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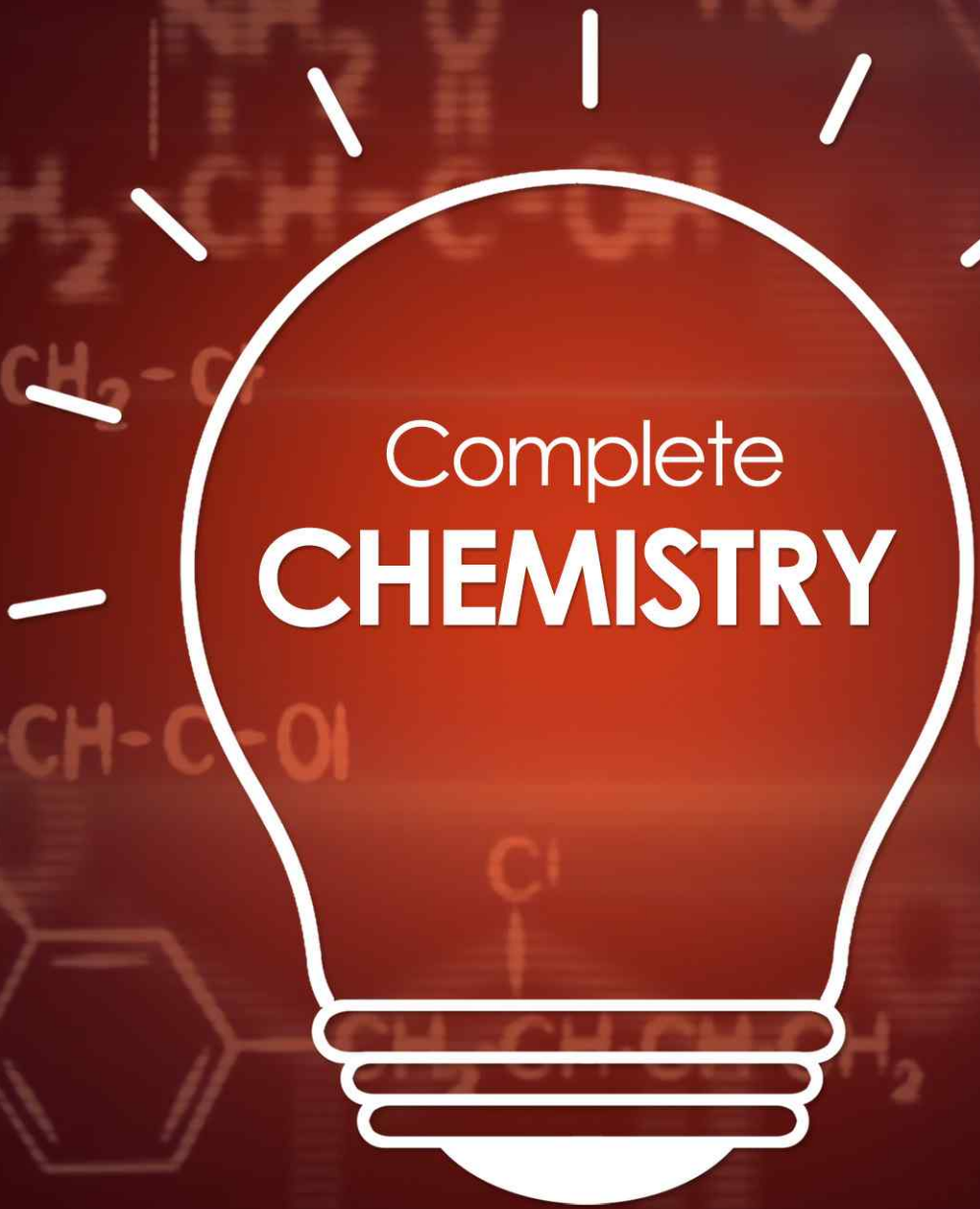


Complete CHEMISTRY

IIT-JEE · NEET · CBSE eBOOKS

CLASS 11&12th

CLASS 12th

Surface Chemistry

01. Introduction

The phenomenon of attracting and retaining the molecules of a substance on the surface of a liquid or solid resulting into a higher concentration of molecules on the surface is called *adsorption*.

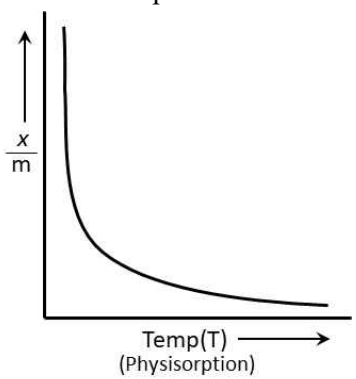
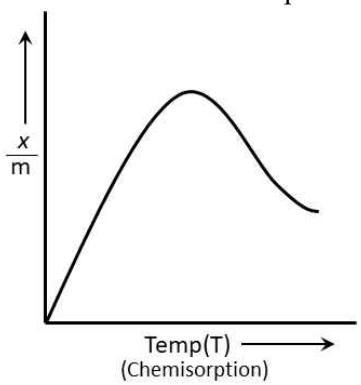
Positive adsorption : When the concentration of the adsorbate is more on the surface of the adsorbent than in the bulk, it is known as positive adsorption.

Negative adsorption : If the concentration of the adsorbate is less on the surface of the adsorbent than in the bulk, it is known as negative adsorption.

