CH-5 SURFACE CHEMISTRY

Ques 1. Define adsorption.

Ans 1. The phenomenon of accumulation or higher concentration of molecular species (gases or, liquids) at the surface rather than in the bulk of a solid -or liquid is called adsorption.

Ques 2. Differentiate between adsorption and absorption.

Ans 2.

Adsorption	Absorption
(a) It is the phenomenon by which one substance gets concentrated mainly on the surface of the other substance rather than in the bulk of a solid or liquid.	(a) It is the phenomenon by which one substance gets uniformly distributed throughout the body of the other substance.
(b) It is a surface phenomenon.	(b) It is a bulk phenomenon.
(c) Its concentration is different at surface from the bulk.	(c) Its concentration is same throughout the bulk.

Ques 3. Define the following terms:
(i) Desorption
(ii) Sorption.

Ans 3. (i) Desorption is a phenomenon whereby an adsorbed substance is removed from or through a surface.
(ii) Sorption : Both adsorption and absorption can take place simultaneously. The term sorption is used to describe both the processes.

Ques 4. Give reason why adsorption is always exothermic?

Ans 4. Adsorption is accompanied by decrease of randomness. For the process to be spontaneous,
ΔG must be negative.
Hence, according to equation $\Delta G = \Delta H - T\Delta S$, ΔG can be -ve only if ΔH is negative.

Ques 5. Differentiate between two types of adsorptions.

Ans 5. The two types of adsorptions are Physisorption and Chemisorption.

Basis	Physisorption	Chemisorption
(i) Specificity	It is not specific in nature i.e. all gases are adsorbed on all solids to some extent.	It is highly specific in nature and occurs only when there is some possibility of compound formation between the gas being adsorbed and the solid being adsorbent.

(ii) Temperature dependence	It is independent of temperature as it occurs at low temperature and deceases with increase in temperature.	It is temperature dependent and increase with increase in temperature.
(iii) Reversibility	It is reversible i.e. desorption of gas takes place by increasing the temperature or decreasing the pressure.	It is irreversible in nature as it involves formation of compound instead of release of gas.
(iv) Enthalpy change	It has low enthalpy of adsorption i.e., 20-40 kJ mol^{-1}.	It has high enthalpy of adsorption i.e., 40-240 kJ mol^{-1}.

Ques 6. Write one similarity between physisorption and chemisorption.

Ans 6. Both physisorption and chemisorption increase with increase in pressure. Both increase with increase in surface area.

Ques 7. Of physisorption or chemisorption, which has a higher enthalpy of adsorption?

Ans 7. Chemisorption has higher enthalpy of adsorption than physisorption due to chemical bond formation.

Ques 8. What is the effect of temperature on chemisorption?

Ans 8. Chemisorption increases with increase of temperature.

Ques 9. Out of NH_3 and CO_2 which gas will be adsorbed more readily on the surface of activated charcoal and why?

Ans 9. NH_3 gas will be adsorbed more readily on activated charcoal. It has higher critical temperature than CO_2 and is an easily liquifiable gas. Its van der Waals forces are stronger.

Ques 10. Write two applications of adsorption.

Ans 10. Applications of adsorption:
(i) In decolourisation of sugar.
(ii) In gas masks, charcoal is used which adsorbs poisonous gases in mines.

Ques 11. Why are powdered substances more effective adsorbents than their crystalline forms?

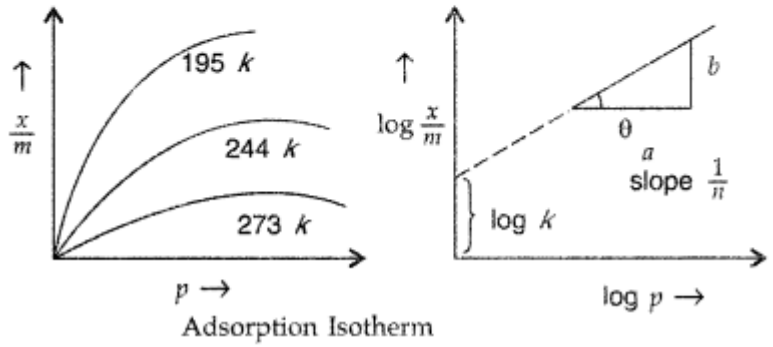
Ans 11. Powdered substances have more surface area which increases rate of adsorption.

Ques 12. What is an adsorption isotherm? Describe Freundlich adsorption isotherm.

Ans 12. Adsorption isotherm : The variation of the amount of the gas adsorbed by the adsorbent with pressure at constant temperature can be expressed by means of a curve. This curve is termed as adsorption isotherm at a particular temperature.
Freundlich adsorption isotherm : A mathematical equation which describes the relationship between pressure (p) of the gaseous adsorbate and the extent of adsorption at any fixed temperature is called Freundlich adsorption isotherm.

$$\frac{x}{m} = kp^{1/n}$$

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



Adsorption Isotherm

Ques 13. What is the difference between lyophobic sol and lyophilic sol?

