(*iv*) Cosmetics, lotions, creams, hair dyes, shampoos and many drugs, and ointments are emulsions. In form of emulsions, these are more effective.

Q. 25. What are micelles? Give an example of a miceller system.

Ans. The particles of colloidal size formed due to aggregation of several units of soap molecules (surfactants) in a dispersion medium are called 'micelles'. A concentrated solution of soap in water is a miceller system. Such substances are also called associated colloids. In other words, miceller system (or associated colloid) behaves as a true solution in low concentration form and as a colloid in high concentration form. The micelles revert to individual ions on dilution.

Q. 26. Explain the following terms with suitable examples (*i*) Alcosol (*ii*) Aerosol and (*iii*) Hydrosol.

Ans. **(*i*) Alcosol:** It is a colloidal dispersion having alcohol as the dispersion medium, *e.g.*, collodion.

(*ii*) Aerosol: It is a colloidal dispersion of a solid or liquid in a gas, *e.g.*, smoke, fog.

(*iii*) Hydrosol: It is a colloidal sol of a solid in water as the dispersion medium *e.g.*, starch sol.

Q. 27. Comment on the statement that "Colloid is not a substance but state of a substance." **[*HOTS*]**

Ans. The given statement is true. This is because the same substance may exist as a colloid under certain conditions and as a crystalloid under some other conditions. For example, NaCl in water behaves as a crystalloid while in benzene, it behaves as a colloid. It is the size of the particles which matters, *i.e.*, the state in which the substance exists. If the size of the particles lies in the range of 1 nm to 1000 nm, it is in the colloidal state.

Multiple Choice Questions [1 mark]

Choose and write the correct option(s) in the following questions.

1. At the equilibrium position in the process of adsorption _____. **[*NCERT Exemplar*]**

(*a*) $\Delta H > 0$ (*b*) $\Delta H = T\Delta S$

(*c*) $\Delta H > T\Delta S$ (*d*) $\Delta H < T\Delta S$

2. Which of the following is true in respect of adsorption?

(*a*) $\Delta G < 0, \Delta S < 0, \Delta H > 0$ (*b*) $\Delta G < 0, \Delta S > 0, \Delta H < 0$

(*c*) $\Delta G < 0, \Delta S < 0, \Delta H < 0$ (*d*) $\Delta G > 0, \Delta S > 0, \Delta H < 0$

3. The term 'sorption' stands for _____. **[*NCERT Exemplar*]**

(*a*) absorption (*b*) absorption

(*c*) both absorption and adsorption (*d*) desorption

4. Which of the following is not a favorable condition for physical adsorption? **[*NCERT Exemplar*]**

(*a*) High pressure (*b*) Negative ΔH

(*c*) Higher critical temperature of adsorbate (*d*) High temperature

5. Extent of physisorption of a gas increases with _____. **[*NCERT Exemplar*]**

(*a*) increase in temperature (*b*) decrease in temperature

(*c*) decrease in surface area of adsorbent (*d*) decrease in strength of van der Waals forces

6. Physical adsorption of a gaseous species may change to chemical adsorption with _____. **[*NCERT Exemplar*]**

(*a*) decrease in temperature (*b*) increase in temperature

(*c*) increase in surface area of adsorbent (*d*) decrease in surface area of adsorbent

7. Extent of adsorption of adsorbate from solution phase increase with _____. **[*NCERT Exemplar*]**

(*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

8. Which of the following relation is correct?

(*i*) $\frac{x}{m}$ = Constant at high pressure

(*ii*) $\frac{x}{m}$ = Constant × $p^{1/n}$ (at intermediate pressure)

(*iii*) $\frac{x}{m}$ = Constant × p^{n} (at lower pressure)

(*a*) All correct (*b*) All wrong

(*c*) (*i*) and (*ii*) are correct (*d*) (*iii*) is correct

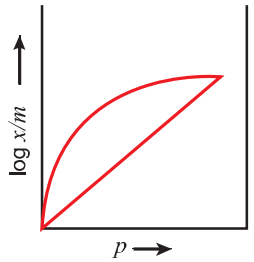
9. In Freundich isotherm, the intercept on *y*-axis is denoted by

(*a*) $\log \frac{1}{k}$ (*b*) $\log k$ (*c*) $\frac{1}{n}$ (*d*) n

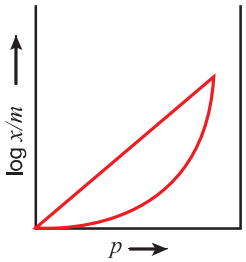
10. Which of the following curves is in accordance with Freundlich adsorption isotherm?

[*NCERT Exemplar*]

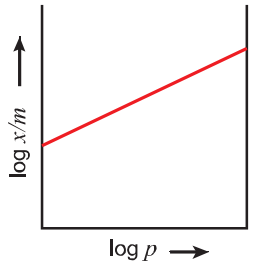
(*a*)



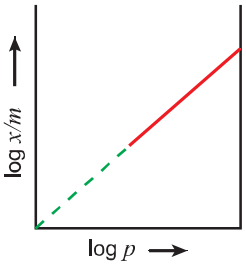
(*b*)



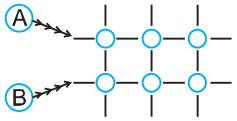
(*c*)



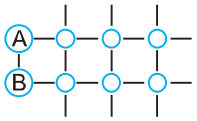
(*d*)



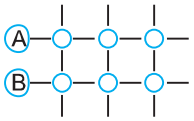
11. Arrange the following diagrams in correct sequence of steps involved in the mechanism of catalysis, in accordance with modern adsorption theory. **[*NCERT Exemplar*]**



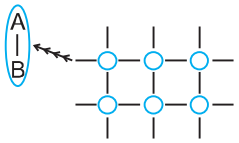
(*i*)



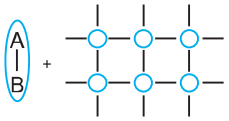
(*ii*)



(*iii*)



(*iv*)



(*v*)

(*a*) (*i*) ⟶ (*ii*) ⟶ (*iii*) ⟶ (*iv*) ⟶ (*v*)

(*b*) (*i*) ⟶ (*iii*) ⟶ (*ii*) ⟶ (*iv*) ⟶ (*v*)

(*c*) (*i*) ⟶ (*iii*) ⟶ (*ii*) ⟶ (*v*) ⟶ (*iv*)

(*d*) (*i*) ⟶ (*ii*) ⟶ (*iii*) ⟶ (*v*) ⟶ (*iv*)

12. Which of the following statements are correct about solid catalyst? [*NCERT Exemplar*]

(*a*) Same reactants may give different product by using different catalysts.

