CBSE Class 12 physics

Important Questions

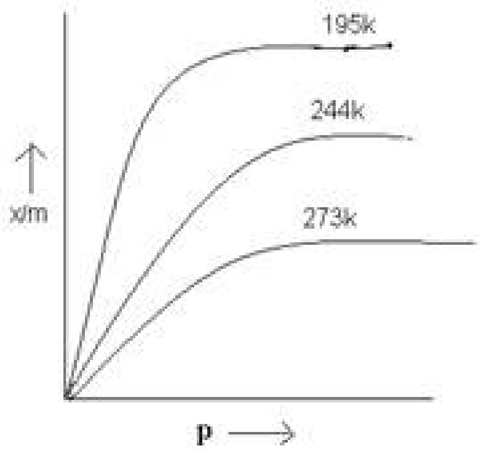
Chapter 5

Surface Chemistry

5 Marks Questions

1. Explain Freundlich adsorption isotherm.

Ans. Freundlich adsorption isotherm gives an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature The relationship is $\frac{x}{m} = K.P^{1/n\,(N>1)}$ Where x is a mass of gas adsorbed on mass m of adsorbent at pressure P, K &n are constant that depend on the nature of adsorbent and adsorbate – The Relationship can be represented by plotting curves between x/m and P. They show that at a fix pressure, the physical adsorption decreases with increase in temperature.



2. What are homogeneous and heterogeneous catalysis? Give example.

Ans. <u>Homogeneous catalysis –</u>

When reactant and catalyst are in the same phase, the process is said to be homogeneous catalysis.

Examples –

(1) Oxidation of sulphur dioxide in the presence of oxygen gas and nitric oxide gas as

catalyst.

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

(2) Hydrolysis of methyl acetate catalysed by H^+ ions.

$$CH_3COOCH_3(\ell) + H_20\ (\ell) \xrightarrow{H_2SO_4(\ell 0)} CH_3COOH(aq) + CH_3OH\ (aq)$$

(3) Hydrolysis of sugar catalysed by H_2S0_4.

Hetrogeneous Catalysis –

The catalytic process in which the reactant and catalyst are in different phases is known as heterogeneous catalysis.

Examples:-

(1) Oxidation of sulphur dioxide in presence of platinum.

$$O_2(g) + 2SO_2(g) \xrightarrow{pt(s)} 2SO_3\ (g)$$

(2) Preparation of ammonia by Haber's process

$$N_2(g) + 3H_2\ (g) \xrightarrow{Fe(S)} 2NH_3(g)$$

(3) Oxidation of ammonia in Ostwald's process.

$$4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g)\ + 6H_2O\ (g)$$

3. Explain the mechanism of enzyme catalysis.

Ans. Mechanism of enzyme catalysed reactions-

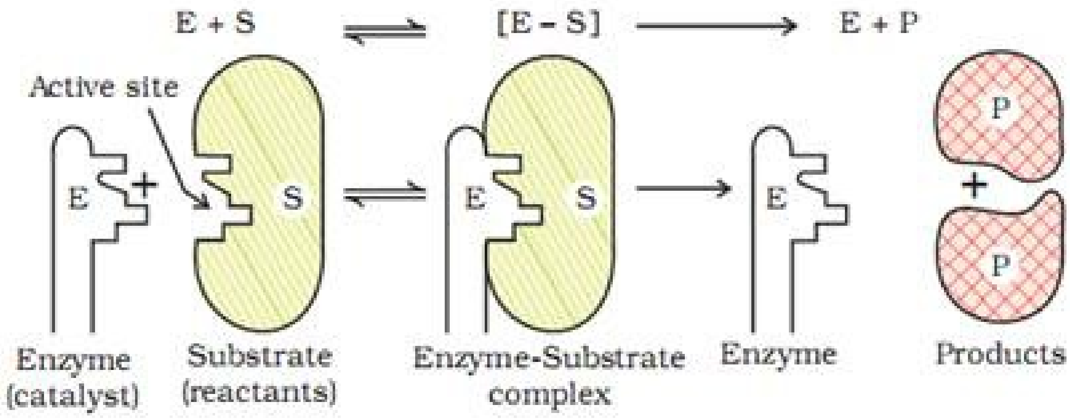
There are active centres or cavities on the surface of enzyme particles. The molecules of the reaction or substrate which have complementary shape fit into these just like a key fits into a lock. This forms an activated complex which decomposes to yield products. The reactions proceed in two steps –

Step 1: Binding of enzymes to substrate to form activated complex.

