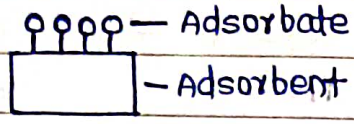
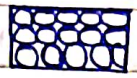
Surface Chemistry

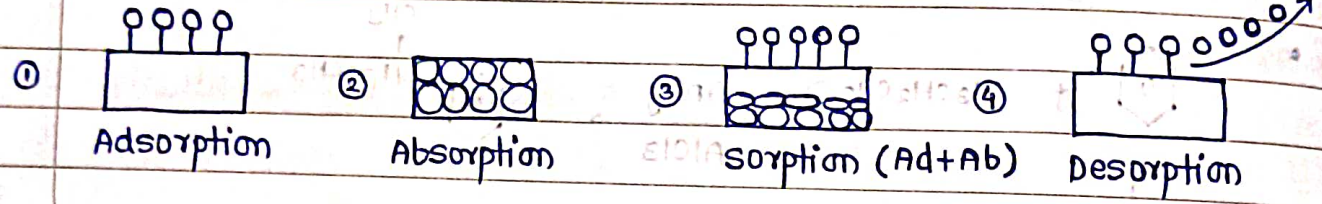
DATE

- **Adsorption:**
  - Accumulation of one substance over the surface of another surface
  - Surface phenomenon
  - Fast



- **Absorption**
  - Accumulation of one substance into the bulk of another substance
  - Bulk phenomenon
  - slow





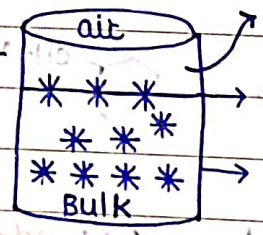
$H_2 \longrightarrow Ni$ water by sponge When chalk is

$CO_2 \longrightarrow$ charcoal moisture by $CaCl_2$ dipped into ink

moisture $\longrightarrow$ silica gel NH_3 by H_2O

$NH_3 \longrightarrow$ charcoal

- **Cause of adsorption:**



UnBalanced Residual Force

Surface

Balanced interactions

when they get adsorbed by other sub. their energy is minimised and Adsorption is a exothermic process

- $\Delta H = -ve$ (Heat is released)
  $\Delta S = -ve$ (entropy)
- $\Delta G = \Delta H - (T\Delta S)$
  - Gibbs Free energy

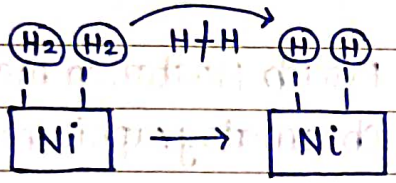
① $\Delta G = -ve$ — spontaneous

② $\Delta G = 0$ — equilibrium

③ $\Delta G = +ve$ — Non-spontaneous

- **Types of Adsorption:**

	Physisorption	Chemisorption
①	Adsorbate - Adsorbent = Weak	① Adsorbate - Adsorbent = Chemical
②	Affinity Based Vandeewaal weak adsorption	② Valency Based strong adsorption
③	During adsorption no new compound Formed	③ During adsorption new compound Formed
④	Heat of adsorption $\Delta H = 20-40$ KJ/mol	④ Heat of adsorption $\Delta H = 80-240$ KJ/mol
⑤	Not specific, reversible, multilayered	⑤ Specific, irreversible, unilayered
⑥	No need of Activation energy	⑥ Specific activation energy required.
⑦	Favourable at low temp.	⑦ Favourable at comparatively High Temp.
⑧	H_2 on charcoal	⑧ H_2 on Ni



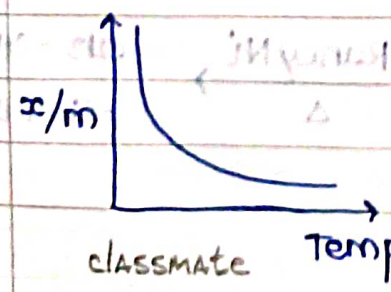
- Factors affecting adsorption: $\frac{x}{m}$ — mass of gas adsorbed / mass of adsorbent → Rate of adsorption

① Adsorbent - more the surface area provided - more will rate of adsorption
- Silica gel, Alumina gel, charcoal

② Adsorbate - (gas) ⟶ solid
- The temperature at which gas can liquify is called Critical Temp.

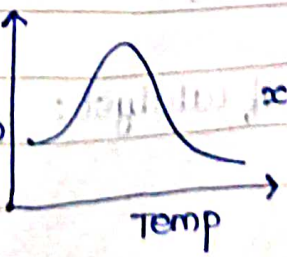
Critical temp ↑ ∝ liquification easily ↑ ∝ Rate of adsorption ↑

③ Temperature: (at adsorption isobar) at constant pressure:



physisorption

$x/m \propto \frac{1}{T}$



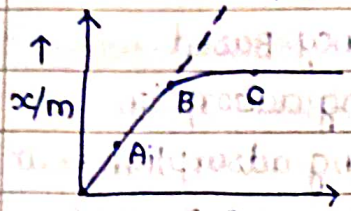
chemisorption

$x/m \propto T \rightarrow x/m \propto \frac{1}{T}$

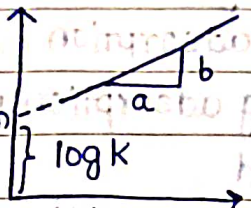
DATE

④ Pressure $x/m \propto p^{1/n}$ — Adsorption Isotherm (at const Temp)

