Term-II

SURFACE CHEMISTRY

Syllabus

- ***Adsorption - physisorption and chemisorption, factors affecting adsorption of gases on solids, colloidal state: distinction between true solutions, colloids and suspension; lyophilic, lyophobic, multi-molecular and macromolecular colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation.***

STAND ALONE MCQs [1 Mark each]

Q. 1. Which one of the following is not applicable to the phenomenon of adsorption [U]

(A) $\Delta H > 0$ **(B)** $\Delta G < 0$

(C) $\Delta S < 0$ **(D)** $\Delta H < 0$

Ans. Option (A) is correct.

Explanation: Adsorption is an exothermic process, so the ΔH of adsorption is always negative.

$$\Delta H < 0$$

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

ΔG = Change in Gibbs free energy

ΔH = Change in enthalpy

T = Temperature in Kelvin

ΔG = Change in entropy

Since, adsorption is a spontaneous process, the thermodynamic requirement is at constant temperature and pressure, ΔG must be negative. So the enthalpy ΔH as well as entropy ΔS of the system is negative.

[AI] **Q. 2.** On the basis of data given below predict which of the following gases shows least adsorption on a definite amount of charcoal?

Gas	CO_2	SO_2	CH_4	H_2
Critical temp./K	304	630	190	33

[AE]

(A) CO_2 **(B)** SO_2

(C) CH_4 **(D)** H_2

Ans. Option (D) is correct.

Explanation: Higher critical temperatures indicate easily liquefiable gases which are readily adsorbed as the van der Waal's forces responsible for adsorption of gases on solid surfaces are stronger near critical temperatures.

Q. 3. Which of the following is an example of absorption? [U]

(A) Water on silica gel

(B) Water on calcium chloride

(C) Hydrogen on highly divided nickel

(D) Oxygen on metal surface

Ans. Option (B) is correct.

Explanation: Water on calcium chloride is an example of absorption, rest of all are examples of adsorption.

Q. 4. Which of the following is an example of absorption?

(A) Water on silica gel

(B) Water on calcium chloride

(C) Hydrogen on finely divided nickel

(D) Oxygen on metal surface

Ans. Option (B) is correct.

Explanation: Calcium chloride ($CaCl_2$) absorbs water and other examples show adsorption.

Q. 5. Extent of adsorption of adsorbate from solution phase increases with:

(A) increase in amount of adsorbate in solution.

(B) decrease in surface area of adsorbent.

(C) increase in temperature of solution.

(D) decrease in amount of adsorbate in solution.

Ans. Option (A) is correct.

Explanation: Extent of adsorption of adsorbate from solution phase increases with increase in the amount of adsorbate in the solution. Therefore, as amount of adsorbate in the solution increases interaction of adsorbent increases which leads to increase in extent of adsorption.

Q. 6. Which of the following interface cannot be obtained?

(A) Liquid-liquid **(B)** Solid-liquid

(C) Liquid-gas **(D)** Gas-gas

Ans. Option (D) is correct.

Explanation: Gas-gas interface cannot be obtained because they are completely miscible in nature.

For example: Air is a mixture of various gases such as, O_2, N_2, CO_2, etc.

Q. 7. In physisorption, adsorbent does not show specificity for any particular gas because :

(A) involved van der Waal's forces are universal.

(B) gases involved behave like ideal gases.

(C) enthalpy of adsorption is low.

(D) it is a reversible process.

Ans. Option (A) is correct.

Explanation: Physisorption is not specific to any gas since it involves van der Waal's forces and no specific bonds formation takes place.

Q. 8. Which of the following is not a favourable condition for physical adsorption?

(A) High pressure

(B) Negative δH

(C) Higher critical temperature of adsorbate

(D) High temperature

Ans. Option (D) is correct.

Explanation: Physical adsorption is favoured at low temperature.

