# CBSE NCERT Solutions for Class 12 Chemistry Chapter 7

***Back of Chapter Questions***

**5.1.** Write any two characteristics of Chemisorption.

**Solution:**

Chemisorption is highly specific in nature. In chemisorption, atoms and molecules are attached to the solid surface through chemical bonds (Covalent or ionic). Also it occurs only if there is a possibility of a chemical bond between the adsorbent and the adsorbate.

Chemisorption increases with an increase in the surface area of the adsorbent since there is an increase in the number of active sites.

**5.2.** Why does physisorption decrease with the increase of temperature?

**Solution:**

Physisorption is exothermic in nature meaning that when gas gets adsorbed on the solid surface, heat is evolved. Therefore, according to the Le-Chatelierers principle, when the temperature is increased the reverse process i.e. Desorption will be favoured. This means that physisorption occurs more readily at a lower temperature and decreases with increase in temperature.

**5.3.** Why are powdered substances more effective adsorbents than their crystalline forms?

**Solution:**

When a substance is in powdered form, its surface area is greater than when it is in crystalline form. So they are more effective adsorbents since the process of adsorption is directly proportional to the surface area of the adsorbent.

Concept Insight: With increase in surface area the adsorption also increases.

**5.4.** In Haber's process, hydrogen is obtained by reacting methane with steam in the presence of NiO as catalyst. The process is known as steam reforming. Why is it necessary to remove CO when ammonia is obtained by Haber's process?

**Solution:**

It is important to remove CO when ammonia is obtained as CO adversely affects the activity of the iron catalyst which is required in Haber's process.

**5.5.** Why is the ester hydrolysis slow in the beginning and becomes faster after sometime?

**Solution:**

Ester hydrolysis is represented by the word equation:

$$\text{Ester} + \text{Water} \rightarrow \text{Acid} + \text{Alcohol}$$

The acid formed as a product in the above reaction acts as a catalyst and makes the reaction faster i.e., it acts as an autocatalyst (Substances that act as catalysts in the same reaction in which they are obtained as products). So, ester hydrolysis is slow initially and becomes faster after some time as more acid is produced on the product side.

**5.6.** What is the role of desorption in the process of catalysis.

**Solution:**

Desorption (opposite of sorption) is a phenomenon in which a substance is released from the surface.

The role of desorption in the process of catalysis is to make the surface of the solid catalyst-free for the fresh adsorption of the reactants on the solid surface. This helps in making the surface available again for further reaction to take place.

**5.7.** What modification can you suggest in the Hardy Schulze law?

**Solution:**

Hardy-Schulze law states that 'Greater the valence of the flocculating ion added, the greater is its power to cause precipitation.'

The above stated law takes into consideration only the charge carried by an ion, not its size. The smaller the size of an ion, the more will be its polarising power. Since, both the size and the charge of an ion determine its polarizing power. Thus, the Hardy-Schulze law can be modified as 'Greater the polarising power of the flocculating ion added, the greater is its power to cause precipitation.'

**5.8.** Why is it essential to wash the precipitate with water before estimating it quantitatively?

**Solution:**

When a substance gets precipitated in any chemical reaction it always contains some traces of unwanted substances (unreacted reactants or catalyst and certain impurities). Some of the reactant ions may be adsorbed or may get adhered to the surface of the precipitate formed during the reaction. Most of these unwanted substances are water soluble. Therefore, it is important to wash the precipitate with water before estimating it quantitatively in order to remove these adsorbed ions or other such impurities. If this is not done, we might get an error during quantitative analysis of the precipitate.

## Back of Chapters

**5.1.** Distinguish between the meaning of the terms adsorption and absorption. Give one example of each.

**Solution:**

Adsorption: The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed as adsorption. Adsorption is a surface phenomenon. In this substance accumulates at surface only and does not penetrate into the adsorbent (material on the surface of which adsorption takes place)

Example: If a gas like oxygen, hydrogen is taken in a closed vessel containing powdered charcoal, it is observed that the pressure of the gas in the enclosed vessel decreases. The gas molecules concentrate at the surface of the charcoal, i.e., gases are adsorbed at the surface.