$E + S \dashrightarrow ES$

Step 2 : Decomposition of complex to form products.

$ES \dashrightarrow E + P.$



4. What is the difference between physisorption and chemisorption?

Ans.

Physisorption		**Chemisorption**
1.	In this type of adsorption, the adsorbate is attached to the surface of the adsorbent with weak van der Waal's forces of attraction.	In this type of adsorption, strong chemical bonds are formed between the adsorbate and the surface of the adsorbent.
2.	No new compound is formed in the process.	New compounds are formed at the surface of the adsorbent.
3.	It is generally found to be reversible in nature.	It is usually irreversible in nature.
4.	Enthalpy of adsorption is low as weak van der Waal's forces of attraction are involved. The values lie in the range of $20 - 40\,\text{kJ mol}^{-1}$.	Enthalpy of adsorption is high as chemical bonds are formed. The values lie in the range of $40 - 400\,\text{kJ mol}^{-1}$.
5.	It is favoured by low temperature conditions.	It is favoured by high temperature conditions.

6.	It is an example of multi-layer adsorption	It is an example of mono-layer adsorption.

5. What are the factors which influence the adsorption of a gas on a solid?

Ans. There are various factors that affect the rate of adsorption of a gas on a solid surface.

(1) Nature of the gas: Easily liquefiable gases such as NH_3, HCl etc. are adsorbed to a great extent in comparison to gases such as H_2, O_2 etc. This is because Van der Waal's forces are stronger in easily liquefiable gases.

(2) Surface area of the solid

The greater the surface area of the adsorbent, the greater is the adsorption of a gas on the solid surface.

(3) Effect of pressure

Adsorption is a reversible process and is accompanied by a decrease in pressure. Therefore, adsorption increases with an increase in pressure.

(4) Effect of temperature

Adsorption is an exothermic process. Thus, in accordance with Le-Chatelier's principle, the magnitude of adsorption decreases with an increase in temperature.

6. What is an adsorption isotherm? Describe Freundlich adsorption isotherm.

Ans. The plot between the extent of adsorption $\left(\frac{x}{m}\right)$ against the pressure of gas (*P)* at constant temperature (T) is called the adsorption isotherm.

Freundlich adsorption isotherm:

Freundlich adsorption isotherm gives an empirical relationship between the quantity of gas adsorbed by the unit mass of solid adsorbent and pressure at a specific temperature.

From the given plot it is clear that at pressure *P*S, $\left(\frac{x}{m}\right)$ reaches the maximum valve. *Ps* is called the saturation pressure. Three cases arise from the graph now.

Case I- At low pressure:

The plot is straight and sloping, indicating that the pressure in directly proportional to $\left(\frac{x}{m}\right)$

i.e., $\frac{x}{m} \alpha P$.

$\frac{x}{m} kP$ (k is constant)

Case II- At high pressure:

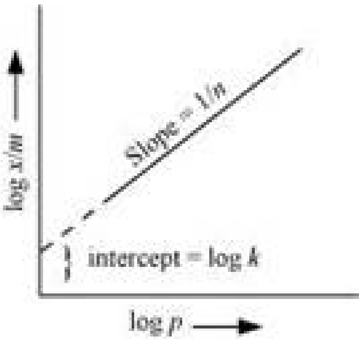
When pressure exceeds the saturated pressure, $\left(\frac{x}{m}\right)$ becomes independent of P values.

