Surface Chemistry

Previous Years' CBSE Board Questions

5.1 Adsorption

VSA (1 mark)

1. Differentiate between adsorption and absorption. *(1/3, Delhi 2016)*

2. Physisorption is reversible while chemisorption is irreversible. Why ? *(Foreign 2015)*

3. Define the following term :
Adsorption
(1/3 Delhi 2015C, 2014C, 1/2, AI 2013)

4. In reference to Freundlich adsorption isotherm write the expression for adsorption of gases on solids in the form of an equation. *(1/3, Delhi 2014)*

5. What is the effect of temperature on chemisorption? *(AI 2014)*

6. Why is adsorption always exothermic? *(AI 2014, 2009C)*

7. What type of forces are responsible for the occurrence of physisorption? *(1/3, Foreign 2014)*

8. Write the expression for the Freundlich adsorption isotherm for the adsorption of gases on solids, in the form of an equation. *(1/3, Foreign 2014)*

9. Define the following term :
Sorption *(1/3, Delhi 2014C)*

10. Of physisorption or chemisorption, which has a higher enthalpy of adsorption? *(AI 2013, 2008)*

11. Out of NH_3 and CO_2, which gas will be adsorbed more readily on the surface of activated charcoal and why? *(Delhi 2012C)*

12. Adsorption of a gas on surface of solid is generally accompanied by a decrease in entropy, still it is a spontaneous process. Explain. *(1/3, Delhi 2012C)*

13. Write two applications of adsorption. *(AI 2012C)*

14. Physisorption is multi-layered, while chemisorption is mono-layered. *(1/3, Delhi 2012C)*

15. Why is a finely divided substance more effective as an adsorbent? *(AI 2011C, Delhi 2010 C)*

16. What is the basic difference between adsorption and absorption? *(AI 2010C)*

17. What are physisorption and chemisorption? *(AI 2010C)*

18. Name the two types of adsorption phenomenon. *(Delhi 2009C)*

19. Why does physisorption decrease with the increase of temperature ? *(Delhi 2008C)*

20. In chemisorption why x/m initially increases and then decreases with rise in temperature? *(Delhi 2008C)*

SA I (2 marks)

21. Give reasons for the following observations :
(i) NH_3 gas absorbs more readily than N_2 gas on the surface of charcoal.
(ii) Powdered substances are more effective adsorbents. *(2/3, Foreign 2015)*

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

SA II (3 marks)

23. Giving appropriate examples, explain how the two types of processes of adsorption (physisorption and chemisorption) are influenced by the prevailing temperature, the surface area of adsorbent and the activation energy of the process? *(AI 2014C)*

24. What is an adsorption isotherm? Describe Freundlich adsorption isotherm. *(Delhi 2013, AI 2012C)*

25. What is an 'adsorption isotherm' ? *(Delhi 2010C)*

26. How do the size of particles of adsorbent, pressure of gas and temperature influence the extent of adsorption. *(Delhi 2009C)*

27. Define adsorption. Write any two features which distinguish physisorption from chemisorption. *(Delhi 2007)*

5.2 Catalysis

VSA (1 mark)

28. Give reasons for the following observation :
It is necessary to remove CO when ammonia is prepared by Haber's process. *(1/3 Delhi 2015)*

29. Define the following term :
Shape selective catalysis
(1/3, Delhi 2015C, 2009C, 1/2, AI 2012, 2011, 2010, 2007)

30. What are biocatalysts ? Give an example.
(Foreign 2014)

31. Give an example of 'shape-selective catalyst'.
(Delhi 2010)

SA I (2 marks)

32. Name the two groups into which phenomenon of catalysis can be divided. Give an example of each group with the chemical equation involved. *(Delhi 2012)*

33. Explain how the phenomenon of adsorption find application in the following processes :
(i) Production of vaccum
(ii) Heterogeneous catalysis *(Foreign 2011)*

34. Distinguish between homogeneous and heterogeneous catalysis. What role does adsorption play in heterogeneous catalysis?
(AI 2008C)

35. Explain the following term giving a suitable example.
Homogeneous catalysis *(Delhi 2007)*

5.4 Classification of Colloids

VSA (1 mark)

36. Write the main reason for the stability of colloidal sols. *(Delhi, AI 2016)*

37. Out of $BaCl_2$ and KCl, which one is more effective in causing coagulation of a negatively charged colloidal sol? Give reason.
(Delhi 2015)