$x/m = kp^{1/n} \longrightarrow \log x/m = \log k + \frac{1}{n} \log P$



Freundlich adsorption Isotherm



$\tan\theta = \frac{a}{b} = \frac{1}{n}$

$\frac{1}{n} = 0$ to 1

$\downarrow$

Physisorption

$x/m \propto c^{1/n}$

$x/m = kc^{1/n}$

① $\frac{1}{n} = 0$ x/m = constant

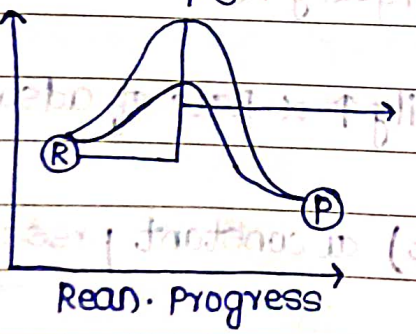
② $\frac{1}{n} = 1$ $x/m = kp$

- Applications of adsorption:

① Vaccum production
② Gas mask
③ Humidity
④ Removal of coloured impurity
⑤ catalysis - Heterogenous catalyst
⑥ Inert gas seperated by charcoal
⑦ Adsorption in treatment
⑧ Froath Floatation method
⑨ Chromatographic method

- Catalysis: (catalyst = Berzelius)

Increases the rate of reaction without taking part in it by lowering down the activation energy.



$2\,KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2\uparrow$

$2\,KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + 3O_2\uparrow$

$CH_2 = CH_2 + H_2 \xrightarrow[\Delta]{Raney\ Ni} CH_3 - CH_3$ Ethane

- Properties of catalyst:

① During reaction course catalyst remain unchanged.
② small qt. of catalyst required to carry larger reaction.
③ cannot initiate reaction from wherever it added the catalyst from that point it will catalyse the Reaction
④ Catalyst are specific in nature.
⑤ It will not alter the position of equilibrium.
⑥ Positive catalyst – promoter

$$N_2 + 3H_2 \xrightarrow[Mo]{Fe} 2NH_3$$

⑦ Negative catalyst – Inhibitor

$$N_2 + 3H_2 \xrightarrow[H_2S/CO]{Fe} 2NH_3 \downarrow$$

- Homogenous catalysis:

$$2SO_2 + O_2 \xrightarrow{NO} 2SO_3 \text{ (lead chamber)}$$

$$CH_3-\overset{\overset{O}{\|}}{C}-O-CH_3 \xrightarrow[H-OH]{H^{\oplus}} CH_3OH + CH_3COOH$$

Methyl acetate

- Heterogenous catalyst:

$$2SO_2 + O_2 \xrightarrow{Pt} 2SO_3 \text{ (contact process)}$$

$$N_2 + 3H_2 \xrightarrow[Mo]{Fe} 2NH_3 \text{ (Haber's process)}$$

- Autocatalysis:

$$CH_3-\overset{\overset{O}{\|}}{C}-OC_2H_5 \xrightarrow[H-OH]{H^{\oplus}} \underbrace{C_2H_5OH + CH_3COOH}_{\text{acidic environment}}$$

ethyl acetate

- Induced catalysis:

$$Na_2SO_3 \xrightarrow{[O]} Na_2SO_4$$

$Na_3AsO_3 \xrightarrow{[O]}$ No Reaction

$Na_2SO_3 + Na_3AsO_3 \xrightarrow{O_2} Na_2SO_4 + Na_3AsO_4$

- Intermediate compound Formation theory : Homogenous catalyst

$A + B \xrightarrow{K} A-B$

Reactant catalyst Product

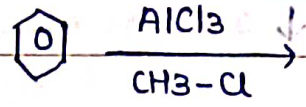
(I) $A + K \longrightarrow A-K$

React catalyst Rean Interm.

(II) $A-K + B \longrightarrow A-B + K$

Product catalyst

① $2SO_2 + O_2 \xrightarrow{NO} 2SO_3$

② 

- Adsorption theory: Heterogenous catalyst

① Diffusion of Reactant near catalyst
② Adsorption of reactant at surface of catalyst
③ Occurrence of Reaction at the surface of catalyst and formation of product.
④ Desorption of Formed product from catalyst
⑤ Diffusion of product away from catalyst surface.

- Enzyme :- Biocatalyst

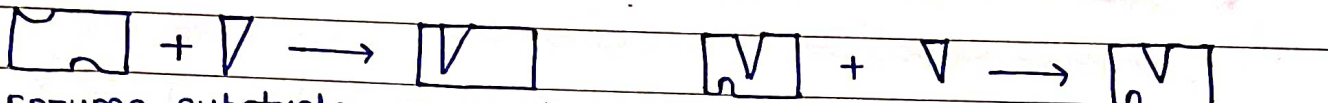
Enzyme + substrate ⟶ E-Z complex ⟶ Enzyme + product

- Highly efficient
- optimum pH (5-7)
- specific in nature
- Collidal tem nature.
- Optimum temp (25-37°C)

DATE

① Invertase → Sucrose — Glu + Fructose
② Diastase → Maltose — 2 Glucose.
③ Zymase → Glucose — $2C_2H_5OH$
④ Amylase → starch — n. glucose - β
⑤ Lactose → lactase — β-glucose + β-galactose
⑥ Urease → Urea — $NH_3 + CO_2$
⑦ pepsin / trypsin → protien — α Amino-acid
⑧ lipase → Fatty acid + glucose — lipid

• Induced-Fit mechanism Look and key model - Rigid



Enzyme substrate ES complex Enzyme substrate ES complex

• shape - selective catalysis :

- Natural / artificial microporous aluminosilicate network.
- zeolite (Boiling stone)
- Al is replaced by Si $M[(AlO_2)_x(SiO_2)_y]n.H_2O$
- ZSM-5 : alcohol → hydrocarbon
- 260 nm - 740 nm (gasoline)