Absorption: It is a bulk phenomenon in which molecules get distributed uniformly throughout the material Instead of accumulating at the surface.

Example: Water absorbed by a dry sponge when dipped in a container of water.

**5.2.** What is the difference between physisorption and chemisorption?

| | **Physisorption** | **Chemisorption** |
|---|---|---|
| 1. | In this type of adsorption, the adsorbate is attached to the surface of the adsorbent with weak van der Waals forces of attraction. | In this type of adsorption, chemical bonds (ionic or covalent) are formed between the adsorbate and the surface of the adsorbent. |
| 2. | No new compound is formed during this process | New compounds are formed at the surface of the adsorbent. |
| 3. | It is usually reversible in nature. | It is usually irreversible in nature. |
| 4. | Low enthalpy of adsorption as weak van der Waals forces of attraction are involved.<br>The values lie in the range of $20 - 40$ kJ $mol^{-1}$. | High Enthalpy of adsorption as chemical bonds are formed.<br>The values lie in the range of $40 - 400$ kJ $mol^{-1}$. |
| 5. | Low temperature conditions are favourable. | High temperature conditions are favourable. |
| 6. | Example of a multi-layer adsorption | Example of a mono-layer adsorption. |

**5.3.** Give the reason why a finely divided substance is more effective as an adsorbent.

**Solution:**

Adsorption is a surface phenomenon and it is directly proportional to the surface area of the adsorbent. A finely divided substance has a larger surface area as compared to a non divided substance. And both the physisorption and

chemisorption phenomena increase with an increase in the surface area. Hence, a finely divided substance is more effective as an adsorbent.

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

**Solution:**

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

(1) Nature of the gas or adsorbate:

Easily liquefiable gases such as ammonia are adsorbed to a great extent in comparison to gases such as hydrogen and oxygen. This is because Van der Waals forces are stronger in gases which are easily liquefiable.

(2) Surface area of the adsorbent:

Greater the surface area of the adsorbent, greater will be the adsorption of a gas on the adsorbent.

(3) Effect of temperature

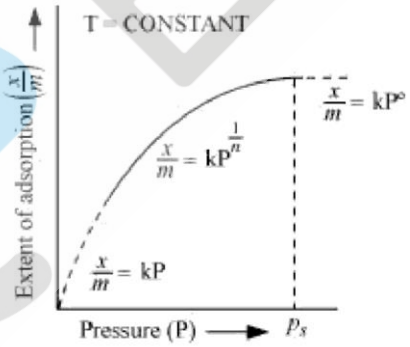
Adsorption is an exothermic process and according to Le-Chatelier's principle the extent of adsorption decreases with an increase in temperature.

(4) Effect of pressure

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

**5.5.** What is an adsorption isotherm? Describe Freundlich Adsorption isotherm.

**Solution:**




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

Where x is the mass of gas adsorbed on mass m of the adsorbent under pressure P. k and n are constants that depend on the nature of adsorbent.

**Freundlich adsorption isotherm:**

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

From the given plot it is clear that at pressure $P_s$, $\frac{x}{m}$ reaches the maximum value. This 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 $\frac{x}{m}$ i.e., $\frac{x}{m} \propto P$

$\frac{x}{m} = k\,P$ (k is a constant)

**Case II- At high pressure:**

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

$\frac{x}{m} \propto P^0$

$\frac{x}{m} \propto kP^0$

**Case III- At intermediate pressure:**

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

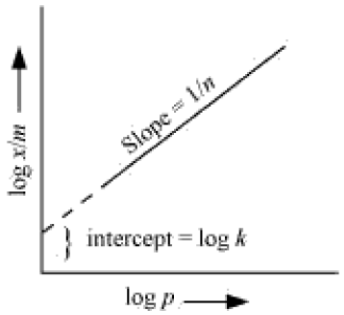
$\frac{x}{m} \propto P^{\frac{1}{n}}$

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

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, we get a straight line with the slope equal to $\frac{1}{n}$ and the intercept equal to log k.