38. Write the dispersed phase and dispersion medium of butter. *(AI 2015, Foreign 2014)*

39. In reference to surface chemistry, define dialysis.
(Delhi 2015C, 2014C, AI 2014C, 2007)

40. Define the following term :
Electrophoresis *(1/3, Delhi 2015C)*

41. Give one example each of sol and gel.
(Delhi 2014)

42. Give one example each of lyophobic sol and lyophilic sol. *(Delhi 2014)*

43. What are the dispersed phase and dispersion medium in milk? *(Delhi 2014)*

44. Name of the temperature above which the formation of micelles takes place.
(Foreign 2014)

45. Based on the type of dispersed phase, what type of colloid is micelles. *(Foreign 2014)*

46. What is the difference between lyophobic sol and lyophilic sol ? *(Delhi 2014C)*

47. Which aerosol depletes ozone layer? *(AI 2013)*

48. To which colloidal system does milk belong ?
(AI 2013C)

49. Which complex ion is formed when undecomposed AgBr is washed with hypo solution in photography ? *(AI 2013C)*

50. Define peptization. *(AI 2012)*

51. How can a colloidal solution and true solution of the same colour be distinguished from each other
(Delhi 2012C)

52. How is a sol different from an emulsion ?
(AI 2012C)

53. What are lyophobic colloids? Give an example for them. *(AI 2011)*

54. Define the term 'Tyndall effect'.
(AI 2010, Delhi 2009)

55. What causes brownian movement in a colloidal solution? *(Delhi 2008)*

56. Describe 'electrophoresis' briefly. *(AI 2008)*

57. What happens when gelatin is added to gold solution? *(AI 2007)*

58. Explain the following terms giving a suitable example :
Emulsification *(Delhi 2007)*

SA I (2 marks)

59. (i) Out of $MgCl_2$ and $AlCl_3$, which one is more effective in causing coagulation of negatively charged sol and why ?
(ii) Out of sulphur sol and proteins, which one forms multimolecular colloids?
(2/3, Delhi 2016)

60. Give reasons for the following observations :
(i) Leather gets hardened after tanning.
(ii) Lyophilic sol is more stable than lyophobic sol. *(2/3, Delhi 2015)*

61. (i) Based on type of particles of dispersed phase, give one example each of associated colloid and multimolecular colloid
(ii) Write an important characteristic of lyophilic sols. *(2/3, Delhi 2014)*

62. Define the following terms :
(i) Peptization
(ii) Sol *(2/3, Delhi 2014C)*

63. Define the following terms :
(i) Tyndall effect
(ii) Electrophoresis *(2/3, Delhi 2014C)*

64. Write the dispersed phase and dispersion medium of the following colloidal systems :
(i) Smoke
(ii) Milk *(Delhi 2013)*

65. What is the difference between multimolecular and macromolecular colloids? Give one example of each. *(Delhi 2013)*

66. How are the following colloidal solutions prepared?
(a) Sulphur in water (b) Gold in water *(Delhi 2013C)*

67. Explain the following terms giving one example for each.
(i) Micelles (ii) Aerosol *(Delhi, AI 2012)*

68. Explain the cleaning action of soap. Why do soaps not work in hard water? *(AI 2012)*

69. (i) Same substances can act both as colloids and crystalloids. Explain
(ii) What will be the charge on AgI colloidal particles when it is prepared by adding small amount of $AgNO_3$ solution to KI solution in water? What is responsible for the development of this charge ? *(2/3, Delhi 2012C)*

70. Define the following terms giving an example of each :
(i) Emulsion
(ii) Hydrosol *(Foreign 2011)*

71. Define the following terms :
(i) Aerosol
(ii) Coagulation of colloids. *(Foreign 2011)*

72. What is meant by coagulation of a colloidal solution? Name any method by which coagulation of lyophobic sols can be carried out. *(AI 2010)*

73. Define the following :
(i) Peptization
(ii) Reversible sols *(AI 2010)*

74. Explain the following terms :
(i) Electrophoresis (ii) Dialysis *(AI 2009C)*

75. Explain the following terms :
(i) Tyndall effect (ii) Coagulation *(AI 2009C)*

76. Distinguish between micelles and colloidal particles. Give one example of each. *(AI 2008C)*

SA II (3 marks)

77. Define the following terms :
(i) Lyophilic colloid (ii) Zeta potential
(iii) Associated colloids *(AI 2016)*

78. Define the following terms :
(i) Brownian movements
(ii) Peptization
(iii) Multimolecular colloids *(AI 2015)*

79. Describe the following processes :
(i) Dialysis
(ii) Electrophoresis
(iii) Tyndall effect *(AI 2015C, 2011C)*

80. What are the characteristics of the following colloids? Give one example of each.
(i) Multimolecular colloids
(ii) Lyophobic sols
(iii) Emulsions *(AI 2013)*

