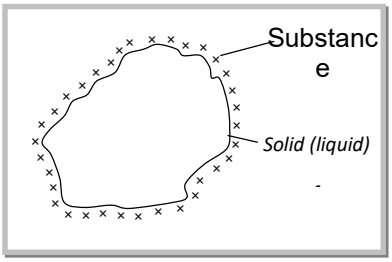
Adsorption.

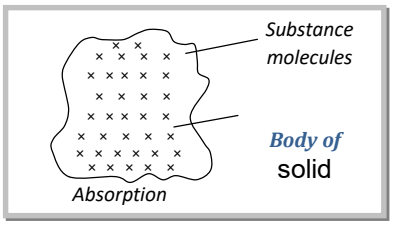
(1) **Definition:** The phenomenon of attracting and retaining the molecules of a substance on the surface of a liquid or solid resulting in to higher concentration of the molecules on the surface is called **adsorption**.



(2) **Causes of adsorption**:Unbalanced forces of attraction or free valencies which is present at the solid or liquid surface, have the property to attract and retain the molecules of a gas or a dissolved substance on to their surfaces with which they come in contact.

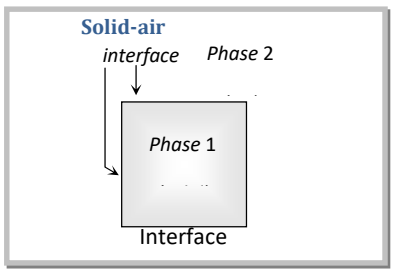
Example**:**(i)Ammonia gas placed in contact with charcoal gets adsorbed on the charcoal whereas ammonia gas placed in contact with water gets absorbed into water, giving NH_4OH solution of uniform concentration.

(ii) If silica gel is placed in a vessel containing water vapors, the latter are adsorbed on the former. On the other hand, if anhydrous $CaCl_2$ is kept in place of silica gel, absorption takes places as the water vapors are uniformly distributed in $CaCl_2$ to form hydrated calcium chloride $(CaCl_2.2H_2O)$



Some basic terms which are used in adsorption

Interface: Any surface is a plane which separates any two phases in contact with each other. The plane which separates any two phase is generally called an **interface** between the two phases.



Adsorbate and Adsorbent: The substance which gets adsorbed on any surface is called **adsorbate** for example, if a gas gets adsorbed on to the surface of a solid, then the gas is termed as the adsorbate.

The substance on the surface of which adsorption takes place is called **adsorbent**.

Adsorbent may be a solid or a liquid metal powders. Powdered

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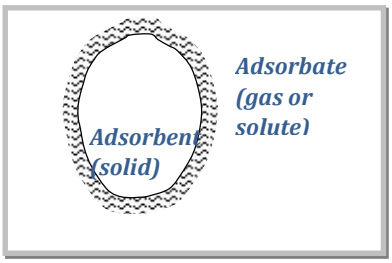
<td> 
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<td>charcoal, animal charcoal silica powder etc. are commonly used as adsorbents.</td>
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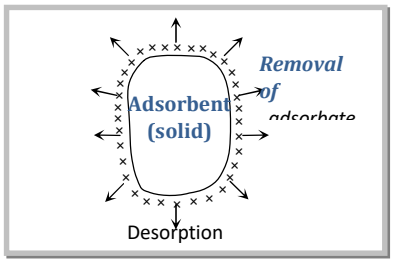
<td>Desorption:The removal of the adsorbed substance from a surface is called desorption.
 
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<td>Absorption:When the molecules of a substance are uniformly distributed throughout the body of a solid or liquid. This phenomenon is called absorption.</td>
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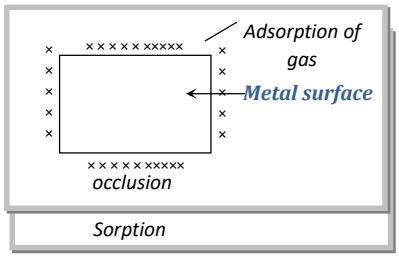
<td>Sorption:The phenomenon in which adsorption and absorption occur simultaneously is called sorption.
 