**5.6.** What do you understand by activation of adsorbent? How is it achieved?

**Solution:**

Increasing the adsorbing power of the adsorbent is called as activation of adsorbent. Some of the ways in which activation of adsorbent can be done is:

(i) By increasing the surface area of the adsorbent. This is achieved by breaking it into smaller pieces or powdering it.

(ii) By making the surface of adsorbent rough.

(iii) Specific treatments can also lead to the activation of the adsorbent, For example, wood charcoal is activated by heating it between 650 K and 1330 K in vacuum or air. It desorps all gases absorbed or adsorbed and thus, creates a space for adsorption of gases.

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

**Solution:**

**Heterogeneous catalysis:**

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

Mechanism of catalysis involves the following four 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.

**Concept Insight:** In Heterogeneous catalysis the reactants and catalyst are present in different phases, mainly the reactants are in Gaseous Phase and the catalyst are in solid phase.

**5.8.** Why is adsorption always exothermic?

**Solution:**

Adsorption is always exothermic. This statement can be explained in two ways.

(i) Adsorption leads to a decrease in the residual forces on the surface of the adsorbent. This causes a decrease in the surface energy of the adsorbent. Therefore, adsorption is always exothermic.

(ii) $\Delta H$ of adsorption is always negative. When a gas is adsorbed on a solid surface, its movement is restricted leading to a decrease in the entropy of the gas i.e., $\Delta S$ is negative. Now for a process to be spontaneous, $\Delta G$ should be negative.

$\therefore \Delta G = \Delta H - T\Delta S$

Since $\Delta S$ is negative, $\Delta H$ has to be negative to make $\Delta G$ negative, Hence, adsorption is always exothermic.

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

**Solution:**

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 are eight types of colloidal systems,

| | Dispersed phase | Dispersion medium | Type of colloid | Example |
|---|---|---|---|---|
| 1. | Solid | Solid | Solid Sol | Pearls |
| 2. | Solid | Liquid | Sol | Paint |
| 3, | Solid | Gas | Aerosol | Dust |
| 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 | Soap lather |

**Concept Insight:** dispersed phase is the component present in small proportion where as Dispersion medium is the component present in excess.

**5.10.** Discuss the effect of pressure and temperature on the adsorption of gases on solids.

**Solution:**

**Effect of pressure**

Adsorption is a reversible process and is accompanied by a decrease in pressure. So, adsorption increases with an increase in pressure at a constant temperature.

**Effect of temperature**

Since adsorption is an exothermic process, therefore according to Le-Chatelier's principle, the extent of adsorption decreases with an increase in temperature.

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

**Solution:**

**(i) Lyophilic sols:**

Colloidal sols that are formed by mixing substances such as gum, starch, etc. with a suitable liquid (dispersion medium) are called lyophilic (liquid loving) sols. These types of sols are reversible sols since the two constituents of the sol when separated by any means (such as evaporation) can be made again by simply mixing the dispersion medium with the dispersion phase. These sols are also known to be quite stable.

**(ii) Lyophobic sols:**

When substances such as metals sulphides are directly mixed with a dispersion medium, they do not form colloidal sols. Colloidal sols of these substances can only be prepared by special methods. Such types of sols are called lyophobic(liquid hating) sols. These sols are also irreversible in nature.

Stability of hydrophilic sols depends on the presence of a charge and the salvation of colloidal particles while the stability of hydrophobic sols is only because of the presence of a charge. Therefore, hydrophobic sols are much less stable than the hydrophilic sols. If the charge of hydrophobic sols is removed by the addition of electrolytes, then the particles present in them come closer and form aggregates, leading to coagulation.

Concept Insight: In case water act as dispersion medium the Lyophilic sol is called Hydrophilic sol and Lyophobic sol is known as Hydrophobic sol.