81. Explain what is observed when :
(i) A beam of light is passed through a colloidal solution.
(ii) NaCl solution is added to hydrated ferric oxide sol.
(iii) Electric current is passed through a colloidal solution. *(AI 2013C, 2009, Delhi 2008C)*

82. What is meant by coagulation of a colloidal solution? Describe briefly any three methods by which coagulation of lyophobic sols can be carried out. *(Delhi 2012)*

83. Classify colloids where the dispersion medium is water. State their characteristics and write an example of each of these classes.
(AI 2011)

84. Distinguish between multimolecular, macromolecular and associated colloids. Give one example of each. *(Delhi 2011C)*

85. Explain the following terms :
(i) Electrophoresis
(ii) Coagulation
(iii) Tyndall effect *(AI 2010C)*

86. What is the difference between multimolecular and macromolecular colloids? Give one example of each type. How are associated colloids different from these two types of colloids ?
(Delhi 2009)

87. How are the following colloids different from each other in respect of dispersion medium and dispersed phase? Give one example of each type.
(i) An aerosol
(ii) A hydrosol
(iii) An emulsion *(Delhi 2009)*

88. What are lyophilic and lyophobic sols? Give one example of each type. Which one of these two types of sols is easily coagulated and why?
(Delhi, AI 2008)

89. Explain what is observed when
(i) KCl, an electrolyte, is added to hydrated ferric oxide sol,
(ii) an electric current is passed through a colloidal solution,
(iii) a beam of light is passed through a colloidal solution.
(AI 2008)

5.5 Emulsions

VSA (1 mark)

90. What are emulsions? Give an example.
(Delhi 2015C)

91. Give one example each of 'oil in water' and 'water in oil' emulsion. *(Delhi 2014)*

92. What is an emulsion?
(Delhi 2014C, 2010, AI 2012, Foreign 2011)

93. What are emulsions? Name an emulsion in which water is a dispersed phase. *(AI 2014C)*

94. Explain the following :
Artificial rain is caused by spraying salt over clouds. *(1/3, Delhi 2012C)*

SA I (2 marks)

95. What is the difference between oil/water (O/W) type and water/oil (W/O) type emulsions? Given an example of each type. *(Delhi 2013)*

96. What are emulsions? State one application of emulsification. *(Delhi 2009C)*

SA II (3 marks)

97. What are emulsions? What are their different types? Give one example of each type.
(AI 2014, Delhi 2013C)

98. (i) What is the difference between a colloidal solution and an emulsion? Give one example of each.
(ii) What are emulsifiers ? *(Delhi 2008C)*

5.6 Colloids Around Us

VSA (1 mark)

99. Give reasons for the following observations :
A delta is formed at the meeting point of sea water and river water *(1/3, Foreign 2015, 2014)*

Detailed Solutions

1. Adsorption is a surface phenomenon. In this process the adsorbate is concentrated on the surface of the adsorbent and does not penetrate into the bulk whereas, absorption of a substance takes place throughout the bulk of the material. In adsorption, concentration of adsorbate is high on the surface of adsorbent, while during absorption concentration is uniform throughout. *e.g.*, water vapour is adsorbed by silica gel whereas absorbed by anhydrous calcium carbide.

2. Physisorption takes place (any one) with the help of non-covalent bonding between an adsorbate and an adsorbent; it makes the process reversible. Chemisorption, on the other hand, takes place with the help of covalent bonding; it makes the process irreversible.

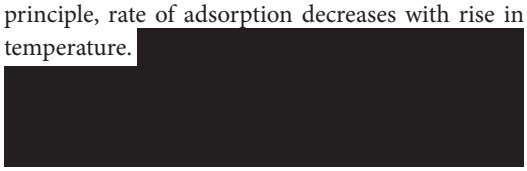
3. Adsorption is the phenomenon of attracting and retaining the molecules of a substance on the surface of a liquid or a solid resulting in higher concentration of the molecules on the surface.

4. $\frac{x}{m} = kp^{1/n} (n > 1)$

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

where $\frac{x}{m}$ is the mass of gas adsorbed per gram of the adsorbent and p is the pressure of gas.

5. Effect of temperature : Chemisorption is an exothermic process. Hence, according to Le Chatelier principle, rate of adsorption decreases with rise in temperature.



6. In adsorption, there is always a decrease in residual unbalanced forces on the surface. This results in decrease in surface energy which appears as heat. Hence, adsorption is unconditionally an exothermic process.