(*b*) Catalyst does not change ΔH of reaction.

(*c*) Catalyst is required in large quantities to catalyse reactions.

(*d*) Catalytic activity of a solid catalyst does not depend upon the strength of chemisorption.

13. The enzyme pepsin present in stomach converts

(*a*) proteins into amino acids (*b*) cane sugar into glucose

(*c*) proteins into peptides (*d*) maltose into glucose

14. The rate of an enzyme catalysed reaction is maximum under pH range of

(*a*) 0–7 (*b*) 5–7 (*c*) 7–14 (*d*) 7–10

15. A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as _____. [*NCERT Exemplar*]

(*a*) solid sol (*b*) gel (*c*) emulsion (*d*) sol

16. Which of the following options are correct? [*NCERT Exemplar*]

(*a*) Micelle formation by soap in aqueous solution is possible at all temperatures.

(*b*) Micelle formation by soap in aqueous solution occurs above a particular concentration.

(*c*) On dilution of soap solution micelles may revert to individual ions.

(*d*) Soap solution behaves as a normal strong electrolyte at all concentrations.

17. Freshly prepared precipitate sometimes gets converted to colloidal solution by _____. [*NCERT Exemplar*]

(*a*) coagulation (*b*) electrolysis (*c*) diffusion (*d*) peptisation

18. 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 _____. [*NCERT Exemplar*]

(*a*) exhibit enormous surface area (*b*) remains suspended in the dispersion medium

(*c*) form lyophilic colloids (*d*) are comparatively less in number.

19. Which property of colloidal solution is independent of charge on the colloidal particles?

(*a*) Electro-osmosis (*b*) Tyndall effect

(*c*) Coagulation (*d*) Electrophoresis

20. Which of the following process is responsible for the formation of delta at a place where rivers meet the sea? [*NCERT Exemplar*]

(*a*) Emulsification (*b*) Colloid formation

(*c*) Coagulation (*d*) Peptisation

21. Which of the following electrolytes will have maximum coagulating value for AgI/Ag^+ sol? [*NCERT Exemplar*]

(*a*) Na_2S (*b*) Na_3PO_4 (*c*) Na_2SO_4 (*d*) NaCl

22. Method by which lyophobic sol can be protected. [*NCERT Exemplar*]

(*a*) By addition of oppositely charged sol. (*b*) By addition of an electrolyte.

(*c*) By addition of lyophilic sol. (*d*) By boiling.

23. The emulsifying agent present in milk which makes it stable is:

(*a*) maltose (*b*) casein

(*c*) lactose (*d*) Lactobacilli

Answers

1. (*b*)	**2.** (*c*)	**3.** (*c*)	**4.** (*d*)	**5.** (*b*)	**6.** (*b*)	**7.** (*a*)	**8.** (*c*)	**9.** (*b*)	**10.** (*c*)
11. (*b*)	**12.** (*a, b*)	**13.** (*c*)	**14.** (*b*)	**15.** (*d*)	**16.** (*b, c*)	**17.** (*d*)	**18.** (*d*)	**19.** (*b*)	**20.** (*c*)
21. (*b*)	**22.** (*c*)	**23.** (*b*)							

Assertion-Reason Questions

In the following questions, two statements are given—one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

(c) Assertion (A) is correct, but Reason (R) is incorrect statement.

(d) Assertion (A) is incorrect, but Reason (R) is correct statement.

1. Assertion (A) : Adsorption decreases with increasing temperature.
Reason (R) : Adsorption is generally temperature dependent.

2. Assertion (A) : The enthalpy of physisorption is quite high.
Reason (R) : In physisorption, the molecules are adsorbed to the surface with van der Waal's forces.

3. Assertion (A) : In chemisorption, all gases are absorbed on all solids.
Reason (R) : Chemisorption takes place at elevated temperature.

4. Assertion (A) : The relation $\frac{x}{m} = k.p^{1/n}$ is known as Freundlich adsorption isotherm, where x is the mass of gas adsorbed by m grams of adsorbate, p is the equilibrium pressure, k and n are constants for given system and temperature.
Reason (R) : When several substances have same value of $\frac{1}{n}$, the lines by which their adsorption isotherms can be represented will meet at a point.

5. 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.

6. 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.

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

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

9. Assertion (A) : Colloidal sols scatter light while true solutions do not.
Reason (R) : The particles in the colloidal sol move much slower than that of the true solution.

10. 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).

11. Assertion (A) : Precipitation of the sol can be done by mixing two oppositely charged sols.
Reason (R) : The greater the valence of the occulating ion added, the greater is its power to cause precipitation.

12. Assertion (A) : Milk is an example of water in oil emulsion.
Reason (R) : Emulsion contains liquid dispersed in liquid.

13. Assertion (A) : Aqueous addition of raw sugar when passed over beds of animals charcoal becomes colourless.
Reason (R) : The colouring substances get adsorbed by the charcoal.

Answers

1. (*b*) **2.** (*d*) **3.** (*d*) **4.** (*c*) **5.** (*a*) **6.** (*c*) **7.** (*b*) **8.** (*d*) **9.** (*b*) **10.** (*a*)
11. (*b*) **12.** (*d*) **13.** (*a*)

Passage-based/Case-based Questions

Read the given passages and answer the questions that follow.

PASSAGE–1

Surface chemistry deals with phenomena that occur at the surfaces or interfaces. The interface or surface is represented by separating the bulk phase by a hyphen or a slash. For example, the interface between a solid and a gas may be represented by solid-gas or solid/gas. Due to complete miscibility, there is no interface between the gases. The bulk phase that we come across in surface chemistry may be pure compounds or solutions. The interface is normally a few molecules thick but its area depends on the size of the particles of bulk phases. Many important phenomena, noticeable amongst these being corrosion, electrode processes, heterogeneous catalysis, dissolution and crystallisation occur at interfaces. There are several examples, which reveal that the surface of a solid has the tendency to attract and retain the molecules of the phase with which it comes into contact. These molecules remain only at the surface and do not go deeper into the bulk. The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed adsorption. The molecular species or substance, which concentrates or accumulates at the surface is termed adsorbate and the material on the surface of which the adsorption takes place is called adsorbent. Adsorption of gases by solids depends on nature and surface area of the adsorbent, nature of the gas being adsorbed, temperature, pressure and activation of the solid adsorbent. When a gas is held on surface of a solid by van der Waals forces, it is called as physical adsorption while if a gas is held on the surface of a solid by chemical bond, it is called as chemical adsorption.

1. How do the size of particles of adsorbent influence the extent of adsorption of a gas on a solid?

Ans. Smaller the size of the particles of the adsorbent, greater is the surface area and greater is the adsorption.

