in volume shifts the equilibrium towards larger number of gaseous molecules.

Effect of Catalyst

- Catalyst has no effect on equilibrium, it simply helps to achieve the equilibrium quickly.
- Position of equilibrium and K_c unchanged.
- Provides an alternative pathway with lower activation energy.
- Increases forward and reverse rates to the same extent.
- Catalyst shortens the time to reach equilibrium.

Effect of Temperature Change

- **Endothermic reaction** is favoured with increase in temperature.

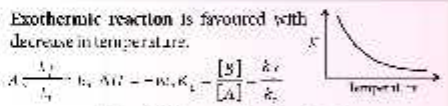


$$A \rightleftharpoons B;\ \Delta H = +ve,\ K_c = \frac{[B]}{[A]} = \frac{k_f}{k_b}$$

Temp. ↑ → Equilibrium shift to right → Absorb heat → Temp. decrease ↓
- $k_f > k_b \rightarrow K_c = \frac{k_f}{k_b} \rightarrow K_c \uparrow$
- More product, less reactant $\rightarrow K_c = \frac{[B]}{[A]} \rightarrow K_c \uparrow$

Temp. ↓ → Equilibrium shift to left → Release heat → Temp. increase ↑
- $k_b > k_f \rightarrow K_c = \frac{k_f}{k_b} \rightarrow K_c \downarrow$
- More reactant, less product $\rightarrow K_c = \frac{[B]}{[A]} \rightarrow K_c \downarrow$

- **Exothermic reaction** is favoured with decrease in temperature.



$$A \rightleftharpoons B;\ \Delta H = -ve,\ K_c = \frac{[B]}{[A]} = \frac{k_f}{k_b}$$

Temp. ↑ → Equilibrium shift to left → Absorb heat → Temp. decrease ↓
- $k_b > k_f \rightarrow K_c = \frac{k_f}{k_b} \rightarrow K_c \downarrow$
- More reactant, less product $\rightarrow K_c = \frac{[B]}{[A]} \rightarrow K_c \downarrow$

Temp. ↓ → Equilibrium shift to right → Release heat → Temp. increase ↑
- $k_f > k_b \rightarrow K_c = \frac{k_f}{k_b} \rightarrow K_c \uparrow$
- More product, less reactant $\rightarrow K_c = \frac{[B]}{[A]} \rightarrow K_c \uparrow$

Effect of Inert Gas Addition

- Addition of an inert gas at constant volume has no effect on equilibrium.
- Addition of an inert gas at constant pressure will shift the equilibrium towards larger number of gaseous molecules.

Condition		Effect
$\Delta V = 0$, V = Constant	$\Delta n = 0$, no gaseous	No effect
At constant pressure	$\Delta n = 0$	No effect
	$\Delta n > 0$	Forward shift
	$\Delta n < 0$	Backward shift

CONCEPT MAP

ACID-BASE TITRATIONS

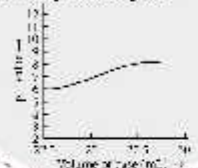
Titrations have wide applications in food industry, medical field as well as in automotive industry. In medical, it is used to determine proper concentration of anaesthetics and to measure glucose level in the blood. In automotive, it is used during production of biodiesel fuel.

Class XI

Titration Curves

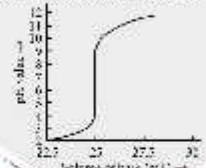
Weak acid-Weak base

In the titration of CH_3COOH with NH_4OH the pH at the equivalence point lies between 6.5–7.5 but no sharp change in pH is observed in these titrations. Thus, no simple indicator can be used for the detection of the equivalence point.



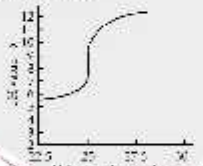
Strong acid-Strong base

In the titration of HCl with NaOH, the equivalence point lies in the pH range of 6–8. Thus, methyl orange (pH range 3.2–4.5), methyl red (pH range 4.2–6.3) and phenolphthalein (pH range 8.3–10) will be the suitable indicators.



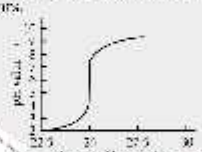
Weak acid-Strong base

In the titration of CH_3COOH with NaOH, the equivalence point lies between the pH range 7.3–10. Hence, phenolphthalein (pH range 8.3–10) will be the suitable indicator.



Strong acid-Weak base

In the titration of HCl with NH_4OH, the pH at equivalence point lies between the pH range 4–6.5. Thus, methyl orange (pH range 3.1–4.4) or methyl red (pH range 4.2–6.3) will be the suitable indicators.



Important Terms

- *Titration* is the measurement of the volume of a solution of one reactant that is required to react completely with a measured amount of another reactant.
- The solution which is to be titrated is called *titrate*.
- The solution with which the titration is to be done is called the *titrant*.
- The substance usually added into the solution taken in the titration flask to detect the equivalence point is called an *indicator*. The *equivalence point* is the ideal point for the completion of titration, i.e., it is the exact point in a titration when moles of one titrant becomes equal to the moles of the substance being titrated.
- The *end point* is the point at which the indicator just changes its colour. End point indicates that equivalence point has been reached.
- The point at which there is a sudden change in pH when a very small amount of the titrant is added to the titrate is called *point of inflection*.
- The curve between pH values of the solution and the volume of titrant added as the titrant on proceeds is called a *titration curve*.
- The determination of concentration of bases by titration with a standard acid is called *acidimetry*.
- The determination of concentration of acids by titration with a standard base is called *alkalimetry*.

Types of Indicators

- *Self indicator* : A substance is said to be self indicator if it itself acts as an indicator in titration e.g., potassium permanganate ($KMnO_4$) and oxalic acid ($COOH)_2$.
- *External indicator* : In a redox titration, the end point is detected with the help of a substance which is not added to the solution being titrated but used outside the titrating system, e.g., potassium ferricyanide.
- *Internal indicator* : The substance or reagents which are added to the solution in the conical flask or beaker during the titration to find out the end point, e.g., phenolphthalein, methyl orange, starch solution, etc.

MASTERJEE CLASSES

MasterJEE
IIT-JEE | Medical | Foundations