7. The forces operating in these cases are weak van der Wals' forces.

8. *Refer to answer 4.*

9. The term sorption is used to describe both the processes adsorption and absorption.

10. Chemisorption has higher enthalpy of adsorption.

11. NH_3 gas will be adsorbed more readily on the surface because it has higher critical temperature than CO_2 gas.

Due to the greater attraction of the gas molecules on the surface of the adsorbent, greater will be the adsorption.

12. For the process to be spontaneous ΔG must be negative.

As ΔS is negative, ΔG can be negative only if ΔH is negative and greater than $T\Delta S$.

13. Applications of adsorption :
(i) Deionisation of water
(ii) In chromatographic analysis.

14. Physical adsorption occurs due to inter-molecular attractive forces between the adsorbate and adsorbent. If the size of the adsorbent pores is close to the size of adsorbate molecules, multilayer adsorption takes place, *i.e.,* adsorption takes place until all the pores are filled with adsorbate molecules, whereas in chemisorption chemical bonds are formed between adsorbate and adsorbent molecules. Therefore, it is monolayered.

15. A finely divided substance is more effective as adsorbent because
(i) It has more surface area so more adsorption occurs.
(ii) The number of active sites (active centres) becomes more and the extent of adsorption increases.

16. *Refer to answer 1.*

17. Physisorption : The phenomenon in which adsorbate and adsorbent are held by van der Waals' forces.

It is reversible in nature. *e.g.,* setting a layer of dust particles on the furniture.

Chemisorption : The phenomenon in which adsorbate and adsorbent are held by chemical bonds.

It is irreversible in nature. *e.g.,* painting on a furniture.

18. The two types of adsorption phenomenon are chemisorption or chemical adsorption and physisorption or physical adsorption.

19. Since, adsorption is exothermic and according to Le-chatelier's principle, low temperature is favourable for physical adsorption hence, physisorption decreases with increase in temperature.

Solid + Gas $\rightleftharpoons$ Gas adsorbed on solid + heat

20. *Refer to answer 5.*

21. (i)

Higher the critical temperature of gas, more readily it can get adsorbed on the surface of an adsorbent due to stronger van der Waals' forces.

NH_3 (132°C) has a higher critical temperature than dinitrogen (–147°C). Thus, NH_3 gas adsorbs more readily than N_2 gas on the surface of charcoal.

(ii) *Refer to answer 15.*

22.

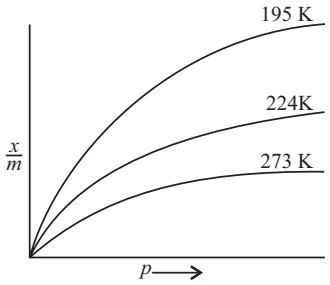
S. No.	Criteria	Physisorption	Chemisorption
(i)	Specificity	It is not specific in nature.	It is highly specific in nature.
(ii)	Temperature dependence	It decreases with increase in temperature. Thus, low temperature is favourable for physisorption.	It increases with increase in temperature. Thus, high temperature is favourable for chemisorption.
(iii)	Reversibility	Reversible in nature.	Irreversible in nature.
(iv)	Enthalpy change	Low enthalpy of adsorption	High enthalpy of adsorption

23. Effect of temperature : Physisorption decreases with increase of temperature and chemisorption first increases then decreases with increase of temperature.

Surface area : Greater the surface area, greater is the physisorption and chemisorption.

Activation energy : In physisorption, no appreciable activation energy is needed. In chemisorption, sometimes high activation energy is needed.

24. Adsorption isotherm : It is the variation in the amount of gas adsorbed by the adsorbent with pressure at constant temperature.



Adsorption isotherm

Freundlich adsorption isotherm : It is an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature.

$$\frac{x}{m} = kp^{1/n} (n > 1) \quad \ldots(i)$$

when, $n = 1, \Rightarrow \frac{x}{m} = kp$ or $\frac{x}{m} \propto p$

where x is the mass of gas adsorbed on mass m of the adsorbent at pressure p. k and n are constants which depend on the nature of the adsorbent and the gas at the particular temperature.

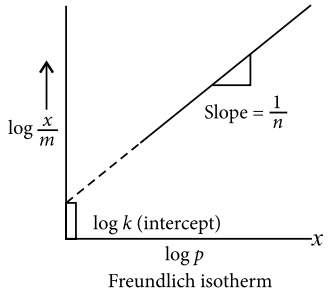
These curves indicate that on increasing temperature, physical adsorption decreases at a fixed pressure.