2. Why is physical adsorption multilayered?

Ans. Physical adsorption involves van der Waals forces, so any number of layers may be formed one over the other on the surface of the adsorbent.

3. Which has a higher enthalpy of adsorption, physisorption or chemisorption? *[CBSE (AI) 2013]*

Ans. Chemisorption due to the involvement of chemical bond formation.

4. How does an increase in temperature affect both physical as well as chemical adsorption?

Ans. With increase in temperature, physical adsorption decreases while chemical adsorption first increases and then decreases.

5. What is the importance of having clean surface in surface studies?

Ans. Clean surface eases the adsorption of adsorbate on the adsorbent.

PASSAGE–2

A colloidal solution is a heterogeneous system in which a definite substance is distributed in the form of very small particles or dispersed phase in another substance called the dispersion medium. If water being the medium, colloids are called hydrosols. Colloids are of two types on the basis of nature of interaction between dispersed phase and dispersion medium: Lyophobic sols and Lyophilic sols. In Lyophobic sols, particles of dispersed phase have no affinity for dispersion medium rather they hate dispersion medium. They are not easily prepared and need stabilizing agents for their preservation. They are irreversible. They are also called extrinsic colloids while in Lyophilic sols, particles of dispersed phase have great affinity for the dispersion medium. They are self-stabilized because of strong attractive forces operating between the suspended particles and the dispersion medium. They are reversible in nature. They are also known as intrinsic colloids.

1. Write the main reason for the stability of colloidal sols. *[CBSE Delhi 2016; 2019 (56/4/3)]*

Ans. All the particles of colloidal sol carry the same charge so they keep on repelling each and other and do not aggregate together to form bigger particles.

2. Write the dispersed phase and dispersion medium of smoke. *[CBSE Guwahati 2015]*

Ans. Dispersed phase—Solid; Dispersion medium—Gas.

3. What type of colloid is formed when a liquid is dispersed in a solid? Give an example. *[CBSE (AI) 2017; 2019 (56/2/2)]*

Ans. Gel, *e.g.*, cheese, jellies

4. In what way is a sol different from a gel?

Ans. Colloidal system in which solid is dispersed in liquid is called sol and that in which liquid is dispersed in solid is called gel.

5. Hydrophobic sol is easily coagulated. Give reason.

Ans. Hydrophobic sol are unstable because they do not undergo hydration. Hence, they are easily coagulated by addition of a small amount of electrolyte, by heating or by shaking.

Very Short Answer Questions [1 mark]

Q. 1. What is sorption?

Ans. Sorption is the process in which adsorption and absorption take place simultaneously, *e.g.*, dyeing of cotton fibres by azo dyes.

Q. 2. What is 'occlusion'?

Ans. The adsorption of gases on the surface of metals is called occlusion.

Q. 3. Define desorption. *[CBSE Delhi 2011]*

Ans. The process of removal of an adsorbed substance from a surface on which it is adsorbed is called desorption.

Q. 4. What is physical adsorption?

Ans. If the adsorbate is held on an adsorbent surface by weak van der Waals' forces, the adsorption is called physical adsorption.

Q. 5. What type of forces are responsible for the occurrence of physisorption? *[CBSE (F) 2014]*

Ans. van der Waals' forces.

Q. 6. What is meant by chemical adsorption?

Ans. If the adsorbate is held on the surface of the adsorbent as a result of chemical reaction forming surface compounds, it is called chemical adsorption.

Q. 7. What is the effect of temperature on chemisorption? *[CBSE (AI) 2014]*

Ans. Chemisorption initially increases then decreases with rise in temperature. The initial increase is due to the fact that heat supplied acts as activation energy. The decrease afterwards is due to the exothermic nature of adsorption equilibrium.

Q. 8. Write one similarity between physisorption and chemisorption. *[CBSE Delhi 2017]*

Ans. Both increase with increase in surface area.

Q. 9. Adsorption of a gas on the surface of solid is generally accompanied by a decrease in entropy still it is a spontaneous process. Why? *[HOTS]*

Ans. According to the equation

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

For a process to be spontaneous, ΔG should be negative. Even though ΔS is negative here, ΔG is negative because reaction is highly exothermic, *i.e.*, ΔH is negative.

Q. 10. Which will be adsorbed more readily on the surface of charcoal and why: NH_3 or CO_2? *[HOTS]*

Ans. NH_3 has higher critical temperature than CO_2, *i.e.*, NH_3 is more liquefiable than CO_2. Hence, NH_3 has greater intermolecular forces of attraction and hence will be adsorbed more readily.

Q. 11. How is adsorption of a gas related to its critical temperature?

Ans. Higher is the critical temperature of a gas, greater is the ease of liquefication, *i.e.*, greater are the van der Waals' forces of attraction and hence greater is the adsorption.

Q. 12. How does a catalyst work?

Ans. Catalysts provide an alternate path involving lower activation energy for the reactants.

Q. 13. What is the role of desorption in the process of catalysis? *[CBSE (F) 2017]*

Ans. Desorption makes the surface available again for fresh adsorption of reactant molecules.

Q. 14. Why is desorption important for a substance to act as good catalyst? *[NCERT Exemplar]*

Ans. After the completion of reaction between adsorbed reactants, the process of desorption is important to remove products and further create space for the other reactant molecules to approach the surface and react.

Q. 15. $CO(g)$ and $H_2(g)$ react to give different products in the presence of different catalysts. Which ability of the catalyst is shown by these reactions? ***[CBSE 2018]***

Ans. Selectivity of the catalyst is shown by these reactions.

Q. 16. Define colloidal solution.

Ans. A colloidal solution is a state in which the particle size lies between 1 nm and 1000 nm. It appears to be homogeneous but actually it is heterogeneous.

Q. 17. What is collodion? ***[NCERT Exemplar]***

Ans. It is a 4% solution of nitrocellulose in a mixture of alcohol and ether.

Q. 18. Why are some medicines more effective in the colloidal form? ***[NCERT Exemplar]***

Ans. Medicines are more effective in the colloidal form because of large surface area and are easily assimilated in this form.

Q. 19. Write the dispersed phase and dispersion medium of butter. ***[CBSE Patna 2015]***

Ans. Dispersed phase : Liquid

Dispersion medium : Solid

Q. 20. Give one example each of sol and gel. ***[CBSE Delhi 2014]***

Ans. Sol: Paints, cell fluids

Gel: Butter, cheese

Q. 21. What is common in aquasols and solid aerosols? How do they differ?

Ans. Aquasol and solid aerosol both have solid as the dispersed phase. They differ in dispersion medium. Aquasols have water as the dispersion medium while aerosols have gas as the dispersion medium.