Factor Affecting Adsorption

(i) Nature and surface area of the adsorbent
(ii) Nature of adsorbate
(iii) Temperature
(iv) Concentration/Pressure

02. Comparison of Physi-Sorption and Chemi-Sorption

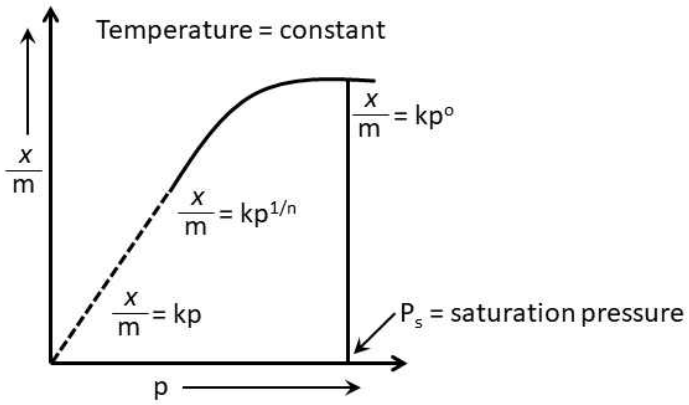
	Physical adsorption	**Chemical adsorption**
(i)	It is caused by intermolecular Vander Waals' forces.	It is caused by chemical bond formation.
(ii)	It is reversible.	It is irreversible.
(iii)	It depends on the nature of gas. More easily liquefiable gases are adsorbed readily.	It depends on the nature of gas. Gases which form compounds with the adsorbent exhibit chemical-sorption
(iv)	Low temperature is favourable. It decreases with increase of temperature. 	High temperature is favourable. It increase with increase of temperature. 

03. Adsorption Isotherms

A relation between x/m (amount adsorbed per unit weight of adsorbent) and the equilibrium concentration or pressure at a fixed temperature is called *adsorption isotherm*.

(i) **Freundlich Adsorption Isotherm :** it is represented as

$\frac{x}{m} = kC^{1/n}$ or $\frac{x}{m} = kP^{1/n}$, depending on whether the adsorbate is a solution or a gas.



(a) **At very low pressure :** At very low pressures, the graph is nearly straight line.

$\frac{x}{m} \propto P$ or $\frac{x}{m} = k \cdot P$

(b) **At intermediate range of pressure :** At these pressures graph is curved

$\frac{x}{m} \propto P^{1/n}$ or $\frac{x}{m} = k \cdot P^{1/n}$ (probable 'n' value is 0.1 – 0.5)

(c) **At very high pressure :** The graph becomes parallel to x-axis

$\frac{x}{m} \propto P^{0}$ or $\frac{x}{m} = k$

(ii) **Langmuir adsorption isotherm :** Langmuir considers the formation of only a monolayer of adsorbate on adsorbent.

(a) It takes place on the surface of solids till a unimolecular layer is formed.

(b) Adsorption is a result of condensation of adsorbate molecules on solid surface and their evaporation.

(c) At equilibrium, the rate of condensation becomes equal to the rate of evaporation.

$\frac{x}{m} = \frac{ap}{1+bp}$

04. Catalysis

The systematic study of the effect of different foreign substances on the rates of chemical reactions was made by Berzelins; in 1835. He named these foreign substances as catalyst. Which alter the rate of a chemical reaction and themselves remain chemically and quantitatively unchanged after the reaction, are known as catalysts and the phenomenon is known as catalysis.

05. Types of Catalysis

(i) **Homogeneous Catalysis :** When the reactants and the catalyst are in the same physical state, i.e. in the same phase, it is called homogeneous catalysis.

Example

$$2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$$

(ii) **Heterogeneous Catalysis :** When the catalyst and the reactants are not in the same physical state i.e. not in the same phase, it is called heterogeneous catalysis.

Example

$$NO_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$$

06. Types of Catalysts

(i) **Positive catalyst (or catalyst) :** The substance which increases the rate of a reaction is known as a positive catalyst. Normally the term catalyst is used for positive catalyst.

Example

$$2KClO_3(s) \xrightarrow{NO(g)} 2KCl(s) + 3O_2(g)$$

(ii) **Negative catalyst (or inhibitor) :** The substance which decreases the rate of chemical reaction is called negative catalyst or inhibitor.

Example

$$2H_2O_2(l) \xrightarrow[\text{or Acetamide}]{H_3PO_4 \text{ or Glycerol}} 2H_2O(l) + O_2(g)$$

(iii) **Auto-catalysts :** When one of the products of the reaction begins to act as a catalyst, it is called auto-catalyst.

Example

$$CH_3COOC_2H_5 + H_2O \rightarrow \underset{\text{Auto-catalyst}}{CH_3COOH} + C_2H_5OH$$

(iv) **Induced catalyst :** When a chemical reaction enhances the rate of another chemical reaction, it is called induced catalysis

Example

$$\underset{\text{Sod. sulphite}}{N_2SO_3} + \underset{\text{air}}{1/2O_2} \rightarrow \underset{\text{Sod. sulphate}}{N_2SO_4}$$

07. Promoters

Those substance which do not themselves act as catalysts but their presence increases the activity of a catalyst are called catalytic promoters.

Example

$$N_2(g) + 3H_2(g) \xrightarrow{Fe\text{-}Mo\ Alloy} 2NH_3(g)$$