Taking log in Eq. (i), gives

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

The validity of Freundlich isotherm can be verified by plotting $\frac{x}{m}$ on y-axis and log p on x-axis.

If it comes to be a straight line, the Freundlich isotherm is valid.



Freundlich isotherm

25. *Refer to answer 24.*

26. Size of adsorbent particles : Smaller the size of adsorbent particles, larger is the surface area and hence, higher is the adsorption.

Pressure : Increase in pressure forces gas molecules to come closer to the surface of adsorbent leading to increase in the amount of adsorption.

Temperature : Adsorption is an exothermic reaction hence is favoured at lower temperature, at higher temperature the *K.E.* of adsorbate is high and hence extent of adsorption is low.

27. *Refer to answers 3 and 22.*

28. CO is a catalytic poison. It reacts with iron to form iron carbonyl thus inhibiting the activity of catalyst.

29. The catalytic reaction that [redacted] pore structure of the catalyst and the size of the reactant and product molecules is called shape selective catalysis.

30. Enzymes are termed as biocatalysts as they help in catalysis of biological reactions.

For example, Inversion of cane sugar with the help of invertase enzyme.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11(aq)}} + H_2O_{(l)} \xrightarrow{\text{Invertase}} \underset{\text{Glucose}}{C_6H_{12}O_{6(aq)}} + \underset{\text{Fructose}}{C_6H_{12}O_{6(aq)}}$$

31. Zeolites (ZSM - 5) are good shape selective catalysts which convert alcohols directly into gasoline (petrol) by dehydrating them to give a mixture of hydrocarbons.

32. Catalysis is divided into following two groups.

Homogeneous catalysis : When reactants and the catalysts are in the same phase

i.e., liquid or gas, the catalysis is known as homogeneous catalysis.

e.g., $2H_2O_{2(aq)} \xrightarrow{I^-_{(aq)}} 2H_2O_{(l)} + O_{2(g)}$

or $\frac{3}{2}O_{2(g)} \xrightarrow{NO_{(g)}} O_{3(g)}$

Heterogeneous catalysis: When reactants and the catalysts are in different phases, the catalysis is known as heterogeneous catalysis. In most cases, the catalyst is solid, while reactants are either liquid or gases. Here, the catalyst is usually a metal or an oxide in finely divided form *e.g.,*

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

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

33. (i) **Production of Vacuum :** Adsorption can be applied to create condition of high vacuum. Vessel which has already been exhausted by vacuum pump is connected to a bulb containing charcoal. The remaining traces of air inspite of low pressure are adsorbed by the charcoal almost completely.

(ii) **Role of adsorption in heterogeneous catalysis** The reactant molecules in gaseous state or in solutions are adsorbed on the surface of the solid catalyst by physisorption or chemisorption. As result, the concentration of the reactant molecules on the surface increases and hence, the rate of reaction increases.

34. *Refer to answers 32 and 33(ii).*

35. *Refer to answer 32.*

36. The main reason for the stability of colloids is the electrostatic stabilisation *i.e.*, equal and same type of charge on the colloidal particles which causes repulsion between them and prevents the coagulation of the sol.

37. $BaCl_2$ is more effective in causing coagulation of negatively charged colloidal sol.

Because greater the valency of the coagulating ion, greater is its power to bring about coagulation.

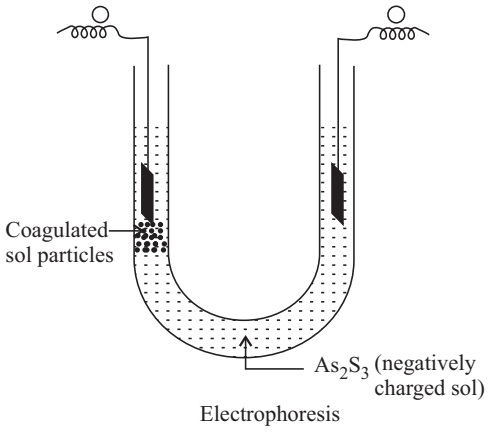
38. Dispersed phase : Liquid
Dispersion medium : Solid

39. Dialysis : It is the process of removing a dissolved substance from a colloidal solution by means of diffusion through a suitable membrane.

A bag of suitable membrane containing the colloidal solution is suspended in a vessel through which fresh water is continuously flowing.

The molecules and ions diffuse through membrane into the water and pure colloidal solution is left behind.

40. The movement of colloidal particles under an applied electric potential is called electrophoresis. Positively charged colloidal particles move towards the cathode, while negatively charged particles move towards the anode.



Electrophoresis

41.

