Unit

5

SURFACE CHEMISTRY

I. Multiple Choice Questions (Type-I)

1. Which of the following process does **not** occur at the interface of phases?

(i) crystallisation

(ii) heterogenous catalysis

(iii) homogeneous catalysis

(iv) corrosion

2. At the equilibrium position in the process of adsorption _____.

(i) $\Delta H > 0$

(ii) $\Delta H = T\Delta S$

(iii) $\Delta H > T\Delta S$

(iv) $\Delta H < T\Delta S$

3. Which of the following interface **cannot** be obtained?

(i) liquid-liquid

(ii) solid-liquid

(iii) liquid-gas

(iv) gas-gas

4. The term 'sorption' stands for _____.

(i) absorption

(ii) adsorption

(iii) both absorption and adsorption

(iv) desorption

5. Extent of physisorption of a gas increases with _____.

(i) increase in temperature.

(ii) decrease in temperature.

(iii) decrease in surface area of adsorbent.

(iv) decrease in strength of van der Waals forces.

6. Extent of adsorption of adsorbate from solution phase increases with _____.

(i) increase in amount of adsorbate in solution.

(ii) decrease in surface area of adsorbent.

(iii) increase in temperature of solution.

(iv) decrease in amount of adsorbate in solution.

7. Which one of the following is **not** applicable to the phenomenon of adsorption?

(i) $\Delta H > 0$

(ii) $\Delta G < 0$

(iii) $\Delta S < 0$

(iv) $\Delta H < 0$

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

(i) high pressure

(ii) negative ΔH

(iii) higher critical temperature of adsorbate

(iv) high temperature

9. Physical adsorption of a gaseous species may change to chemical adsorption with _____.

(i) decrease in temperature

(ii) increase in temperature

(iii) increase in surface area of adsorbent

(iv) decrease in surface area of adsorbent

10. In physisorption adsorbent does not show specificity for any particular gas because _____.

(i) involved van der Waals forces are universal.

(ii) gases involved behave like ideal gases.

(iii) enthalpy of adsorption is low.

(iv) it is a reversible process.

11. Which of the following is an example of absorption?

(i) Water on silica gel

(ii) Water on calcium chloride

(iii) Hydrogen on finely divided nickel

(iv) Oxygen on metal surface

12. 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

(i) CO_2
(ii) SO_2
(iii) CH_4
(iv) H_2

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

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

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

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

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

(i) (b), (c)
(ii) (b), (c), (d)
(iii) (a), (b), (c)
(iv) (d)

14. At high concentration of soap in water, soap behaves as _____.

(i) molecular colloid
(ii) associated colloid
(iii) macromolecular colloid
(iv) lyophilic colloid

15. Which of the following will show Tyndall effect?

(i) Aqueous solution of soap below critical micelle concentration.
(ii) Aqueous solution of soap above critical micelle concentration.
(iii) Aqueous solution of sodium chloride.
(iv) Aqueous solution of sugar.

16. Method by which lyophobic sol can be protected.

(i) By addition of oppositely charged sol.
(ii) By addition of an electrolyte.
(iii) By addition of lyophilic sol.
(iv) By boiling.

17. Freshly prepared precipitate sometimes gets converted to colloidal solution by _____.

(i) coagulation
(ii) electrolysis

(iii) diffusion

(iv) peptisation

18. Which of the following electrolytes will have maximum coagulating value for AgI/Ag^+ sol?

(i) Na_2S

(ii) Na_3PO_4

(iii) Na_2SO_4

(iv) NaCl

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

(i) solid sol

(ii) gel

(iii) emulsion

(iv) sol

20. 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 _____.