Q. 9. Which of the following is most effective in coagulating negatively charged hydrated ferric oxide sol?

(A) $NaNO_3$ **(B)** $MgSO_4$

(C) $AlCl_3$ **(D)** KCl

U **[CBSE Comptt. Delhi Set-I 2017]**

Ans. Option (C) is correct.

Explanation: The coagulating power of Al^{3+} is highest due to charge & small size, therefore, aluminium chloride will be required in minimum amount to coagulate negatively charged Sol of AS_2S_3.

Q. 10. Which of the following is most effective in coagulating positively charged hydrated ferric oxide sol?

(A) $NaNO_3$ **(B)** Na_2SO_4

(C) $(NH_4)_3PO_4$ **(D)** $LiAlH_4$

U **[CBSE Comptt. Delhi Set-II 2017]**

Ans. Option (C) is correct.

Explanation: For the coagulating of positively charged Hydrated ferric sol, the coagulating process of the anions are in the order: $PO_4^{3-} > SO_4^{2-} > NO_3^-$

Q. 11. Which of the following is most effective in coagulating positively charged methylene blue sol?

(A) Na_3PO_4 **(B)** $K_4[Fe(CN)_6]$

(C) Na_2SO_4 **(D)** $Al_2(SO_4)_3$

U **[CBSE Comptt. Delhi Set-III 2017]**

Ans. Option (B) is correct.

Explanation: Greater the valence of the flocculating ion, greater its ability to bring coagulation as per hardy-Schulze rule.

Q. 12. A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as _____.

(A) solid sol. **(B)** gel.

(C) emulsion. **(D)** sol.

Ans. Option (D) is correct.

Explanation: It is called as sol.

Q. 13. The values of colligative properties of colloidal solution are of small order in comparison to those shown by true solutions of same concentration because of colloidal particles _____.

(A) exhibit enormous surface area.

(B) remain suspended in the dispersion medium.

(C) form lyophilic colloids.

(D) are comparatively less in number.

Ans. Option (D) is correct.

Explanation: Colloidal particles are large in size and less in number.

Q. 14. Method by which lyophobic sol can be protected :

(A) by addition of oppositely charged sol.

(B) by addition of an electrolyte.

(C) by addition of lyophilic sol.

(D) by boiling.

Ans. Option (C) is correct.

Explanation: Lyophobic sol can be protected by adding lyophilic sol which is known as protective colloid.

Q. 15. Freshly prepared precipitate sometimes gets converted to colloidal solution by:

(A) coagulation. **(B)** electrolysis.

(C) diffusion. **(D)** peptisation.

Ans. Option (D) is correct.

Explanation: Peptisation is the process of converting freshly prepared precipitate into colloid.

Q. 16. Which of the following will show Tyndall effect?

(A) Aqueous solution of soap below critical micelle concentration.

(B) Aqueous solution of soap above critical micelle concentration.

(C) Aqueous solution of sodium chloride.

(D) Aqueous solution of sugar.

Ans. Option (B) is correct.

> ***Explanation:*** Tyndall effect is a characteristic of colloidal solution in which colloidal particles show a coloured appearance when sunlight is passes through it and seen perpendicularly.

ASSERTION AND REASON BASED MCQs [1 Mark each]

Directions: In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A

(C) A is true but R is false

(D) A is false and R is True

Q. 1. Assertion (A): Extent of adsorption of adsorbate from solution phase increases with increase in amount of adsorbate in solution.
Reason (R): Freundlich's equation describes the behaviour of adsorption from a solution.

Ans. Option (A) is correct.