Type of colloid	Dispersed phase	Dispersion medium	Examples
Sol	Solid	Liquid	Paints or Cell fluids
Gel	Liquid	Solid	Cheese or Butter or Jellies

42. A colloidal sol in which dispersed phase and dispersion medium attract each other is called lyophilic colloid. *e.g.,* gum. A colloidal sol in which dispersed phase and dispersion medium repel each other is called lyophobic colloid. *e.g.,* gold solution.

43. Liquid fat is the dispersed phase and water is the dispersion medium.

44. The formation of micelles takes place only above a particular temperature called Kraft temperature (T_k).

45. Associated colloids

46. Lyophilic sols : The colloidal solution in which particles of the dispersed phase have a strong affinity for the dispersion medium.

These colloidal sols, even if precipitated, change back to the colloid form simply by adding dispersion medium. So, lyophilic sols are reversible in nature. *e.g.,* glue, starch, rubber, etc.

Lyophobic sols : The colloidal solution in which particles of the dispersed phase have no or very little affinity for dispersion medium.

These are irreversible in nature *i.e.*, once precipitated, they have little tendency to get back into the colloidal form on simply adding dispersion medium *e.g.,* As_2S_3 solution. Lyophobic sols need stabilising agents for their preservation.

47. CFC (Chlorofluorocarbon)

48. Emulsion

49. The developed film is immersed in sodium thiosulphate (hypo) solution which removes unchanged silver bromide as a complex ion.

This is known as fixing.

$$AgBr + 2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2] + NaBr$$

After fixing, the film is not sensitive to light.

50. Peptization is the process of conversion of a precipitate into colloidal state in the presence of some electrolyte.

51. When a powerful beam of light is passed through true and colloidal solutions each kept in a glass vessel then, colloidal solution exhibits tyndall effect whereas true solution does not.

52. Sol is a type of colloid in which the dispersed phase is solid and the dispersion medium is a liquid.

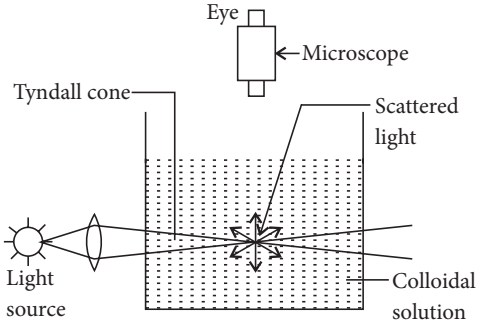
Examples include mud, milk of magnesia.

Emulsion is a type of colloid in which the dispersed phase is liquid and dispersion medium is also a liquid.

Examples include milk, face cream etc.

53. *Refer to answer 46.*

54. When a beam of light is passed through a colloidal solution and viewed perpendicular to the path of incident light, the path of beam is illuminated by a bluish light. This phenomenon is called Tyndall effect. This is due to the fact that colloidal particles scatter light in all the directions in space.



55. The continuous rapid zig-zag motion of the colloidal particles in the dispersion medium is called Brownian movement.

Unbalanced bombardment of the particles of dispersed phase by molecules of dispersion medium causes Brownian motion.

This stabilises the sol.

56. *Refer to answer 40.*

57. Gold solution which is lyophobic solution starts behaving like a lyophilic colloid when gelatin is added to it.

58. Emulsification : The process of making emulsion is known as emulsification. To stabilise an emulsion, an emulsifying agent or emulsifier is added. Soaps and detergents are most frequently used emulsifiers.

59. (i) According to Hardy-Schulze rule, for negatively charged sol greater the valency of positive ion added to it, greater is its coagulation power.

In $AlCl_3$, Al has +3 charge which is more than Mg with +2 charge in $MgCl_2$. Thus, $AlCl_3$ is more effective in causing coagulation of negatively charged sol.

(ii) Proteins are macromolecules which cannot form multimolecular colloids while sulphur sol have smaller S_8 molecules which can form multimolecular colloids.

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

(ii) Lyophilic sol is more stable than lyophobic sol because It is highly hydrated in the solution.

61. (i) Associated colloid : Soap
Multimolecular colloid : Sulphur sol

(ii) Lyophilic sols are reversible sols. These are quite stable and cannot be easily precipitated.

62. *(i) Refer to answer 50.*

(ii) Sol is a type of colloid in which dispersed phase is solid and dispersion medium is liquid *e.g.*, paints

63. *(i) Refer to answer 54.*
(ii) Refer to answer 40.

64. (i) Dispersed phase of smoke = Solid
Dispersion medium of smoke = Gas

(ii) Dispersed phase of milk = Liquid
Dispersion medium of milk = Water (liquid)

65.