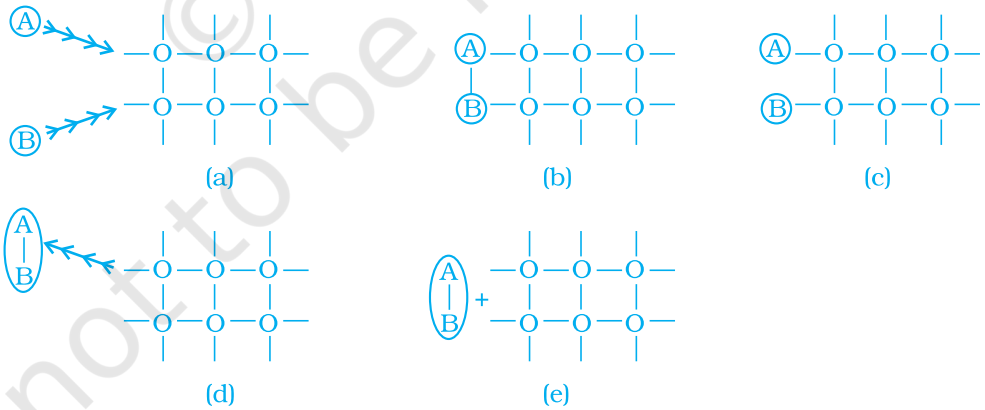
(i) exhibit enormous surface area.

(ii) remain suspended in the dispersion medium.

(iii) form lyophilic colloids.

(iv) are comparatively less in number.

21. Arrange the following diagrams in correct sequence of steps involved in the mechanism of catalysis, in accordance with modern adsorption theory.



(i) a ⟶ b ⟶ c ⟶ d ⟶ e

(ii) a ⟶ c ⟶ b ⟶ d ⟶ e

(iii) a ⟶ c ⟶ b ⟶ e ⟶ d

(iv) a ⟶ b ⟶ c ⟶ e ⟶ d

22. Which of the following process is responsible for the formation of delta at a place where rivers meet the sea?

(i) Emulsification

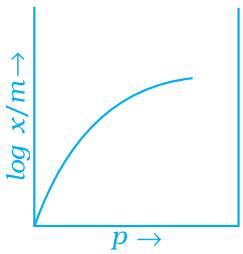
(ii) Colloid formation

(iii) Coagulation

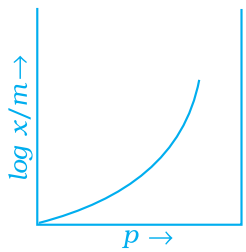
(iv) Peptisation

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

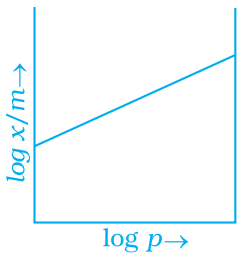
(i)



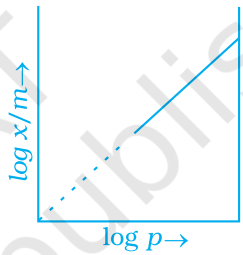
(ii)



(iii)



(iv)



24. Which of the following process is **not** responsible for the presence of electric charge on the sol particles?

(i) Electron capture by sol particles.

(ii) Adsorption of ionic species from solution.

(iii) Formation of Helmholtz electrical double layer.

(iv) Absorption of ionic species from solution.

25. Which of the following phenomenon is applicable to the process shown in the Fig. 5.1?

(i) Absorption

(ii) Adsorption

(iii) Coagulation

(iv) Emulsification

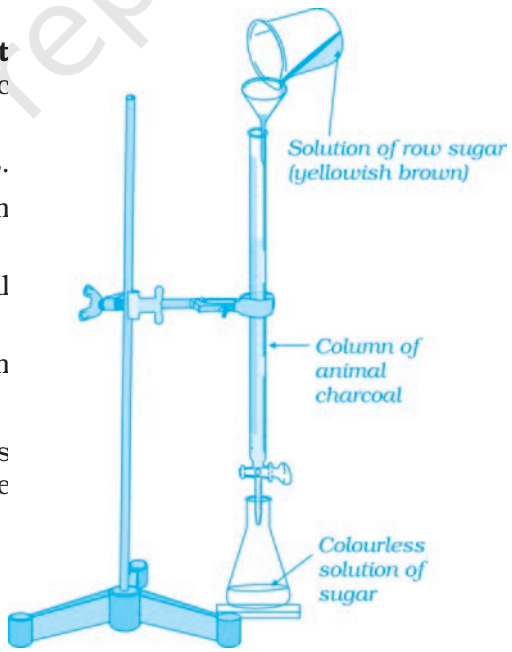


Fig. *5.1*

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

26. Which of the following options are correct?

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

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

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

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

27. Which of the following statements are correct about solid catalyst?

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

(ii) Catalyst does not change ΔH of reaction.