> ***Explanation:*** Freundlich's equation describes the behaviour of adsorption from a solution.
>
> $$\frac{x}{m} = kC^{1/n}$$
>
> It also written as
>
> $$\log\frac{x}{m} = \log k + \frac{1}{n}\log C$$
>
> x = mass of adsorbate
> m = mass of adsorbent
> p = equilibrium pressure of the gaseous adsorbate in case of experiments made in gas phase (gas/solid interaction with gaseous species/adsorbed species).
> C = equilibrium constant of adsorbate in case of experiments made with an aqueous solution in contact with dispersed solid phase (dissolved species/adsorbed species).
> k and n are constants of a given adsorbate and adsorbent at a given temperature (from there, the item isotherm needed to avoid significant gas pressure fluctuations due to uncontrolled temperature variations in the case of adsorption experiments of a gas onto a solid phase).

Q. 2. Assertion (A): At the equilibrium position in the process of adsorption $\Delta H = T\Delta S$.
Reason (R): Adsorption is accompanied by decrease in surface energy.

Ans. Option (B) is correct.

> ***Explanation:*** $\Delta G = \Delta H - T\Delta S$
> Gibb's Free energy equation
> Adsorption is a spontaneous process so ΔG is negative. At equilibrium it becomes zero and $\Delta H = T\Delta S$ is attained.

Q. 3. Assertion (A): Extent of physisorption of a gas increases with decrease in temperature.
Reason (R): It is due to decrease in strength of van der Waals forces.

Ans. Option (C) is correct.

> ***Explanation:*** In physisorption, phenomenon particles are held to the surface by weak van der Waals' force of attraction which get destroyed due to increase in temperature.

Q. 4. Assertion (A): Activated adsorption is also known as chemical adsorption or chemisorption.
Reason (R): It involves formation of chemical bonds between adsorbent and reactants.

Ans. Option (A) is correct.

> ***Explanation:*** Activated adsorption is also known as chemical adsorption or chemisorption as it involves formation of chemical bonds between adsorbent and reactants.

Q. 5. Assertion (A): An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.
Reason (R): Pore size of the filter paper becomes more than the size of colloidal particle. U

Ans. Option (C) is correct.

> ***Explanation:*** Pore size of the filter paper becomes less than the size of colloidal particles hence colloidal particles do not flow through it.

Q. 6. Assertion (A): Colloidal solutions do not show Brownian motion.
Reason (R): Brownian motion is responsible for stability of sols. U

Ans. Option (D) is correct.

> ***Explanation:*** Colloidal particles show Brownian movement and it is responsible for the stability of colloidal solution.

Q. 7. Assertion (A): Detergents with low CMC are more economical to use.
Reason (R): Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

Ans. Option (A) is correct.

> ***Explanation:*** Cleansing of clothes takes place by micelles and their formation starts at CMC. The lesser is the CMC, the better and more economical is the detergent.

Q. 8. Assertion (A): Coagulation power of Al^{3+} is more than Na^{+}.
Reason (R): Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy-Schulze rule).

Ans. Option (A) is correct.

> *Explanation:* According to Hardy-Schulze law, the greater is the valency of the coagulating ion, the more is the power to coagulate the colloidal solution. Thus, coagulation power of Al^{3+} is greater than that of Na^{+}.

Q. 9. Assertion (A): Colloidal solutions show colligative properties.
Reason (R): Colloidal particles are large in size.

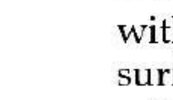
Ans. Option (B) is correct.

> *Explanation:* Colloidal particles are large in size and hence the number of particles is lesser than the true solution. The lesser number of particles results in lower colligative properties.

Q. 10. Assertion (A): Colloids are stable.
Reason (R): Brownian movement has a stirring effect, which does not allow the particles to settle.

Ans. Option (A) is correct.

> *Explanation:* Colloids are stable due to Brownian movement which is the movement of colloidal particles striking against the dispersion medium. It prevents them from settling down.



CASE-BASED MCQs

I. Read the passage given below and answer the following questions:

The amount of moisture that leather adsorbs or loses is determined by temperature, relative humidity, degree of porosity, and the size of the pores. Moisture has great practical significance because its amount affects the durability of leather, and in articles such as shoes, gloves and other garments, the comfort of the wearer. High moisture content accelerates deterioration and promotes mildew action. On the other hand, a minimum amount of moisture is required to keep leather properly lubricated and thus prevent cracking.