S.No.	Multimolecular Colloids	Macromolecular colloids
1.	When a large number of small molecules or atoms (diameter < 1 nm) of a substance combine together in a dispersion medium to form aggregates, having size in the colloidal range, the colloidal solutions thus, formed are known as multimolecular colloids.	When substances which possess very high molecular masses are dispersed in suitable dispersion medium, the colloidal solutions thus, formed are called macromolecular colloids.
2.	*e.g.*, gold sol, sulphur sol, etc.	*e.g.*, cellulose, starch, etc.

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

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

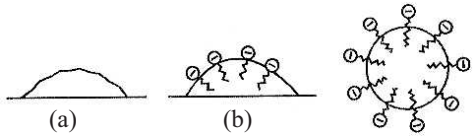
(ii) Gold sol is prepared by Bredig's arc process or by the reduction of $AuCl_3$ with HCHO.

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

67. (i) Aggregated particles of associated colloids at high concentration are called micelles. *e.g.,* soaps.

(ii) Colloid of a liquid in a gas is called aerosol *e.g.,* fog, sprays etc.

68. The cleansing action of soap is due to the fact that soap molecules form micelle around the oil droplet in such a way that hydrophobic part is in the oil droplet and hydrophilic part 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. The negatively charged sheath around the globules prevents them from coming together and forming aggregates.



Hard water contains calcium and magnesium ions. These ions form insoluble calcium and magnesium salts when sodium or potassium soaps are dissolved in hard water. These insoluble soaps separate as scum in water and are useless as cleansing agent.

69. (i) The same substance can act as both colloid and crystalloid. It depends on the size of the particles. When the size of the particles lies between 1 to 1000 nm, it behaves as a colloid. If particle size is less than 1 nm, it exists as a true solution and behave like a crystalloid.

(ii) When $AgNO_3$ solution is added to aqueous KI solution, a negatively charged sol of AgI is formed.

This is due to selective adsorption of I^- ions from the dispersion medium.

$$\underset{\text{Dispersion medium}}{AgI + I^-} \longrightarrow \underset{\text{Negative sol}}{[AgI]I^-}$$

70. (i) **An emulsion :** It is a colloidal system when both the dispersed phase and the dispersion medium are in the liquid state. *e.g.*, milk.

(ii) **A hydrosol :** It is a colloidal solution of a solid in water as the dispersion medium. *e.g.*, starch solution.

71. (i) *Refer to answer 67 (ii).*

(ii) **Coagulation :** The process of aggregating together the colloidal particles into large sized particle which ultimately settle down under the force of gravity as a precipitate is called coagulation.

72. Coagulation : *Refer to answer 71 (ii).*

Coagulation of lyophobic sol can be carried out by adding electrolyte.

73. *(i) Refer to answer 50.*

(ii) **Reversible sols :** Lyophilic colloids are also known as reversible sols. These sols are directly formed by mixing substances like gum, gelatin, starch etc with a suitable liquid. These sols are stable and cannot be easily coagulated.

74. *(i) Refer to answer 40.*

(ii) Refer to answer 39.

75. *(i) Refer to answer 54.*

(ii) *Refer to answer 71 (ii).*

76. Micelles : When small particles (ions) of an electrolyte molecule form the aggregate particles which behave like colloidal particles, these aggregated particles are known as micelles.

Examples : Soap and detergents.

Colloidal particles : Colloidal particles have an enormous surface area per unit mass as a result of their small size. Its size ranges between 1 nm to 100 nm. *e.g.*, sulphur sol.

77. (i) *Refer to answer 46.*

(ii) The difference of potential between fixed layer and diffused layer of a colloidal sol is known as electrokinetic or zeta potential. It is given by

$$Z = \frac{4\pi\eta u}{K}$$

Z - Zeta potential

η - Co-efficient of viscosity of sol

u - Velocity of sol particles; K - Dielectric constant.

(iii) **Associated colloids** : The substances which at low concentration, behave as normal strong electrolytes but at higher concentration exhibit colloidal behaviour due to the formation of aggregated particles, are known as associated colloids.

These are also known as micelles. The formation of micelles takes place only above a particular temperature, called the Kraft temperature and above a particular concentration, called the Critical Micelle Concentration (CMC), *e.g.*, surface active agents such as soaps and synthetic detergents.

78. (i) **Brownian movement :** When the colloidal particles are observed under the ultramicroscope, the particles are seen to be in constant motion in zig-zag path. This zig-zag motion of dispersed phase particles is called Brownian movement.