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

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

28. Freundlich adsorption isotherm is given by the expression $\frac{x}{m} = k\ p^{\frac{1}{n}}$ which of the following conclusions can be drawn from this expression.

(i) When $\frac{1}{n} = 0$, the adsorption is independent of pressure.

(ii) When $\frac{1}{n} = 0$, the adsorption is directly proportional to pressure.

(iii) When $n = 0$, $\frac{x}{m}$ vs p graph is a line parallel to x-axis.

(iv) When $n = 0$, plot of $\frac{x}{m}$ vs p is a curve.

29. H_2 gas is adsorbed on activated charcoal to a very little extent in comparison to easily liquefiable gases due to _____.

(i) very strong van der Waal's interaction.

(ii) very weak van der Waals forces.

(iii) very low critical temperature.

(iv) very high critical temperature.

30. Which of the following statements are correct?

(i) Mixing two oppositely charged sols neutralises their charges and stabilises the colloid.

(ii) Presence of equal and similar charges on colloidal particles provides stability to the colloids.

(iii) Any amount of dispersed liquid can be added to emulsion without destabilising it.

(iv) Brownian movement stabilises sols.

31. An emulsion cannot be broken by _____ and _____.

(i) heating

(ii) adding more amount of dispersion medium

(iii) freezing

(iv) adding emulsifying agent

32. Which of the following substances will precipitate the negatively charged emulsions?

(i) KCl

(ii) glucose

(iii) urea

(iv) NaCl

33. Which of the following colloids **cannot** be coagulated easily?

(i) Lyophobic colloids.

(ii) Irreversible colloids.

(iii) Reversible colloids.

(iv) Lyophilic colloids.

34. What happens when a lyophilic sol is added to a lyophobic sol?

(i) Lyophobic sol is protected.

(ii) Lyophilic sol is protected.

(iii) Film of lyophilic sol is formed over lyophobic sol.

(iv) Film of lyophobic sol is formed over lyophilic sol.

35. Which phenomenon occurs when an electric field is applied to a colloidal solution and electrophoresis is prevented?

(i) Reverse osmosis takes place.

(ii) Electroosmosis takes place.

(iii) Dispersion medium begins to move.

(iv) Dispersion medium becomes stationary.

36. In a reaction, catalyst changes _____.

(i) physically

(ii) qualitatively

(iii) chemically

(iv) quantitatively

37. Which of the following phenomenon occurs when a chalk stick is dipped in ink?

(i) adsorption of coloured substance

(ii) adsorption of solvent

(iii) absorption and adsorption both of solvent

(iv) absoprtion of solvent

III. Short Answer Type

38. Why is it important to have clean surface in surface studies?

39. Why is chemisorption referred to as activated adsorption?

40. What type of solutions are formed on dissolving different concentrations of soap in water?

41. What happens when gelatin is mixed with gold sol?

42. How does it become possible to cause artificial rain by spraying silver iodide on the clouds?

43. Gelatin which is a peptide is added in icecreams. What can be its role?

44. What is collodion?

45. Why do we add alum to purify water?

46. What happens when electric field is applied to colloidal solution?

47. What causes brownian motion in colloidal dispersion?

48. A colloid is formed by adding $FeCl_3$ in excess of hot water. What will happen if excess sodium chloride is added to this colloid?

49. How do emulsifying agents stabilise the emulsion?

50. Why are some medicines more effective in the colloidal form?

51. Why does leather get hardened after tanning?

52. How does the precipitation of colloidal smoke take place in Cottrell precipitator?

53. How will you distinguish between dispersed phase and dispersion medium in an emulsion?

54. On the basis of Hardy-Schulze rule explain why the coagulating power of phosphate is higher than chloride.

55. Why does bleeding stop by rubbing moist alum?

56. Why is $Fe(OH)_3$ colloid positively charged, when prepared by adding $FeCl_3$ to hot water?

57. Why do physisorption and chemisorption behave differently with rise in temperature?

58. What happens when dialysis is prolonged?

59. Why does the white precipitate of silver halide become coloured in the presence of dye eosin.

60. What is the role of activated charcoal in gas mask used in coal mines?

61. How does a delta form at the meeting place of sea and river water?

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

63. Why is desorption important for a substance to act as good catalyst?

64. What is the role of diffusion in heterogenous catalysis?

65. How does a solid catalyst enhance the rate of combination of gaseous molecules?

66. Do the vital functions of the body such as digestion get affected during fever? Explain your answer.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