The study indicates that adsorption of moisture by leather is a multi- molecular process and is accompanied by low enthalpies of adsorption. Further at 75-percent relative humidity, the adsorption is a function of surface area alone.

Untanned hide and chrome- tanned leathers have the largest surface areas. The leathers tanned with vegetable tanning materials have smaller surface areas since they are composed of less hide substance and the capillaries are reduced to smaller diameters, in some cases probably completely filled by tanning materials. This process of tanning occurs due to mutual coagulation of positively charged hide with negatively charged tanning material. The result of the study indicated that untanned hide and chrome-tanned leather adsorb the most water vapour. **[CBSE SQP 2020-21]**

In these questions a statement of Assertion followed by a statement of Reason is given. Choose the correct answer out of the following choices.

(A) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(B) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(C) Assertion is correct statement but reason is wrong statement.

(D) Assertion is wrong statement but reason is correct statement.

Q. 1. Assertion (A): Vegetable tanned leather cannot adsorb a large amount of moisture.
Reason (R)**:** Porous materials have higher surface area.

Ans. Option (B) is correct.

> *Explanation:* Vegetable tanned leather cannot adsorb a large amount of moisture as these leathers have smaller surface areas since they are composed of less hide substance and the capillaries are reduced to smaller diameters, in some cases probably completely filled by tanning materials. Whereas porous materials have higher surface area.

Q. 2. Assertion (A): Animal hide soaked in tannin results in hardening of leather.
Reason (R): Tanning occurs due to mutual coagulation.

Ans. Option (A) is correct.

> *Explanation:* Animal hide soaked in tannin results in hardening of leather as tanning occurs due to mutual coagulation.

Q. 3. Assertion (A): Adsorption of moisture by leather is physisorption.
Reason (R)**:** It is a multimolecular process and is accompanied by low enthalpies of adsorption.

Ans. Option (A) is correct.

> *Explanation:* Adsorption of moisture by leather is physisorption. It is a multimolecular process and is accompanied by low enthalpies of adsorption.

Q . 4. Assertion (A): Leathers tanned with vegetable tanning materials have smaller surface areas.
Reason (R)**:** The capillaries present in leather are reduced to smaller diameters.

Ans. Option (A) is correct.

> *Explanation:* Leathers tanned with vegetable tanning materials have smaller surface areas, the capillaries present in leather are reduced to smaller diameters.

OR

Assertion (A): Leather absorbs different amount of moisture.
Reason (R): Some moisture is necessary to prevent cracking of leather.

Ans. Option (B) is correct.

Explanation: The amount of moisture that leather adsorbs or loses is determined by temperature, relative humidity, degree of porosity, and the size of the pores. A minimum amount of moisture is required to keep leather properly lubricated and thus prevent cracking.

II. Read the given passage and answer the questions (i) to (v) that follow: AE

Colloidal particles always carry an electric charge which may be either positive or negative. For example, when $AgNO_3$ solution is added to KI solution, a negatively charged colloidal sol is obtained. The presence of equal and similar charges on colloidal particles provide stability to the colloidal sol and if, somehow, charge is removed, coagulation of sol occurs. Lyophobic sols are readily coagulated as compared to lyophilic sols.

Q. 1. What is the reason for the charge on sol particles ?

Ans. The charge on the colloidal sol particles depends upon the preferential adsorption of the ions from the electrolyte. When $AgNO_3$ is added to KI solution the yellow precipitate of AgI absorbs I^- ions from the electrolyte and form negatively charged sol.

Q. 2. Why the presence of equal and similar charges on colloidal particles provide stability ?

Ans. Presence of equal and similar charges on colloidal particles provides stability to colloids as repulsive forces between charge particle having same charge, prevent from colliding when they come closer to each other. Hence provide stability.