Q. 22. What are lyophobic colloids? Give one example for them. ***[CBSE (AI) 2011]***

Ans. Lyophobic sols are those sols in which the particles of the dispersed phase have little affinity for the particles of the dispersion medium, *e.g.*, sols of metal and their sulphides and hydroxides.

Q. 23. Give one example each of lyophobic sol and lyophilic sol. ***[CBSE Delhi 2014]***

Ans. Lyophobic sol — Gold sol, As_2S_3 sol

Lyophilic sol — Sol of starch, sol of gum

Q. 24. What is Kraft temperature? ***[CBSE 2020 (56/3/1)]***

Ans. Kraft temperature is the minimum temperature above which the formation of micelles takes place.

Q. 25. How will you prepare arsenic sulphide sol in the lab?

Ans. $As_2O_3 + 3H_2S \longrightarrow \underset{\text{(Yellow sol)}}{As_2S_3} + 3H_2O$

Q. 26. What is the principle of dialysis?

Ans. Dialysis is based on the principle that ions can pass through semipermeable membrane whereas colloidal particles cannot pass through it.

Q. 27. What happens when dialysis is prolonged? ***[NCERT Exemplar]***

Ans. Due to excessive dialysis, traces of electrolyte which stabilises the colloids is removed completely, making the colloid unstable. As a result, coagulation takes place.

Q. 28. What happens when an electric field is applied to a colloidal dispersion? ***[NCERT Exemplar]***

Ans. The colloidal particles move towards the oppositely charged electrode and get neutralised and coagulated there.

Q. 29. What is electrodialysis?

Ans. It is a process by which colloidal solutions containing ionic impurities are purified. The colloidal solution containing ionic impurities is placed in a bag of parchment paper in distilled water in electric field. The ions come out through parchment paper and the sol is purified.

Q. 30. Define ultrafiltration.

Ans. In this process, colloidal solutions are purified by carrying out filtration through special types of graded filters called ultra-filters. Filter paper allows the passage of electrolyte but does not allow the passage of colloidal particles.

Q. 31. Why do colloidal solutions exhibit Tyndall effect?

Ans. Colloidal solutions exhibit Tyndall effect because the size of the colloidal particles (1 nm–1000 nm) is such that they can scatter light.

Q. 32. What causes Brownian movement in a colloidal solution? *[NCERT Exemplar]*

Ans. Unbalanced bombardment of the particles of dispersed phase by molecules of dispersion medium causes Brownian motion. This stabilizes the sol.

Q. 33. What is the main cause of charge on a colloidal solution?

Ans. The charge on the colloidal particles is due to adsorption of common ions of the electrolyte on the surface of the colloidal particles, *e.g.*, Fe^{3+} from $FeCl_3$ on the surface of $Fe(OH)_3$ particles.

Q. 34. Give one example of positively charged sol and one example of negatively charged sol.

Ans. $Fe(OH)_3$ is a positively charged sol whereas As_2S_3 is a negatively charged colloid.

Q. 35. What causes electrophoresis?

Ans. Electrophoresis is due to charge on colloidal particles, the charged particles move towards one of the electrodes in electric field.

Q. 36. What is the type of charge on AgI colloidal sol formed when $AgNO_3$ solution is added to KI solution? *[CBSE Bhubaneshwar 2015]*

Ans. Negatively charged sol, AgI/I^- is formed when $AgNO_3$ solution is added to KI solution.

Q. 37. Why is ferric chloride preferred over potassium chloride in case of a cut leading to bleeding? *[CBSE 2019 (56/4/1)]*

Ans. Fe^{3+} ion has greater coagulating power than K^+ ion as ferric ion has higher charge.

Q. 38. Which of the following is most effective electrolyte in the coagulation of AgI/Ag^+ sol?
K_2SO_4, $MgCl_2$, $K_4[Fe(CN)_6]$ *[CBSE Sample Paper 2014]*

Ans. $K_4[Fe(CN)_6]$

Q. 39. Out of $BaCl_2$ and KCl, which one is more effective in causing coagulation of a negatively charged colloidal sol? Give reason. *[CBSE Delhi 2015]*

Ans. $BaCl_2$, Ba^{2+} ion has greater coagulating power than K^+ ion as Ba^{2+} ion has higher charge.

Q. 40. How can a lyophilic sol be coagulated?

Ans. This can be done (*i*) by adding an electrolyte, (*ii*) by adding a suitable solvent.

Q. 41. Give one example each of 'oil in water' and 'water in oil' emulsion. *[CBSE Delhi 2014]*

Ans. Oil in water emulsion: milk, vanishing cream.

Water in oil emulsion: Butter, cold cream, cod liver oil.

Q. 42. How will you distinguish between dispersed phase and dispersion medium in an emulsion? *[NCERT Exemplar]*

Ans. On adding dispersion medium, emulsions can be diluted to any extent. The dispersed phase forms a separate layer if added in excess.

Q. 43. Write two differences between sols and emulsions.

Ans. (*i*) Sols are dispersions of solids in liquids while emulsions are dispersions of liquids in liquids.

(*ii*) Sols are quite stable whereas emulsions are less stable.

Q. 44. How do emulsifying agents stabilise the emulsion? *[NCERT Exemplar]*

Ans. The emulsifying agent forms an interfacial layer between suspended particles and the dispersion medium thereby stabilising the emulsion.

Q. 45. A delta is formed at the meeting point of sea water and river water. Why? *[CBSE Allahabad 2015]*

Ans. River water is a colloidal solution of clay and sea water contains a number of electrolytes. When river water meets the sea water, the electrolytes present in the sea water coagulate the colloidal solution of clay resulting in its deposition with the formation of delta.

Q. 46. It is possible to cause artificial rain by spraying silver iodide on the clouds. Comment. *[NCERT Exemplar] [HOTS]*

Ans. Yes. Clouds are colloidal in nature and carry charge. Spray of silver iodide, an electrolyte, results in coagulation leading to rain.

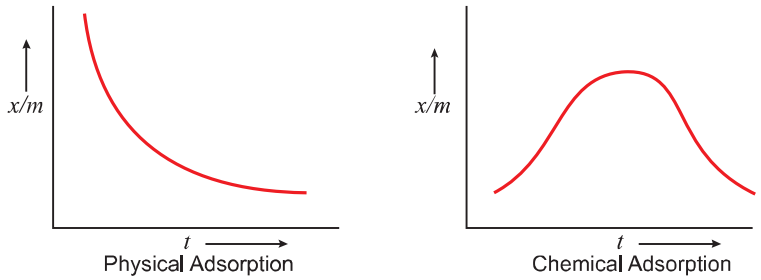
Short Answer Questions–I [2 marks]

Q. 1. Write the differences between physisorption and chemisorption with respect to the following:
(*i*) Specificity (*ii*) Temperature dependence
(*iii*) Reversibility and (*iv*) Enthalpy change [*CBSE Delhi 2013*]

Ans.

