

Adsorption● **Physical and chemical adsorption and their characteristics**

Surface chemistry : The study of the boundary separating two bulk states or phases is called surface chemistry.”

The boundary separating the two bulk phases is called interface. The interface on boundary is indicated by a hyphen or slash.

Surface phenomenon : “The phenomenon that keeps the solid and liquid or solid and gas phases in contact even though they are being separate.”

Ex. Dissolution, crystallization, reactions of electrolysis, heterogeneous catalysis, corrosion of metals etc.

The surface should be pure and clean. For this $10^{-8} - 10^{-9}$ pascal high vacuum is created and the surfaces of metals can be used. So as to keep them free from the effect of the air they are kept in vacuum.

Adsorption : “Adsorption is the phenomenon in which molecules are maintained on the solid or liquid surface and the concentration of molecules on the surface becomes more than the concentration of the molecules in the bulk.”

Example : If powder of activated charcoal or clay is added to a dilute solution of a dye the intensity of the colour decreases in the bulk solution.

“The substance which is adsorbed on the surface of the solid (or liquid) is called adsorbate and the solid substance on which adsorption takes place is called adsorbent and that overall phenomenon is called Adsorption.”

Surface energy decreases due to Adsorption.

Charcoal, silica gel, chalk, alumina clay etc. act as good adsorbents because they are more porous and possess more contact surface.

Desorption : “If for some reason (like decreasing pressure or increasing temperature), the absorbed molecules are released from the surface of the adsorbent or mix in the gas, the phenomenon is called desorption.”

This phenomenon is opposite of Adsorption.

Absorption : “Absorption is the phenomenon in which molecules of the substance are spread in the whole part of solid or liquid.”

Sorption : “When both adsorption and absorption sometimes occur simultaneously it is called sorption.” Example, H_2 is first adsorbed on palladium metal and then it is absorbed into Pd metal. Hence it is the phenomenon of sorption.

● **Some Examples of Adsorption**

(1) Gases filled in closed vessels containing charcoal, their pressure decreases because of their adsorption on the surface of charcoal.

(2) Intensity of the colour of dye solution decreases when charcoal is added due to adsorption of the dye on charcoal.

(3) Yellow sugar solution passed through the layer of charcoal so that yellow colour is adsorbed on charcoal and sugar becomes colourless.

(4) To remove moisture from air, it is kept in a closed vessel which contains silica gel.

Mechanism of adsorption : Reason for Adsorption phenomenon...

(1) Imbalance or Residual forces

- Residual forces are responsible for the phenomenon of adsorption.
- At given temperature and pressure adsorption depends upon surface area.

(2) Enthalpy of Adsorption

- Adsorption is an exothermic process.
- ΔH is negative. Thus, Entropy of adsorbate molecules decreases so, ΔS is negative for adsorption.

- Adsorption phenomenon is related to decrease in ΔH and ΔS .

(3) According to Second Law of Thermodynamics $\Delta G = \Delta H - T\Delta S$ (Gibbs – Helmholtz Equation)

- Adsorption is spontaneous process, so value of ΔG will be negative.

● **Types of Adsorption**

There are two types of adsorption (1) Physical adsorption or physisorption (2) Chemical adsorption or chemisorption.

Distinguish between physical adsorption and chemical adsorption below.

Physical Adsorption	Chemical Adsorption
(1) There are weak Van-der Waal's forces between molecules of adsorbent and adsorbate.	(1) There are chemical bond type forces between adsorbent and adsorbate.
(2) The value of adsorption energy is less negative. about 20 to -40 KJ/mol	(2) The value of adsorption energy is comparatively high negative, about 80 to -240 KJ/mol
(3) Physisorption generally takes place at low temperature and it decreases with rise in temperature.	(3) It takes place relatively at higher temperature. There is no specific effect of change in temperature.
(4) It is not specific i.e. all gases are adsorbed in more or less proportion on all solid adsorbents.	(4) It is highly specific, If there is some possibility of chemical bond formation between adsorbent and adsorbate chemisorption can occur.
(5) It is instantaneous.	(5) It can be slow or fast.
(6) Multi-molecular layers can be formed on the surface of adsorbent.	(6) Generally uni molecular layer is formed on the surface of adsorbent.
(7) It is a reversible process.	(7) It is an irreversible process.
(8) Activation energy is low.	(8) Activation Energy is high.
(9) It depends upon the nature of gas. Gases which can be easily liquefied are adsorbed rapidly.	(9) There is no relation between extent of adsorption and the ease of liquefaction of the gas.
(10) Ex. Adsorption of H_2 gas on charcoal.	(10) Ex. Adsorption of H_2 gas on Ni metal.