Ans 13.

lyophobic sol	**lyophilic sol**
Disperse phase has high affinity for dispersion medium.	Disperse phase has low affinity for dispersion medium.
They are reversible in nature.	They are irreversible in nature.
They are easily formed by direct mixing or on heating.	They cannot be prepared directly. They can be prepared by special methods.
They are quite stable and are not easily coagulated.	They are unstable and are easily coagulated by adding a small amount of suitable electrolyte.
Example: AS_2S_3 sol.	Example: Starch sol, Gum sol, Gelatine sol

Ques 14. 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 14.

Multimolecular colloids	Macromolecular colloids	Associated colloids
1. They are formed by the aggregation of a large number of atoms or molecules which generally have diameter less than 1 mm, e.g. sols of gold, sulphur etc.	They are molecules of large size e.g. polymers like rubber, nylon, starch, proteins etc.	They are formed by aggregation of a large number of ions in concentrated solution e.g. soap sol.
2. Their molecular masses are not very high.	They have high molecular masses.	Their molecular masses are generally high.
3. Their atoms or molecules are held together by weak Van der Waals forces.	Due to long chain, the Van der Waals forces holding them are comparatively stronger.	Higher is the concentration, greater are the Van der Waals forces.

Ques 15. Define Tyndall effect.

Ans 15. When a beam of light is passed through a colloidal solution and viewed perpendicular to the path of the incident light, the path of light becomes visible as a bright streak. The illuminated path is called Tyndall cone and the phenomenon is called Tyndall effect. The phenomenon is due to scattering of light by the colloidal particles.

Ques 16. Why do true colloids show Tyndall effect whereas true solutions don't?

Ans 16. In true solution, the diameter of the dispersed particles is much smaller than the wavelength of the light used, hence there is no scattering of light whereas in colloidal solutions particle size of dispersed phase is comparable to the wavelength of light used.

Ques 17. How can a colloidal solution and true solution of the same colour be distinguished from each other?

Ans 17. A colloidal solution scatters a beam of light but a true solution does not. Or A colloid shows Tyndall effect whereas a true solution does not.

Ques 18. Explain Brownian movement.

Ans 18. Brownian movement is the continuous and random zig-zag motion of the colloidal particles. This motion is due to kinetic motion of striking colloidal particles which produces a resultant force to cause motion.

Ques 19. What are emulsions? Give an example.

Ans 19. An emulsion is a colloidal dispersion in which both the dispersed phase and dispersion medium are liquids. For example, milk, cream.

Ques 20. Define 'electrophoresis'.

Ans 20. When electric current is passed through a colloidal solution, the positively charged particles move towards cathode while negatively charged particles move towards anode where they lose their charge and get coagulated. The phenomenon is known as Electrophoresis.

Ques 21. Define micelles.

Ans 21. The substances, which when dissolved in a medium at low concentrations behave as normal, strong electrolytes but at higher concentration exhibit colloidal state properties due to the formation of aggregated particles and such aggregated particles thus formed are called micelles.

Ques 22. Define Critical micelle concentration

Ans 22. Critical micelle concentration: The formation of micelles takes place only above a particular temperature i.e., Kraft temperature (T_k) and above a particular concentration.

Ques 23. Define dialysis.

Ans 23. The process of separating the particles of colloids from those of crystalloids by diffusion of the mixture through a parchment or an animal membrane is known as dialysis.

Ques 24. What is meant by coagulation of a colloidal solution? Describe briefly any three methods by which coagulation of lyophobic sols can be carried out.

Ans 24. The process of setting of colloidal particles is called coagulation or precipitation of the sol. Methods of coagulation:

(i) By electrophoresis : The colloidal particles move towards oppositely charged electrodes.

(ii) By mixing two oppositely charged sols.

(iii) By addition of electrolytes : When excess of an electrolyte is added, the colloidal particles are precipitated.

Ques 25. Define Reversible sols.

Ans 25. The lyophilic solutions in which if the dispersed phase is separated from the dispersion medium, the sol can be made again by simply remixing with the dispersion medium. This shaking is called as Reversible sol.

Ques 26. Define the following terms :
(i) Kraft temperature
(ii) Peptization
(iii) Electrokinetic/ Zeta potential

Ans 26. (i) Kraft temperature: The formation of micelles takes place only above a particular temperature known as Kraft temperature (T_k).

(ii) Peptization: It is a process of converting a fresh precipitate into colloidal particles by shaking it with the dispersion medium in the presence of a small amount of a suitable, electrolyte.

(iii) The potential difference between the fixed layer and the diffused layer is known as electrokinetic potential or zeta potential.

Ques 27. Write one difference in each of the following:
(i) Solution and Colloid and Suspension
(ii) Coagulation and Peptization

Ans 27. (i) Solution and Colloid and Suspension
Solution is a homogenous solution whose particle size is less than 10^{-9} m while colloid is a heterogenous solution whose particle size is in between 10^{-9} to 10^{-6} m and a suspension is also a heterogeneous solution whose article size is greater than 10^{-6} m.

(ii) Coagulation and Peptization. Coagulation is a process of aggregating together the colloidal particles into large sized particles to form their precipitate while peptization is a process of converting fresh precipitate into colloidal particles by shaking it with the dispersion medium in the presence of a small amount of a suitable electrolyte.