	Physisorption	Chemisorption
(*i*) Specificity	It is not specific in nature.	It is highly specific in nature.
(*ii*) Temperature dependence	Low temperature is favourable for adsorption. It decreases with increase of temperature.	High temperature is favourable for adsorption. It increases with the increase of temperature.
(*iii*) Reversibility	It is reversible in nature.	It is irreversible.
(*iv*) Enthalpy change	Enthalpy of adsorption is low (20–40 kJ/mol) in this case.	Enthalpy of adsorption is high (80-240 kJ/mol) in this case.

Q. 2. Physical and chemical adsorption respond differently with a rise in temperature. What is this difference and why is it so?



Ans. Adsorption isobar for physical adsorption shows that the extent of adsorption decreases with the increase in temperature. The adsorption isobar of chemical adsorption shows that the extent of adsorption first increases and then decreases with the increase in temperature. The initial unexpected increase in the extent of adsorption with temperature is due to the fact that the heat supplied acts as activation energy required for chemical adsorption which is much more than that of physical adsorption.

Q. 3. Give an example where physisorption changes to chemisorption with rise in temperature. Explain the reason for change.

Ans. The process of physisorption, for example that of H_2 on finely divided nickel, involves weak van der Waals' forces. With increase in temperature, hydrogen molecules dissociate into hydrogen atoms which are held on the surface by chemisorption.

Q. 4. How are the following colloidal solutions prepared?
(*i*) Sulphur in water (*ii*) Gold in water [*CBSE Delhi 2013*]

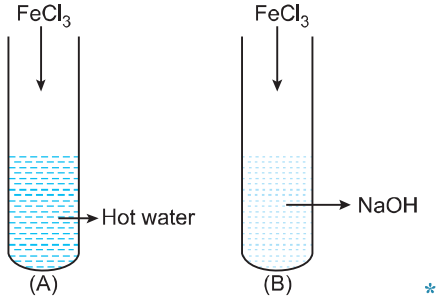
Ans. (*i*) Sulphur sol is prepared by the oxidation of H_2S with SO_2.

$$SO_2 + 2H_2S \xrightarrow{\text{Oxidation}} 3S(\text{Sol}) + 2H_2O$$

(*ii*) Gold sol is prepared by the reduction of $AuCl_3$ with formaldehyde.

$$2AuCl_3 + 3HCHO + 3H_2O \xrightarrow{\text{Reduction}} 2Au(\text{Sol}) + 3HCOOH + 6HCl$$

Q. 5. A colloidal solution of ferric oxide is prepared by two different methods as shown below. [*HOTS*]



(*i*) What is the charge on colloidal particles in two test tubes (A) and (B)?

(*ii*) Give reasons for the origin of charge.

Ans. (*i*) Colloidal particles of test tube (A) are positively charged whereas colloidal particles of test tube (B) are negatively charged.

(*ii*) In test tube (A), Fe^{3+} is adsorbed on the precipitate $Fe_2O_3.xH_2O$ [or $Fe_2O_3.xH_2O/Fe^{3+}$ is formed].

In test tube (B), OH^- ion is adsorbed on the precipitate $Fe_2O_3.xH_2O$ [or $Fe_2O_3.xH_2O/OH^-$ is formed].

Q. 6. What is meant by coagulation of a colloidal solution? Describe briefly any three methods by which coagulation of lyophobic sols can be carried out. ***[CBSE Delhi 2012]***

Ans. The process of settling of colloidal particles through induced aggregation by the addition of some suitable electrolyte is known as coagulation. Three methods by which coagulation of lyophobic sols can be carried out are:

(*i*) Electrophoresis: During electrophoresis the colloidal particles move towards oppositely charged electrodes, get discharged and coagulated.

(*ii*) Boiling: On boiling a sol, the adsorbed layer is disturbed due to increased collision with the molecules of dispersion medium. This reduces the charge on the particles which ultimately settle down in the form of a precipitate.

(*iii*) Addition of Electrolytes: When excess of an electrolyte is added to a colloidal solution, the colloids interact with ions carrying charge opposite to that present on themselves. This causes neutralisation leading to their coagulation.

Short Answer Questions–II [3 marks]

Q. 1. Define adsorption with an example. Why is adsorption exothermic in nature? Write the types of adsorption based on the nature of forces between adsorbate and adsorbent. ***[CBSE Ajmer 2015]***

Ans. The accumulation of the molecular species at the surface rather than in the bulk of a solid or liquid is known as adsorption. For example, water vapour are adsorbed by silica gel.

When a gas is adsorbed on the surface of a solid its entropy decreases, *i.e.*, ΔS becomes –ve. Since adsorption is a spontaneous process, therefore, ΔG ($= \Delta H - T\Delta S$) must be negative. As $-T\Delta S$ is +ve, ΔG can be negative only if ΔH has sufficiently high –ve value. Hence, adsorption is exothermic in nature.

There are two types of adsorption based on the nature of forces between adsorbate and adsorbent.

(*i*) Physical adsorption, when accumulation of gas on the surface of a solid occurs due to weak van der Waal forces.

(*ii*) Chemical adsorption, when the gas molecules or atoms are held to the surface of solid by chemical bonds.

Q. 2. Give reasons for the following: ***[CBSE Sample Paper 2013]***

(*i*) Rough surface of catalyst is more effective than smooth surface.

(*ii*) Smoke passed through charged plates before allowing it to come out of chimneys in factories.

(*iii*) Ne gets easily adsorbed over charcoal than He.

Ans. (*i*) Rough surface of a catalyst provides more surface area for adsorption.

(*ii*) Smoke is passed through charged plates so that unburnt charged carbon particles get settled between the charged plate leaving behind air free from pollutants.

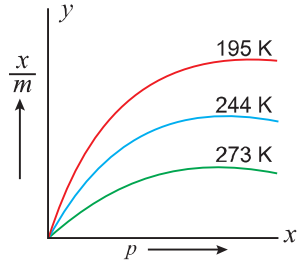
(*iii*) Ne has higher critical temperature, *i.e.*, stronger van der Waals forces therefore easily adsorbed.

Q. 3. Consider the adsorption isotherms given alongside and interpret the variation in the extent of adsorption (x/m) when

(*i*) (*a*) temperature increases at constant pressure.

(*b*) pressure increases at constant temperature.