**5.12.** 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?

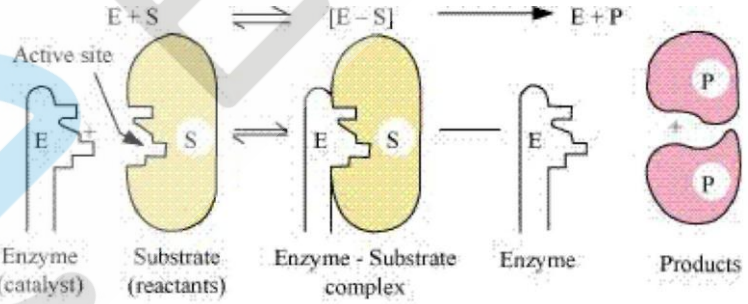
| Multimolecular colloids | | Macromolecular colloids | |
|---|---|---|---|
| 1. | These colloids are formed by aggregation of large number of atoms of smaller radii | 1. | These colloids are formed by particles of large size. |
| 2. | Have low molecular masses | 2. | Have High molecular masses |
| 3. | Weak van der waals forces present | 3. | Strong van der waals forces present |
| 4. | Gold and sulphur sols are examples of multimolecular colloids | 4. | Starch, cellulose, nylon are examples of macromolecular colloids. |

Associated colloids are formed by aggregation of large number of ions instead of atoms and molecules like in multimolecular and macromolecular colloids. Soap sol is an example of associated colloid.

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

**Solution:**

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




**Mechanism of enzyme catalysis:**

Various cavities are present on the surface of colloidal particles of enzymes with characteristic shapes. These cavities contain groups like $NH_3, -COOH, -SH$ etc. The reactant molecules having a complementary shape that fit into the cavities. This leads to the formation of an activated complex which then decomposes to give products.

**The reaction occurs in two steps:**

**Step-1:** $\text{Enzyme(E)} + \text{Substrate(S)} \rightarrow \text{ES}^{+}$ (Activated complex)

**Step-2:** $\text{ES}^{+} \rightarrow \text{Enzyme(E)} + \text{Products(P)}$

**5.14.** How are colloids classified on the basis of

(i) physical states of components

(ii) nature of dispersed phase and

(iii) interaction between dispersed phase and dispersion medium?

**Solution:**

**Colloids can be classified on various bases:**

(i) On the basis of the physical state of the components (by components we mean the dispersed phase and dispersion medium) we can have eight types of colloids:

| Dispersed phase | | Dispersion medium | Type of colloid | Example |
|---|---|---|---|---|
| 1. | Solid | Solid | Solid Sol | Pearls |
| 2. | Solid | Liquid | Sol | Paint |
| 3, | Solid | Gas | Aerosol | Dust |
| 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 | Soap lather |

(ii) On the basis of the dispersed phase, sols can be divided into 3 categories:

(a) Multimolecular Colloids- These are colloids in which particles consist of aggregates of atoms or small molecules having diameter less than 1nm. Example is sulphur sol.

(b) Macromolecular colloids- These colloids in which large particle aggregates and dissolved into suitable liquid. Example is cellulose, starch

(c) Associated colloids – These colloids are formed by aggregation of large number of ions instead of atoms and molecules like in multimolecular and macromolecular colloids.

(iii) On the basis of the nature of the interaction between the dispersed phase and dispersion medium, the colloids can be divided into lyophilic (solvent attracting) and lyophobic (solvent repelling) sols.

**5.15.** Explain what is observed

(i) when a beam of light is passed through a colloidal sol.

(ii) an electrolyte, NaCl is added to hydrated ferric oxide sol.

(iii) electric current is passed through a colloidal sol?

**Solution:**

(i) When a beam of light is passed through a colloidal solution, then scattering of light is observed. This phenomenon is known as the Tyndall effect. This scattering of light effect makes the path of light visible.