Ques 28. Write one difference between each of the following:
(i) Sol and Gel
(ii) O/W emulsion and W/O emulsion

Ans 28. (i) Sol is a colloidal system in which dispersed phase is a solid and dispersion medium is a liquid. Gel is a colloidal system in which dispersed phase is a liquid and dispersion medium is a solid.

(ii) In O/W emulsion, water acts as dispersion medium while in W/O emulsion oil acts as dispersion medium.

Ques 29. Explain the following:
(i) Deltas are formed when river and sea water meet.
(ii) Artificial rain is caused by spraying salt over clouds.
(iii) Physisorption is multi-layered, while chemisorption is mono-layered.

Ans 29. (i) River water is a colloidal solution of day. Sea water contains a number of electrolytes. When river water meets the sea water, the electrolytes present in sea water coagulate the colloidal solution of clay resulting in its deposition with the formation of deltas.

(ii) Clouds are colloidal dispersion of water particles in air carrying some charge over them.
It is possible to cause artificial rain by throwing electrified sand or spraying a sol carrying charge opposite to the one on clouds from an aeroplane. The colloidal water particles present in the clouds will get neutralized and as result they will come closer and grow in size to form bigger water drops and ultimately cause artificial rain.

(iii) In physical adsorption, layers of the gas can be adsorbed one over the other by van der Waals forces. Multi-molecular layers are formed under high pressure. In chemical adsorption, chemical bond can be formed only with the layer of molecules coming in

direct contact with the surface of the adsorbent, hence this type of adsorption is mono-layered.

Ques 30. Explain what is observed when:
(i) A beam of light is passed through a colloidal solution.
(ii) NaCl solution or an electrolyte is added to hydrated ferric oxide sol.
(iii) Electric current is passed through a colloidal solution.

Ans 30. (i) When a beam of strong light is passed through a colloidal solution, scattering of light occurs by colloidal particles and the path of light becomes visible and the phenomenon is known as Tyndall effect.

(ii) When NaCl is added to hydrated ferric oxide solution, then coagulation will take place. A negatively charged solution is obtained with absorption of OH^- ion.

(iii) When electric current is passed through a colloidal solution, the positively charged particles move towards cathode while negatively charged particles move towards anode where they lose their charge and get coagulated. The phenomenon is known as Electrophoresis.

Ques 31. Give reasons for the following observations:
(i) Leather gets hardened after tanning.
(ii) Lyophilic sol is more stable than lyophobic sol.
(iii) A delta is formed at the melting point of sea water and river water.

Ans 31. (i) Due to mutual coagulation of leather by tanning. [Positively charged animal hyde (leather) with negatively charged colloidal particles of tannin].

(ii) Lyophilic sols are more stable because there is strong interaction between dispersed phase and dispersion medium.

(iii) Delta is formed at the meeting point of sea water and river water due to coagulation of colloidal clay particles.

Ques 32. Explain the following:
(a) Same substance can act both as colloids and crystalloids.
(b) Artificial rain is caused by spraying salt over clouds.

Ans 32. (a) Sodium chloride behaves as a crystalloid when dissolved in water but behaves as a colloid when dissolved in benzene.
(b) Artificial rain is caused by spraying common salt over the clouds, as it is an electrolyte and brings about coagulation of water particles.

Ques 33. What is Hardy Schulze Rule?

Ans 33. Hardy schulze rule states that greater is the valency of oppositely charged ion of the electrolyte being added, Faster is coagulation.

Ques 34. Which of the following is most effective in coagulating negatively charged hydrated ferric oxide sol?
(i) $NaN0_3$ (ii) $MgSO_4$ (iii) $AlCl_3$

Ans 34. $AlCl_3$ (Aluminium chloride) is most effective in coagulating negatively charged hydrated ferric oxide sol.

Ques 35. Out of $MgCl_2$ and $AlCl_3$ which one is more effective in causing coagulation of negatively charged sol and why?

Ans 35. $AlCl_3$ is more effective than $MgCl_2$ in causing coagulation of negatively charged sol because coagulating power of an electrolyte is directly proportional to the valency of the active ion i.e., $Al^{3+} > Mg^{2+}$.

Ques 36. Which of the following is most effective in coagulating positively charged hydrated ferric oxide sol? (i) $NaNO_3$ (ii) Na_2SO_4 (iv) $(NH_4)_3PO_4$

Ans 36. Ammonium phosphate $(NH_4)_3PO_4$ is most effective in coagulating positively charged hydrated ferric oxide sol.

Ques 37. Which of the following is most effective in coagulating positively charged methylene blue sol?
(i) Na_3PO_4 (ii) $K_4[Fe(CN)_6]$ (iii) Na_2SO_4

Ans 37. Potassium ferrocyanide $K_4[Fe(CN)_6]$

Ques 38. What will be the charge on Agl colloidal particles when it is prepared by adding small amount of $AgNO_3$ solution to KI solution in water? What is responsible for the development of this charge ?

Ans 38. When $AgNO_3$ solution is added to Kl solution, the precipitated Agl adsorbs I^- ions from the dispersion medium and negatively charged colloidal solution results.