(*ii*) Name the catalyst and the promoter used in Haber's process for manufacture of ammonia. ***[HOTS]***



Ans. (*i*) (*a*) At constant pressure, extent of adsorption $\left(\frac{x}{m}\right)$ decreases with increase in temperature as adsorption is an exothermic process.

(*b*) At constant temperature, first adsorption $\left(\frac{x}{m}\right)$ increases with increase in pressure up to a particular pressure and then it remains constant.

At low pressure, $\frac{x}{m} = kp$

At intermediate range of pressure, $\frac{x}{m} = kp^{1/n}$ $(n > 1)$

At high pressure, $\frac{x}{m} = k$ (independent of pressure)

(*ii*) Finely divided iron is used as a catalyst and molybdenum is used as promoter.

Q. 4. Explain how the phenomenon of adsorption finds application in each of the following processes:

(*i*) Production of vacuum **(*ii*) Heterogeneous catalysis**

(*iii*) Froth Floatation process ***[CBSE Delhi 2011; (F) 2011]***

Ans. **(*i*) Production of Vacuum:** Adsorption can be successfully applied to create conditions of high vacuum. For this, a bulb of charcoal cooled in liquid air, is connected to vessel which has already been exhausted as far as possible by vacuum pump. The remaining traces of air inspite of low pressure are adsorbed by the charcoal almost completely.

(*ii*) Heterogeneous Catalysis: There are many gaseous reactions of industrial importance involving solid catalyst. Manufacture of ammonia using iron as a catalyst, manufacture of H_2SO_4 by contact process using V_2O_5 catalyst and use of finely divided nickel in the hydrogenation of vegetable oils are the excellent examples. The gaseous reactants are adsorbed on the surface of the solid catalyst. As a result, the concentration of the reactants increases on the surface of the catalyst and hence the rate of reaction increases.

(*iii*) Froth Floatation Process: In froth floatation process, the powdered ore is mixed with water. It is then mixed with pine oil (a frother). The oil particles are adsorbed on the surface of ore particles. Now a stream of air is blown through the mixture from below when froth is formed at the water surface. The ore particles stick to the bubbles of the air rises to surface along with the foam while the gangue particles which are wetted by water settle at the bottom. The foam is separated out and is collected and in the course, the ore particles also settle down.

Q. 5. Write one difference in each of the following:

(*i*) Lyophobic sol and Lyophilic sol **(*ii*) Solution and Colloid**

(*iii*) Homogeneous catalysis and Heterogeneous catalysis ***[CBSE Delhi 2017]***

Ans.

(*i*)	Lyophobic Sol	Lyophilic Sol
	• Solvent hating • Irreversible in nature	• Solvent loving • Reversible in nature (*Any one*)
(*ii*)	**Solution**	**Colloid**
	• Homogeneous mixture • Does not show Tyndall effect	• Heterogeneous mixture • Shows Tyndall effect (*Any one*)
(*iii*)	**Homogeneous catalysis**	**Heterogeneous catalysis**
	• Reactants and catalyst are in same phase. • $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$ (*Any one*)	• Reactants and catalyst are not in same phase. • $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$ (*Any one*)

Q. 6. Explain the cleansing action of soap. Why do soaps not work in hard water? ***[CBSE (AI) 2012]***

Ans. The cleansing action of soap such as sodium stearate is due to the fact that soap molecules form micelle around the oil droplet in such a way that hydrophobic part of the stearate ions is in the oil droplet and hydrophilic part projects out of the grease droplet like the bristles. Since the polar groups can interact with water, the oil droplet surrounded by stearate ions is now pulled in water and removed from the dirty surface. Thus, soap helps in emulsification and washing away of oils and fats.

Hard water contains calcium and magnesium salts. In hard water, soap gets precipitated as calcium and magnesium soap which being insoluble stick to the clothes as gummy mass. Therefore, soaps do not work in hard water.

Q. 7. What type of colloidal sols are formed in the following:

(*i*) Sulphur vapours are passed through cold water.

(*ii*) White of an egg is mixed with water.

(*iii*) Soap solution.

Ans. (*i*) Multimolecular because sulphur molecules associate together to form multimolecular colloids.

(*ii*) Macromolecular because protein molecules present in the white of the egg are macromolecules soluble in water.

(*iii*) Associated because $RCOO^-$ ions associate together to form micelles.

Q. 8. (*i*) Write the dispersed phase and dispersion medium of milk. ***[CBSE 2019 (56/2/2)]***

(*ii*) Write one similarity between physisorption and chemisorption.

(*iii*) Write the chemical method by which $Fe(OH)_3$ sol is prepared from $FeCl_3$. ***[CBSE (AI) 2017]***

Ans. (*i*) Both the dispersed phase and dispersion medium of milk are liquid.

(*ii*) Both the physisorption and chemisorption increase with increase in surface area.

(*iii*) **Hydrolysis:** $FeCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} Fe(OH)_3(sol) + 3HCl$

The $Fe(OH)_3$ molecules formed as result of hydrolysis of $FeCl_3$ aggregate leading to the formation of sol.

Q. 9. Define the following terms:

(*i*) Brownian movement

(*ii*) Peptization ***[CBSE 2020 (56/3/1)]***

(*iii*) Multimolecular colloids ***[CBSE Patna 2015]***

Ans. **(*i*) Brownian movement:** The motion of the colloidal particles in a zig-zag path due to unbalanced bombardment by the particles of dispersion medium is called Brownian movement.

(*ii*) Peptization: The process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of a small amount of suitable electrolyte is called peptization. During peptization, the precipitate absorbs one of the ions of the electrolyte on its surface. This causes development of positive or negative charge on precipitates, which ultimately break up into particles of colloidal dimension.

(*iii*) Multimolecular colloids: A large number of atoms or smaller molecules (diameter < 1 nm) of a substance on dissolution aggregate together to form species having size in the colloidal range. Such species are called multimolecular colloids. **Examples:** a sulphur sol consist of particles containing thousands of S_8 sulphur molecules, a platinum or gold sol may have particles of various sizes having many atoms.

Q. 10. Define the following terms giving one suitable example for each:

(*i*) Electrophoresis

(*ii*) Micelles

(*iii*) Peptization ***[CBSE (F) 2012]***

Ans. (*i*) The movement of colloidal particles towards oppositely charged electrodes in an electric field is called electrophoresis.

(*ii*) There are some substances such as soap which at low concentration behave as normal electrolytes, but at higher concentration exhibit colloidal behaviour due to the formation of aggregates. The aggregated particles thus formed are known as micelles or associated colloids.

(*iii*) The process of converting a precipitate into colloidal solution by shaking it with dispersion medium in the presence of small amount of electrolyte is called peptization.