Q. 3. Why a negatively charged sol is obtained on adding $AgNO_3$ solution to KI solution ?

Ans. On adding $AgNO_3$ to KI solution the yellow ppt. of AgI absorbs I^- ions from the electrolyte KI, so negatively charged sol is obtained. AgI/I^-

Q. 4. Name one method by which coagulation of lyophobic sol can be carried out.

Ans. By chemical method: (i) Oxidation, (ii) Reduction, (iii) Hydrolysis, (iv) Double decomposition (Any one)

Q. 5. Out of KI or K_2SO_4, which electrolyte is better in the coagulation of positive sol ?

[CBSE OD Set-1, 2020]

Ans. K_2SO_4 because the coagulation power increases with increase in charge on the ions,

$$SO_4^{2-} > I^-$$

III. Read the passage given below and answer the following questions: U $(1 \times 4 = 4)$

Some colloids are stable by their nature, i.e., gels, alloys, and solid foams. Gelatin and jellies are two common examples of a gel. The solid and liquid phases in a gel are interpersed with both phases being continuous. In most systems, the major factor influencing the stability is the charge on the colloidal particles. If a particular ion is preferentially adsorbed on the surface of the particles, the particles in suspension will repel each other, thereby preventing the formation of aggregates that are larger than colloidal dimensions. The ion can be either positive or negative depending on the particular colloidal system, i.e., air bubbles accumulate negative ions, sulphur particles have a net negative charge in a sulphur sol, and the particles in a metal hydroxide sol are positively charged. Accumulation of charge on a surface is not an unusual phenomenon-dust is attracted to furniture surfaces by electrostatic forces. When salts are added to lyophobic colloidal systems the colloidal particles begin to form larger aggregates and a sediment forms as they settle. This phenomenon is called flocculation, and the suspension can be referred to as flocculated, or colloidally unstable. If the salt is removed, the suspension can usually be restored to its original state; this process is called deflocculation or peptization. The original and restored colloidal systems are called deflocculated, peptized, or stable sols.

Why does a small amount of salt have such a dramatic effect on the stability of a lyophobic colloidal system? The answer lies in an understanding of the attractive and repulsive forces that exist between colloidal particles. Van der Waals forces are responsible for the attractions, while the repulsive forces are due to the surface charge on the particles. In a stable colloid, the repulsive forces are of greater magnitude than the attractive forces. The magnitude of the electrical repulsion is diminished by addition of ionized salt, which allows the dispersed particles to aggregate and flocculate. River deltas provide an example of this behaviour. A delta is formed at the mouth of a river because the colloidal clay particles are flocculated when the freshwater mixes with the salt water of the ocean

Q. 1. Gelatin is a _____ colloidal system.

(A) Solid in solid (B) Solid in gas
(C) Liquid in solid (D) Liquid in gas

Ans. Option (C) is correct.

Q. 2. Colloidal solutions are stable due to:

(A) presence of charges on the colloidal particles
(B) formation of aggregates by colloidal particles
(C) preferential adsorption on the surface
(D) preferential absorption on the surface

Ans. Option (C) is correct.

Q. 3. Settling down of colloidal particles to form a suspension is called:

(A) flocculation (B) peptization
(C) aggregation (D) deflocculation

Ans. Option (A) is correct.

Q. 4. When Van der Waals forces are greater than forces due to the surface charge on the particles,

(A) flocculation occurs.
(B) the colloid is stable.
(C) peptization takes place.
(D) deflocculation occurs.

Ans. Option (A) is correct.

Q. 5. The particles in suspension will repel each other, thereby preventing the formation of aggregates that are larger than colloidal dimensions. This statement explains:

(A) formation of delta
(B) river water is a colloidal of clay particles
(C) effect of salt on lyophobic colloid
(D) phenomenon of flocculation

Ans. Option (B) is correct.