Mc. Bain introduced a general term sorption describing both the processes, however adsorption is instantaneous i.e. a fast process while absorption is a slow process.</td>
<td>Occlusion:When adsorption of gases occur on the surface of metals this is called occlusion.</td>
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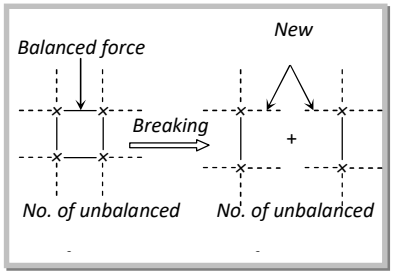
Difference between adsorption and absorption

Adsorption	**Absorption**
It is a surface phenomenon.	**It concerns with the whole mass of the absorbent.**
In it, the substance is only retained on the surface and does not go into the bulk or interior of the solid or liquid.	**It implies that a substance is uniformly distributed, through the body of the solid or liquid.**
In it the concentration of the adsorbed molecules is always greater at the free phase.	In it the concentration is low.
It is rapid in the beginning and slows down near the equilibrium.	**It occurs at the uniform rate.**
Examples: (i) Water vapors adsorbed by silica gel. (ii) NH_3 is adsorbed by charcoal. (iii) N_2 is adsorbed on mica. (iv) O_2 is adsorbed on tungsten surface (v) Decolourisation of sugar solution by activated or animal charcoal. (vi) Ink is adsorbed by blotting paper.	Examples : (i) Water vapors absorbed by anhydrous $CaCl_2$ (ii) NH_3 is absorbed in water forming NH_4OH

(3) **Surface forces:**Only the surface atoms of an adsorbent play an active role in adsorption. These atoms possess unbalanced forces of various types such as, Vander Waal's forces and chemical bond forces.

Thus**, the residual force-field on a free surface which is responsible for adsorption is produced**. For example, when a solid substance is broken into



two pieces, two new surfaces are formed and therefore, the number of unbalanced forces becomes more. As a result the tendency for adsorption become large.

(4) **Reversible and Irreversible adsorption:**The adsorption is reversible, if the adsorbate can be easily removed from the surface of the adsorbent by physical methods. If the adsorbate cannot be easily removed from the surface of the adsorbent is called irreversible adsorption.

(i) **Example for Reversible adsorption:**A gas adsorbed on a solid surface can be completely removed in vacuum.

(ii) **Example for Irreversible adsorption:** Adsorption of O_2 on tungsten adsorbent.

(5) **Characteristics of adsorption**

(i) Adsorption refers to the existence of a higher concentration of any particular component at the surface of a liquid or a solid phase.

(ii) Adsorption is accompanied by decrease in the ΔG (free energy charge) of the system when $\boxed{\Delta G = 0}$, **adsorption equilibrium is said to be established.**

(iii) Adsorption is invariably accompanied by evolution of heat, i.e. it is an exothermic process. In other words, **ΔH of adsorption is always negative.**

(iv) When a gas is adsorbed, the freedom of movement of its molecules becomes restricted. On account of it decrease in the entropy of the gas after adsorption, i.e. **ΔS is negative.**
Adsorption is thus accompanied by decrease in enthalpy as well as decrease in entropy of the system an ΔG also decreases.
(v) For a process to be spontaneous, the thermodynamic requirement is that ΔG **must be negative**, i.e. there is decrease in free energy. On the basis of **Gibb's Helmholtz equation**, $\boxed{\Delta G = \Delta H - T\Delta S}$, ΔG can be negative if ΔH has sufficiently high negative value and $T\Delta S$ **has positive value.**

Note:When adsorbents are porous, the adsorbate is actually condensed in the pores. This is called **Capillary Condensation.**