67. Method of formation of solution is given in Column I. Match it with the type of solution given in Column II.

	Column I		**Column II**
(i)	Sulphur vapours passed through cold water	(a)	Normal electrolyte solution
(ii)	Soap mixed with water above critical micelle concentration	(b)	Molecular colloids
(iii)	White of egg whipped with water	(c)	Associated colloid
(iv)	Soap mixed with water below critical micelle concentration	(d)	Macro molecular colloids

68. Match the statement given in Column I with the phenomenon given in Column II.

	Column I		**Column II**
(i)	Dispersion medium moves in an electric field	(a)	Osmosis
(ii)	Solvent molecules pass through semi permeable membrane towards solvent side	(b)	Electrophoresis
(iii)	Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes	(c)	Electroosmosis
(iv)	Solvent molecules pass through semi permeable membranes towards solution side	(d)	Reverse osmosis

69. Match the items given in Column I and Column II.

	Column I		Column II
(i)	Protective colloid	(a)	$FeCl_3$ + NaOH
(ii)	Liquid - liquid colloid	(b)	Lyophilic colloids
(iii)	Positively charged colloid	(c)	Emulsion
(iv)	Negatively charged colloid	(d)	$FeCl_3$ + hot water

70. Match the types of colloidal systems given in Column I with the name given in Column II.

	Column I		Column II
(i)	Solid in liquid	(a)	Foam
(ii)	Liquid in solid	(b)	Sol
(iii)	Liquid in liquid	(c)	Gel
(iv)	Gas in liquid	(d)	Emulsion

71. Match the items of Column I and Column II.

	Column I		Column II
(i)	Dialysis	(a)	Cleansing action of soap
(ii)	Peptisation	(b)	Coagulation
(iii)	Emulsification	(c)	Colloidal sol formation
(iv)	Electrophoresis	(d)	Purification

72. Match the items of Column I and Column II.

	Column I		Column II
(i)	Butter	(a)	dispersion of liquid in liquid
(ii)	Pumice stone	(b)	dispersion of solid in liquid
(iii)	Milk	(c)	dispersion of gas in solid
(iv)	Paints	(d)	dispersion of liquid in solid

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and the reason is correct explanation of assertion.

(ii) Assertion and reason both are correct but reason does not explain assertion.

(iii) Assertion is correct but reason is incorrect.

(iv) Both assertion and reason are incorrect.

(v) Assertion is incorrect but reason is correct.

73. **Assertion** : An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.

Reason : Pore size of the filter paper becomes more than the size of colloidal particle.

74. **Assertion** : Colloidal solutions show colligative properties.

Reason : Colloidal particles are large in size.

75. **Assertion** : Colloidal solutions do not show brownian motion.

Reason : Brownian motion is responsible for stability of sols.

76. **Assertion** : Coagulation power of Al^{3+} is more than Na^{+}.

Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy Schulze rule).

77. **Assertion** : Detergents with low CMC are more economical to use.

Reason : Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

VI. Long Answer Type

78. What is the role of adsorption in heterogenous catalysis?

79. What are the applications of adsorption in chemical analysis?

80. What is the role of adsorption in froth floatation process used especially for concentration of sulphide ores?

81. What do you understand by shape selective catalysis? Why are zeolites good shape selective catalysts?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (ii)	3. (iv)	4. (iii)	5. (ii)	6. (i)
7. (i)	8. (iv)	9. (ii)	10. (i)	11. (ii)	12. (iv)
13. (i)	14. (ii)	15. (ii)	16. (iii)	17. (iv)	18. (ii)
19. (iv)	20. (iv)	21. (ii)	22. (iii)	23. (iii)	24. (iv)
25. (ii)					

II. Multiple Choice Questions (Type-II)

26. (ii), (iii)	27. (i), (ii)	28. (i), (iii)	29. (ii), (iii)
30. (ii), (iv)	31. (ii), (iv)	32. (i), (iv)	33. (iii), (iv)
34. (i), (iii)	35. (ii), (iii)	36. (i), (ii)	37. (i), (iv)