$\frac{x}{m} \alpha P^{\circ}$

$\frac{x}{m} kP^{\circ}$

Case III- At intermediate pressure:

At intermediate pressure, $\left(\frac{x}{m}\right)$ depends on *P* raised to the powers between 0 and 1. This relationship is known as the Freundlich adsorption isotherm.



$$\frac{x}{m} \alpha P^{\frac{1}{n}}$$

$$\frac{x}{m} kP^{\frac{1}{n}} \quad n > 1$$

Now, taking log:

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log P$$

On plotting the graph between log $\left(\frac{x}{m}\right)$ and log P, a straight line is obtained with the slope equal to $\frac{1}{n}$ and the intercept equal to log k.

7. **What role does adsorption play in heterogeneous catalysis?**

Ans. Heterogeneous catalysis:

A catalytic process in which the catalyst and the reactants are present in different phases is known as a heterogeneous catalysis. This heterogeneous catalytic action can be explained in terms of the adsorption theory. The mechanism of catalysis involves the following steps:

(i) Adsorption of reactant molecules on the catalyst surface.

(ii) Occurrence of a chemical reaction through the formation of an intermediate.

(iii) De-sorption of products from the catalyst surface

(iv) Diffusion of products away from the catalyst surface.

In this process, the reactants are usually present in the gaseous state and the catalyst is present in the solid state. Gaseous molecules are then adsorbed on the surface of the catalyst. As the concentration of reactants on the surface of the catalyst increases, the rate of reaction also increases. In such reactions, the products have very less affinity for the catalyst and are quickly desorbed, thereby making the surface free for other reactants.

8. How are the colloidal solutions classified on the basis of physical states of the dispersed phase and dispersion medium?

Ans. One criterion for classifying colloids is the physical state of the dispersed phase and dispersion medium. Depending upon the type of the dispersed phase and dispersion medium (solid, liquid, or gas), there can be eight types of colloidal systems.

Dispersed phase		Dispersion medium	Type of colloid	Example
1.	Solid	Solid	Solid Sol	Gemstone
2.	Solid	Liquid	Sol	Paint
3.	Solid	Gas	Aerosol	Smoke
4.	Liquid	Solid	Gel	Cheese
5.	Liquid	Liquid	Emulsion	Milk
6.	Liquid	Gas	Aerosol	Fog
7.	Gas	Solid	Solid foam	Pumice stone
8.	Gas	Liquid	Foam	Froth

9. What are lyophilic and lyophobic sols? Give one example of each type. Why are hydrophobic sols easily coagulated?

Ans. (i) Lyophilic sols:

Colloidal sols that are formed by mixing substances such as gum, gelatin, starch, etc. with a suitable liquid (dispersion medium) are called lyophilic sols. These sols are reversible in nature i.e., if two constituents of the sol are separated by any means (such as evaporation), then the sol can be prepared again by simply mixing the dispersion medium with the dispersion phase and shaking the mixture.

(ii) Lyophobic sols:

When substances such as metals and their sulphides etc. are mixed with the dispersion medium, they do not form colloidal sols. Their colloidal sols can be prepared only by special methods. Such sols are called lyophobic sols. These sols are irreversible in nature. For example: sols of metals.

Now, the stability of hydrophilic sols depends on two things- the presence of a charge and the salvation of colloidal particles. On the other hand, the stability of hydrophobic sols is only because of the presence of a charge. Therefore, the latter are much less stable than the former. If the charge of hydrophobic sols is removed (by addition of electrolytes), then the particles present in them come closer and form aggregates, leading to precipitation.

10. What is the difference between multimolecular and macromolecular colloids? Give one example of each. How are associated colloids different from these two types of colloids?