(ii) When NaCl is added to ferric oxide sol, it dissociates to give $Na^+$ and $Cl^-$ ions. Since the particles of ferric oxide sol are positively charged they get coagulated when they come in the presence of negatively charged $Cl^-$ ions.

(iii) After passing electric current through colloidal solution, particles will get attracted towards oppositely charged electrodes. and lose their charge and coagulate.

**5.16.** What are emulsions? What are their different types? Give an example of each type.

**Solution:**

The colloidal solution in which both the dispersed phase and dispersion medium are liquids is called an emulsion.

**Emulsions are of two types:**

(a) **Oil in water type:**

Oil is the dispersed phase while water is the dispersion medium.

Examples are milk, vanishing cream

(b) **Water in oil type:**

Water is the dispersed phase while oil is the dispersion medium.

Examples are cold cream, butter.

**5.17.** How do emulsifiers stabilise emulsion? Name two emulsifiers.

**Solution:**

Emulsifiers forms an interfacial film between the suspended particles and medium. It provides a coating to every drop of suspended particle and prevent it from coagulation. Therefore emulsifiers stabilise emulsion.

**5.18.** Action of soap is due to emulsification and micelle formation. Comment.

**Solution:**

The cleansing action of soap is due to emulsification and micelle formation.

Soaps are basically sodium and potassium salts of long chain fatty acids, $R-COONa^+$ . The end of the molecule to which the sodium is attached is polar in nature, while the alkyl-end is non-polar. Thus, a soap molecule contains a hydrophilic (polar) and a hydrophobic (non-polar) part. When soap is added to water containing dirt, the soap molecules surround the dirt particles in such a manner that their hydrophobic parts get attached to the dirt molecules and the hydrophilic parts point away from the dirt molecules. This is known as micelle formation. Thus, we can say that the polar group dissolves in water while the non-polar group dissolves in the dirt particles.

Soap molecules form micelle around oil droplets. Soaps emulsifies the oil or grease droplets and form emulsion after washing the cloth this emulsion easily gets removed. Hence action of soap is due to emulsification and micelle formation.

**5.19.** Give four examples of heterogeneous catalysis.

**Solution:**

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

$$2SO_{2(g)} \xrightarrow{Pt_x} 2SO_{3(g)}$$

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

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

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

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

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

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

**5.20.** What do you mean by activity and selectivity of catalysts?

**Solution:**

(a) **Activity of a catalyst:**

Activity of a catalyst is the ability to increase the rate of a particular reaction. The governing factor is Chemisorption in deciding the activity of a catalyst.

(b) **Selectivity of the catalyst:**

The ability of the catalyst to direct a reaction to yield a particular product is referred to as the selectivity of the catalyst.

(i) $CO_{(g)} + 3H_{2(g)} \xrightarrow{Ni} CH_{4(g)} + H_2O_{(g)}$

(ii) $CO_{(g)} + 3H_{2(g)} \xrightarrow{Ni} CH_{4(g)} + H_2O_{(g)}$

(iii) $CO_{(g)} + H_{2(g)} \xrightarrow{Cu} HCHO_{(g)}$

**5.21.** Describe some features of catalysis by zeolites.

**Solution:**

Zeolites are alumino-silicates which are micro-porous in nature. They have a honeycomb structure. This makes them shape-selective catalysts. They have an extended 3D-network of silicates in which some *Si* atoms are replaced by aluminium atoms, giving them an $Al - O - Si$ framework. Reactions taking place are very sensitive to the pores and cavity size of the zeolite. Zeolites are used in the petrochemical industry.

**5.22.** What is shape selective catalysis?

**Solution:**

A catalytic reaction that depends upon the pore structure of the catalyst and the size of the reactant and product molecules is called shape-selective catalysis. For example, Zeolites are good shape-selective catalysts. The pore size present in the zeolites ranges between 260-740 pm. Molecules having a larger pore size cannot enter the zeolite and undergo the reaction.