III. Short Answer Type

38. It is important to have clean surface as it facilitates the adsorption of desired species.
39. Chemisorption involves formation of bond between gaseous molecules/ atoms and the solid surface for which high activation energy is required. Thus it is referred to as activated adsorption.
40. At lower concentration soap forms a normal electrolytic solution with water. After a certain concentration called critical micelle concentration, colloidal solution is formed.
41. Gold sol is a lyophobic sol. Addition of gelatin stabilises the sol.
42. Clouds are colloidal in nature and carry charge. Spray of silver iodide, an electrolyte, results in coagulation leading to rain.
43. Icecreams are emulsions which get stabilised by emulsifying agents like gelatin.
44. It is a 4% solution of nitrocellulose in a mixture of alcohol and ether.
45. The colloidal impurities present in water get coagulated by added alum, thus making water potable.
46. The charged colloidal particles start moving towards oppositely charged electrodes.
47. Unbalanced bombardment of the particles of dispersed phase by molecules of dispersion medium causes brownian motion. This stabilises the sol.
48. Positively charged sol of hydrated ferric oxide is formed and on adding excess of NaCl, negatively charged chloride ions coagulate the positively charged sol of hydrated ferric oxide.

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

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

51. Animal hide is colloidal in nature and has positively charged particles. When it is soaked in tanin which has negatively charged colloidal particles, it results in mutual coagulation taking place.

52. In Cottrell precipitator, charged smoke particles are passed through a chamber containing plates with charge opposite to the smoke particles. Smoke particles lose their charge on the plates and get precipitated.

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

54. Minimum quantity of an electrolyte required to cause precipitation of a sol is called its coagulating value. Greater the charge on flocculating ion and smaller is the amount of electrolyte required for precipitation, higher is the coagulating power of coagulating ion (Hardy-Schulze rule).

55. Moist alum coagulates the blood and so formed blood clot stops bleeding.

56. The adsorption of positively charged Fe^{3+} ions by the sol of hydrated ferric oxide results in positively charged colloid.

57. Physisorption involves weak van der Waals forces which weaken with rise in temperature. The chemisorption involves formation of chemical bond involving activation energy and like any other chemical reaction is favoured by rise in temperature.

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

59. Eosin is adsorbed on the surface of silver halide precipitate making it coloured.

60. Activated charcoal acts as an adsorbent for various poisonous gases present in the coal mines.

61. River water is a colloidal solution of clay and sea water contains lot of electrolytes. The point at which river and sea meet is the site for coagulation. Deposition of coagulated clay results in delta formation.

62. 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.

63. After the reaction is over 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.

64. The gaseous molecules diffuse on to the surface of the solid catalyst and get adsorbed. After the required chemical changes the products diffuse away from the surface of the catalyst leaving the surface free for more reactant molecules to get adsorbed and undergo reaction.

65. When gaseous molecules come in contact with the surface of a solid catalyst, a weak chemical combination takes place between the surface of the catalyst and the gaseous molecules, which increases the concentration of reactants on the surface. Different moelcules adsorbed side by side have better chance to react and form new molecules. This enhances the rate of reaction. Also, adsorption is an exothermic process. The heat released in the process of adsorption is utilised in enhancing the reaction rate.

66. **Hint :** The optimum temperature range for enzymatic activity is 298-310 K. On either side of this temperature range, enzymatic activity gets affected. Thus, during fever, when temperature rises above 310 K, the activity of enzymes may be affected.

IV. Matching Type

67.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
68.	(i) → (c)	(ii) → (d)	(iii) → (b)	(iv) → (a)
69.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
70.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
71.	(i) → (d)	(ii) → (c)	(iii) → (a)	(iv) → (b)
72.	(i) → (d)	(ii) → (c)	(iii) → (a)	(iv) → (b)

V. Assertion and Reason Type

73. (iii) 74. (ii) 75. (v) 76. (i) 77. (i)

VI. Long Answer Type

78. **Hint**
- reactants are adsorbed on the surface of the catalyst
- occurrence of chemical reaction on the surface of catalyst
- desorption.

79. **Hint:**
- In TLC
- Adsorption indicators.
- In qualitative analysis.

80. **Hint:**
- Adsorption of pine oil on sulphide ore particles.
- Formation of emulsion.
- Hence ore comes out with froth.
- Explanation for shape selective catalysis.

81. **Hint:**
- Honey comb like structure of zeolites.
- Pores provide sites for reactants to react.