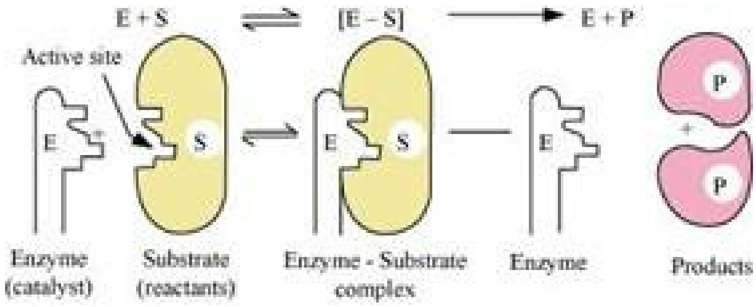
Ans. (i) In multi-molecular colloids, the colloidal particles are an aggregate of atoms or small molecules with a diameter of less than 1 nm. The molecules in the aggregate are held together by van der Waal's forces of attraction. Examples of such colloids include gold sol and sulphur sol.

(ii) In macro-molecular colloids, the colloidal particles are large molecules having colloidal dimensions. These particles have a high molecular mass. When these particles are dissolved in a liquid, sol is obtained. For example: starch, nylon, cellulose, etc.

(iii) Certain substances tend to behave like normal electrolytes at lower concentrations. However, at higher concentrations, these substances behave as colloidal solutions due to the formation of aggregated particles. Such colloids are called aggregated colloids.

11. What are enzymes? Write in brief the mechanism of enzyme catalysis.

Ans.



Enzymes are basically protein molecules of high molecular masses. These form colloidal solutions when dissolved in water. These are complex, nitrogenous organic compounds produced by living plants and animals. Enzymes are also called 'biochemical catalysts'.

Mechanism of enzyme catalysis:

On the surface of the enzymes, various cavities are present with characteristic shapes. These cavities possess active groups such as $-NH_2, -COOH$ etc. The reactant molecules having a complementary shape fit into the cavities just like a key fits into a lock. This leads to the formation of an activated complex. This complex then decomposes to give the product.

Hence,

Step 1: $E + S \rightarrow ES +$

(Activated complex)

Step 2: $ES \rightarrow E + P$

12. Give four examples of heterogeneous catalysis.

Ans. (i) Oxidation of sulphur dioxide to form sulphur trioxide. In this reaction, Pt acts as a catalyst.

$$2SO_{2(g)} \xrightarrow{Pt_{(s)}} 2SO_{3(g)}$$

(ii) Formation of ammonia by the combination of dinitrogen and dihydrogen in the presence of finely divided iron.

$$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe_{(s)}} 2NH_{3(g)}$$

This process is called the Haber's process.

(iii) Oswald's process: Oxidation of ammonia to nitric oxide in the presence of platinum.

$$4NH_{3(g)} + 5O_{2(g)} \xrightarrow{Pt_{(s)}} 4NO_{(g)} + 6H_2O_{(g)}$$

(iv) Hydrogenation of vegetable oils in the presence of Ni.

$$\text{Vegetable oil}_{(l)} + H_{2(g)} \xrightarrow{Ni_{(s)}} \text{vegetable ghee}_{(s)}$$

13. Explain the following terms:

(i) Electrophoresis (ii) Coagulation

(iii) Dialysis (iv) Tyndall effect.

Ans. (i) Electrophoresis:

The movement of colloidal particles under the influence of an applied electric field is known as electrophoresis. Positively charged particles move to the cathode, while negatively charged particles move towards the anode. As the particles reach oppositely charged electrodes, they become neutral and get coagulated.

(ii) Coagulation:

The process of settling down of colloidal particles i.e., conversion of a colloid into a precipitate is called coagulation.

(iii) Dialysis

The process of removing a dissolved substance from a colloidal solution by the means of diffusion through a membrane is known as dialysis. This process is based on the principle that ions and small molecules can pass through animal membranes unlike colloidal particles.

(iv) Tyndall effect:

When a beam of light is allowed to pass through a colloidal solution, it becomes visible like a column of light. This is known as the Tyndall effect. This phenomenon takes place as particles of colloidal dimensions scatter light in all directions.