Q. 11. Define the following terms:

(*i*) Homogeneous catalysis

(*ii*) Coagulation

(*iii*) Macromolecular colloids **[*CBSE Chennai 2015*]**

Ans. (*i*) In a catalysis process if the catalyst and the reactants are in the same phase (liquid or gas), the process is said to be homogeneous catalysis. For example, oxidation of SO_2 to SO_3 with O_2 in the presence of NO as a catalyst.

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

(*ii*) The process of settling of colloidal particles forming a precipitate is called coagulation.

(*iii*) Macromolecules in a suitable solvent form solutions in which the size of the macromolecules may be in colloidal range. Such colloids are called macromolecular colloids. These colloids are quite stable and resemble true solutions in many respect, *e.g.*, starch dispersed in water.

Q. 12. (*i*) Differentiate between adsorption and absorption.

(*ii*) Out of $MgCl_2$ and $AlCl_3$, which one is more effective in causing coagulation of negatively charged sol and why?

(*iii*) Out of sulphur sol and proteins, which one forms multimolecular colloids? [*CBSE Delhi 2016*]

Ans. (*i*)

S.No.	Adsorption	Absorption
(*i*)	It is a surface phenomenon. Adsorbate molecules are held at the surface of adsorbent.	Absorption occurs in the bulk of absorbing substance.
(*ii*)	The concentration of the adsorbate at the adsorbent surface is much more than that in the bulk.	Absorbed material is uniformly distributed throughout the bulk. Thus, concentration is same throughout.
(*iii*)	Initially, rate of adsorption is rapid. It decreases slowly till equilibrium is attained. **Example:** Water vapours on silica gel.	Absorption occurs with uniform rate. **Example:** Water vapours are absorbed by anhydrous $CaCl_2$.

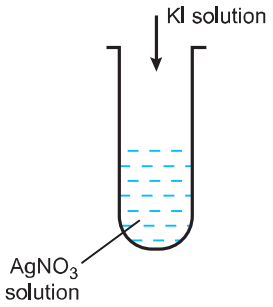
(*ii*) $AlCl_3$ is more effective in causing coagulation of negatively charged sol as Al^{3+} ion has greater positive charge than Mg^{2+} ion.

(*iii*) Sulphur sol.

Q. 13. (*i*) Write the dispersed phase and dispersion medium of dust.

(*ii*) Why is physisorption reversible whereas chemisorption is irreversible?

(*iii*) A colloidal sol is prepared by the method given in the figure. What is the charge on AgI colloidal particles formed in the test tube? How is the sol represented? [*CBSE 2019 (56/2/1)*]



Ans. (*i*) Dust is aerosol in which dispersed phase is solid whereas the dispersion medium is gas.

(*ii*) Physisorption is caused by weak van der Waal's forces therefore it is reversible whereas chemisorption is caused by chemical bond formation therefore it is irreversible.

(*iii*) ● Positive charge

● AgI/Ag^+

Q. 14. (*i*) Out of silica gel and anhydrous $CaCl_2$, which will adsorb the water vapours?

(*ii*) Out of H_2SO_4 and H_3PO_4, which one is more effective in causing coagulation of positively charged sol? Give reason.

(*iii*) Out of sulphur sol and proteins, which one forms macromolecular colloids? [*CBSE South 2016*]

Ans. (*i*) Silica gel

(*ii*) H_3PO_4, as PO_4^{3-} ion has greater negative charge than SO_4^{2-}.

(*iii*) Proteins.

Q. 15. SnO_2 forms a positively charged colloidal sol in acidic medium and a negatively charged sol in the basic medium. Why? Explain. **[*HOTS*]**

Ans. SnO_2 is amphoteric in nature. It reacts with acids such as HCl, to form $SnCl_4$ in the solution. The common Sn^{4+} ions are adsorbed on the surface of SnO_2 particles to give a positively charged colloidal sol.

$$SnO_2 + 4HCl \longrightarrow SnCl_4 + 2H_2O$$

$$SnO_2 + Sn^{4+} \longrightarrow \underset{\text{Positively charged sol}}{(SnO_2) : Sn^{4+}}$$

Similarly, with base like NaOH, it forms sodium stannate (Na_2SnO_3). The stannate ions get adsorbed on the surface of SnO_2 to give negatively charged colloidal sol.

$$SnO_2 + 2NaOH \longrightarrow \underset{\text{Sodium stannate}}{Na_2SnO_3} + H_2O$$

$$SnO_2 + SnO_3^{2-} \longrightarrow \underset{\text{Negatively charged sol}}{(SnO_2) : SnO_3^{2-}}$$

Q. 16. Explain what is observed when **[*CBSE Sample Paper 2015*]**

(*i*) silver nitrate solution is added to potassium iodide solution.

(*ii*) the size of the finest gold sol particles increases in the gold sol.

(*iii*) two oppositely charged sols are mixed in almost equal proportions.

Ans. (*i*) If silver nitrate solution is added to potassium iodide solution, the precipitated silver iodide adsorbs iodide ions from the dispersion medium and negatively charged colloidal solution results.

$$AgI + \underset{\text{(From dispersion medium)}}{I^-} \longrightarrow \underset{\substack{\text{Negatively charged}\\ \text{Sol}}}{AgI / I^-}$$

(*ii*) The colour of the colloidal solution depends on the wavelength of the light scattered by the colloidal particles which in turn depends on size and nature of the colloidal particle. Finest gold sol is red in colour, as the size of the particle increases, it appears purple, then blue and finally golden.

(*iii*) Two oppositely charged sols when mixed in almost equal proportions, neutralise their charges and get partially or completely precipitated. Such type of coagulation is called mutual coagulation.

Q. 17. Answer the following questions: **[*CBSE Sample Paper 2016*]**

(*i*) What happens when a freshly precipitated $Fe(OH)_3$ is shaken with a little amount of dilute solution of $FeCl_3$?

(*ii*) Why are lyophilic colloidal sols more stable than lyophobic colloidal sols?

(*iii*) What form Freundlich adsorption equation will take at high pressure?

Ans. (*i*) It is converted into colloidal state by preferential adsorption of Fe^{3+} ions.

$$Fe(OH)_3 + FeCl_3 \longrightarrow \underset{\substack{\text{Reddish brown}\\ \text{coloured colloid}}}{[Fe(OH)_3]\,Fe^{3+}} + 3Cl^-$$

(*ii*) This is because the stability of lyophobic sol is only due to the presence of charge on the colloidal particles. On the other hand, the stability of lyophilic sol is due to charge on the colloidal particles as well as solvation of colloidal particles.