**5.23.** Explain the following terms:

(i) Electrophoresis

(ii) Coagulation

(iii) Dialysis

(iv) Tyndall effect.

**Solution:**

(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. Hence this technique is used to separate charged molecules.

(ii) **Coagulation:**

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

(iii) **Dialysis:**

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

(iv) **Tyndall effect:**

When a beam of light is passed through a colloidal solution, then scattering of light is observed. This phenomenon is known as the Tyndall effect. This scattering of light effect makes the path of light visible.

Concept Insight: Important from examination point.

**5.24.** Give four uses of emulsions.

**Solution:**

Four uses of emulsions:

(i) Cleansing action of soaps is based on the formation of emulsions.

(ii) Digestion of fats in the intestine takes place by the process of emulsification.

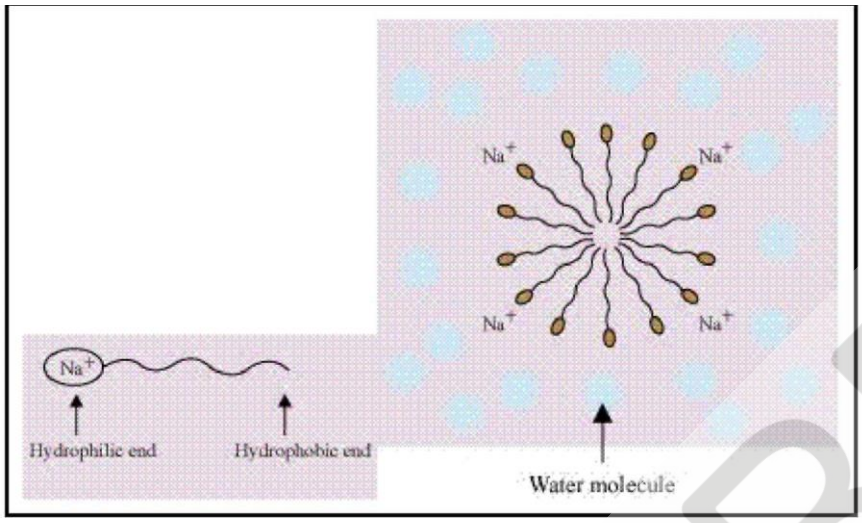
(iii) The process of emulsification is used to make medicines

(iv) Antiseptics and disinfectants when added to water form emulsions for cleaning.

**5.25.** What are micelles? Give an example of a micellers system.

**Solution:**

Micelle formation is done by substances such as soaps and detergents when dissolved in water, The molecules of such substances contain a hydrophobic and a hydrophilic part, When present in water, these substances arrange themselves in spherical structures in such a manner that their hydrophobic parts are present towards the centre, while the hydrophilic parts are pointing towards the outside (as shown in the given figure), This is known as micelle formation.




**5.26.** Explain the terms with suitable examples:

(i) Alcosol

(ii) Aerosol

(iii) Hydrosol.

**Solution:**

(i) **Alcosol:**

A colloidal solution having alcohol as the dispersion medium and a solid substance as the dispersed phase is called an alcosol.

For example: colloidal sol of cellulose nitrate in ethyl alcohol.

(ii) **Aerosol:**

A colloidal solution having a gas as the dispersion medium and a solid as the dispersed phase is called an aerosol.

For example: fog, smoke

(iii) **Hydrosol:**

A colloidal solution having water as the dispersion medium and a solid as the dispersed phase is called a hydrosol.

For example: Gold sol

**5.27.** Comment on the statement that "colloid is not a substance but a state of substance".

**Solution:**

Colloid is not a substance but a state of substance is a true statement because some substances which are crystalloids under certain conditions can be colloids under the other. If size lies in range of $1 - 1000$ nm, it is in the colloidal state. It is dependent

on the size of particle. Colloidal state is intermediate between a true solution and a suspension.

For example:

NaCl is a crystalloid in aqueous medium, but when mixed with benzene, it behaves as a colloid.