Importance : Avogadro's number can be calculated with the help of Brownian movement.

(ii) *Refer to answer 50.*

(iii) **Multimolecular colloids :** A colloid in which large number of small molecules combine to form a particle of colloidal size is called multimolecular colloid *e.g.*, sulphur sol.

79. (i) *Refer to answer 39.*

(ii) *Refer to answer 40.*

(iii) *Refer to answer 54.*

80. (i) *Refer to answer 78 (iii).*

(ii) *Refer to answer 46.*

(iii) *Refer to answer 70 (i).*

81. (i) Scattering of light by the colloidal particles takes place and the path of light becomes visible (Tyndall effect).
(ii) The positively charged colloidal particles of ferric hydroxide sol get coagulated by the oppositely charged Cl^- ions provided by NaCl.
(iii) On passing electric current through a sol, colloidal particles start moving towards oppositely charged electrodes where they lose their charge and get coagulated (electrophoresis).

82. The process of setting of colloidal particles is called coagulation of the sol. It is also known as precipitation. Following are the three methods by which coagulation of lyophobic sols can be carried out :
(i) **Electrophoresis:** In this process, the colloidal particles move towards oppositely charged electrodes and get discharged resulting in coagulation.
(ii) **Mixing of two oppositely charged sols:** When equal proportions of oppositely charged sols are mixed, they neutralise each other resulting in coagulation.
(iii) **Dialysis:** By this method, electrolytes present in sol are removed completely and colloid becomes unstable resulting in coagulation.

83. (i) **Sol:** When solids is dispersed in water, it is called sol, *e.g.*, gold sol starch sol.
(ii) **Emulsion:** When liquid is dispersed in water, it is called emulsion, *e.g.*, milk.
(iii) **Foam :** When gas is dispersed in water, it is called foam or froth, *e.g.*, soap lather, whipped cream.

84. *Refer to answers 65 and 77 (iii).*

85. *(i) Refer to answer 40.*
(ii) Refer to answer 71 (ii).
(iii) Refer to answer 54.

86. *Refer to answer 65.*
Refer to answer 77 (iii).

87. *(i) Refer to answer 67 (ii).*
(ii) Refer to answer 70 (ii).
(iii) Refer to answer 70 (i).

88. *Refer to answer 46.*
Hydrophobic solutions get easily coagulated on the addition of small amount of electrolyte or by heating or even shaking as they are not stable.

89. *Refer to answer 81.*

90. *Refer to answer 70 (i).*

91. Oil in water emulsion : Milk
Water in oil emulsion : Butter

92. *Refer to answer 70 (i).*

93. *(i) Refer to answer 70 (i).*
(ii) Butter is an emulsion in water acts a dispersed phase and oil acts as the dispersion medium.

94. Clouds are colloidal dispersion of water particles in air. These water particles carry some charge over them. On spraying oppositely charged colloidal dust or sand particles over a cloud from an aeroplane, the colloidal water particles present in the cloud will get neutralized and as a result they will come closer and will grow in size to form bigger water drops and ultimately will coagulate or precipitate causing artificial rain.

95. The two types of emulsions are :
(i) Oil-in-water type in which small droplets of an oil are dispersed in water.
Example : Milk, cod liver oil.
(ii) Water-in-oil type in which water droplets are dispersed in an oil medium.
Example : Butter.

96. *(i) Refer to answer 70 (i).*
(ii) **Application of emulsification** Cleansing action of soaps is due to the emulsification of oils and fats. Actually, soaps help in emulsification of oils and fats.

97. *Refer to answer 70(i).*

Types of emulsions :
Oil dispersed in water *e.g.*, milk.
Water dispersed in oil *e.g.*, butter.

98. (i) **Colloidal solution :** These are the solutions in which the diameter of dispersed phase particles may range from 1 to 1000 nm. These are intermediate of true solutions and suspensions. The colloidal particles do not settle down under the force of gravity even on long standing. A colloid is a heterogeneous system, *e.g.*, gold sol, sulphur sol, soap, etc. Emulsions are one of the types of colloidal system, in which both the dispersed phase and dispersion medium are liquids, *e.g.*, milk.
(ii) **Emulsifiers :** The substances which are added to stabilise the emulsion are called emulsifiers. *e.g.,* various kinds of soaps, lyophilic colloids (proteins, gum etc.).

99. Sea water contains a lot of electrolytes. River contains colloids of sand and clay. When they meet the electrolytes neutralise the charge on colloidal particles which results in the precipitation of sand, clay etc. thus, resulting in a delta formation.