(*iii*) Freundlich Adsorption Isotherm, $\frac{x}{m} = kp^{1/n}$

At high pressure (beyond saturation pressure), $\frac{1}{n} = 0$ and $\frac{x}{m}$ = constant *i.e.*, the adsorption is independent of pressure. So, $\frac{x}{m} = kp^0$ or $\frac{x}{m} = k$.

Q. 18. (*i*) What are micelles? How do they differ from ordinary colloidal particles? Give two examples of micelle forming substances.

(*ii*) State Hardy–Schulze rule.

Ans. (*i*) There are some substances which at low concentration behave as normal electrolyte but at higher concentrations exhibit colloidal behaviour due to formation of aggregated particles. The aggregated particles thus formed are called micelles. Surface active agents such as soaps and detergents are the example of micelle forming substances.

The formation of micelles takes place only above a particular temperature called Kraft temperature and above a particular concentration called critical micelle concentration (CMC). On dilution, these colloids revert back to individual ions.

(*ii*) **Hardy–Schulze rule:** Refer to Basic Concepts Point 23(*h*).

Q. 19. Classify colloids where the dispersion medium is water. State their characteristics and write an example of each of these classes. ***[CBSE (AI) 2011; (F) 2012]***

Ans. These are of two types:

(*i*) Hydrophilic

Stability: More stable as the stability is due to charge and water envelope surrounding the sol particles.

Nature: Reversible

Examples: Starch, gum, etc.

(*ii*) Hydrophobic

Stability: Less stable as the stability is due to charge only.

Nature: Irreversible

Examples: Metal hydroxide like $Fe(OH)_3$ and metal sulphide like As_2S_3.

Q. 20. Explain the following observations:

(*i*) Sun looks red at the time of setting.

(*ii*) Cottrell's smoke precipitator is fitted at the mouth of the chimney used in factories.

(*iii*) Physical adsorption is multilayered while chemical adsorption is monolayered. ***[HOTS]***

Ans. (*i*) At the time of setting, the sun is at horizon. The light emitted by the sun has to travel a relatively longer distance through the atmosphere. As a result, blue part of light is scattered away by the particulate in the atmosphere causing red part to be visible.

(*ii*) Cottrell's smoke precipitator, neutralises the charge on unburnt carbon particles, coming out of chimney and they get precipitated and settle down at the floor of the chamber.

(*iii*) Physical adsorption involves van der Waals' forces, so any number of layers may be formed one over the other on the surface of the adsorbent. Chemical adsorption takes place as a result of the reaction between adsorbent and adsorbate. When the surface of adsorbent is covered with one layer, no further reaction can take place.

Q. 21. (*i*) Why does leather get hardened after tanning? ***[CBSE 2019 (56/4/1)]***

(*ii*) On the basis of Hardy-Schulze rule explain why the coagulating power of phosphate is higher than chloride.

(*iii*) Do the vital functions of the body such as digestion get affected during fever? Explain your answer. ***[CBSE Sample Paper 2017]***

Ans. (*i*) Animal hides are colloidal in nature. When a hide, which has positively charged particles, is soaked in tannin, which contains negatively charged colloidal particles, mutual coagulation takes place. This results in the hardening of leather.

(*ii*) Greater the valency of flocculating ion added, greater is its power to cause coagulation. Thus, for the coagulation of a positively charged sol PO_4^{3-} ion has higher coagulating power than Cl^- ion.

(*iii*) The optimum temperature for enzymatic activity is 298-310 K. On either side of this range enzyme activity decreases, that is why vital function of the body such as digestion get affected during fever.

Self-Assessment Test

Time allowed: 1 hour **Max. marks: 30**

Choose and write the correct answer for each of the following. (3 × 1 = 3)

1. **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

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

   (*a*) CO_2 (*b*) SO_2

   (*c*) CH_4 (*d*) H_2

3. **In which of the following reactions heterogenous catalysis is involved?**

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

   (II) $2SO_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

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

   (IV) $CH_3COOCH_3(l) + H_2O(l) \xrightarrow{HCl(l)} CH_3COOH(aq) + CH_3OH(aq)$

   (*a*) (II), (III) (*b*) (II), (III), (IV)

   (*c*) (I), (II), (III) (*d*) (IV)

In the following questions, two statements are given—one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(*a*) *Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).*

(*b*) *Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).*

(*c*) *Assertion (A) is correct, but Reason (R) is incorrect statement.*

(*d*) *Assertion (A) is incorrect, but Reason (R) is correct statement.* (3 × 1 = 3)

4. **Assertion (*A*) :** If a finely divided mixture of clay and charcoal is shaken with water and benzene, the clay will remain in water layer and charcoal will concentrate at the interface between the two liquids.

   Reason (*R*) : In the adsorption of acetic acid from aqueous solution by charcoal it is assumed that a multimolecular layer of adsorbed substance is formed.

5. **Assertion (*A*) :** For the coagulation of sols carrying positive charge, PO_4^{3-} ions are more efficient than SO_4^{2-} or Cl^- ions.

   Reason (*R*) : This follows Hardy-Schulze rule.

6. **Assertion (*A*) :** Colloidal solution is electrically neutral.

   Reason (*R*) : Due to similar nature of the charge carried by the particles, they repel each other and do not combine to form bigger particles.

Answer the following questions:

7. What is the role of diffusion in heterogenous catalysis? **(1)**

8. What happens when gelatin is added to gold sol? **(1)**

9. (*i*) How does BF_3 act as a catalyst in industrial process?
   (*ii*) Give an example of shape-selective catalysis. **(2)**

10. Give reasons:
   (*i*) Physisorption decreases with increase of temperature.
   (*ii*) Gelatin which is a peptide is added in ice-creams. **(2)**

11. How does a solid catalyst enhance the rate of combination of gaseous molecules? **(2)**

12. Give an example of
   (*i*) Heterogeneous catalysis
   (*ii*) Shape selective catalyst **(2)**

13. Give reason for the following observations:
   (*i*) Colloidal gold is used for intermuscular injection.
   (*ii*) Peptizing agent is added to convert precipitate into colloidal solution.
   (*iii*) Finely divided substance is more effective as an adsorbent. **(3)**

14. Differentiate between the following pairs:
   (*i*) Macromolecular colloids and multimolecular colloids
   (*ii*) Peptization and coagulation
   (*iii*) Electrophoresis and electrodialysis **(3)**

15. What are enzymes? Give mechanism of enzyme catalysis. **(3)**

16. What is heterogeneous catalysis? Explain modern adsorption theory of heterogeneous catalysis. **(5)**

Answers

1. (*b*) **2.** (*d*) **3.** (*a*) **4.** (*c*) **5.** (*a*) **6.** (*b*)