1. Due to Adsorption phenomenon

- (A) surface energy decreases. (B) surface energy increases.
(C) surface energy becomes zero. (D) surface energy remains same.

2. In which of the following surface phenomenon is used ?

- (A) Production of NH_3 (B) In Industries
(C) Analytical chemistry (D) All the given

3. From below which characteristics is false for physical adsorption ?
 (A) Adsorption is reversible process.
 (B) Adsorption increases by increasing in temperature.
 (C) Adsorption is spontaneous process.
 (D) Both entropy and enthalpy for this adsorption is negative.
4. Which of the following will be true for adsorption phenomenon ?
 (A) $\Delta G < 0$; $\Delta H < 0$; $\Delta S < 0$ (B) $\Delta G > 0$; $\Delta H > 0$; $\Delta S > 0$
 (C) $\Delta G > 0$; $\Delta H < 0$; $\Delta S > 0$ (D) $\Delta G < 0$; $\Delta H > 0$; $\Delta S > 0$
5. Which of the following is not example of surface phenomenon ?
 (A) Heterogeneous catalysis (B) Corrosion
 (C) Water and its vapour in close vessel (D) Crystallization
6. Which of the following statement is false for chemical adsorption ?
 (A) No specific effect of change in temperature.
 (B) Multimolecular layer can be formed on the surface of adsorbent.
 (C) It depends upon the nature of gas.
 (D) It is irreversible process.
7. How many Pascal high vacuum is required for obtaining completely pure surface of metals ?
 (A) 10^{-8} to 10^{-9} (B) 10^8 to 10^9 (C) 10^{-6} to 10^{-8} (D) 10^{-9} to 10^{-10}
8. Which of the following statements is not correct for the phenomenon of adsorption ?
 (A) Adsorption increases as the pressure increases.
 (B) Adsorption increases as the temperature increases.
 (C) Adsorption can be unimolecular or multi-molecular.
 (D) Size of Adsorbent will not effect Adsorption.
9. Which of the following will increase Rate of physical adsorption ?
 (A) By decreasing pressure. (B) By increasing temperature.
 (C) By decreasing temperature. (D) by decreasing volume of system.
10. Which of the following statement is incorrect for physical adsorption ?
 (A) It is evolved by Van der Waal's attraction forces.
 (B) Easily liquified gases adsorbs rapidly.
 (C) Multi-molecular layers generated at high pressure
 (D) Value of ΔH (Adsorption Enthalpy) will be less and positive.
11. Which of the following statement is incorrect ?
 (A) Physical adsorption is reversible. Where as chemical adsorption is irreversible.
 (B) At high pressure, physical adsorption will occur where as at low pressure chemical adsorption will occur.
 (C) Physical adsorption is not specific where as chemical Adsorption is specific.
 (D) High activation Energy is required for chemical adsorption.
12. Spontaneous adsorption of gas on solid surface is an exothermic reaction, because...
 (A) ΔH of system increases. (B) ΔS of gas increases.
 (C) ΔS of gas decreases. (D) ΔG of gas increases.
13. Which of the following gas will be maximum adsorbed on solid adsorbent ?
 (A) CO_2 (B) N_2 (C) CH_4 (D) Ar

14. During adsorption....
 (A) $T\Delta S$ will positive. (B) ΔH will positive.
 (C) $\Delta H - T\Delta S$ will negative. (D) $T\Delta S$ and ΔG both will zero.
15. At 298 K temperature what is the decreasing order of H_2 , CH_4 , CO_2 and NH_3 gases on 1 gm charcoal ?
 (A) $H_2 > CH_4 > CO_2 > NH_3$ (B) $CO_2 > NH_3 > H_2 > CH_4$
 (C) $NH_3 > CO_2 > CH_4 > H_2$ (D) $CH_4 > CO_2 > NH_3 > H_2$
16. Which of the following example is of adsorption ?
 (A) Water on silica gel (B) Water on calcium chloride
 (C) H_2 on pure Nickel metal (D) Oxygen on metal surface
17. Physical adsorption of gases increases...
 (A) by increasing temperature.
 (B) by decreasing temperature.
 (C) by decreasing surface area of adsorbent.
 (D) by increasing in Van der waal's attraction forces.
18. What is correct for adsorption phenomenon at equilibrium ?
 (A) $\Delta H > 0$ (B) $\Delta H = T\Delta S$ (C) $\Delta H > T\Delta S$ (D) $\Delta H < T\Delta S$
19. Adsorption of any gas by adsorbent in physical adsorption is not possible, because...
 (A) Van der Waal's attraction forces are universal.
 (B) gases Act as ideal gas.
 (C) less value of adsorption enthalpy.
 (D) it will be reversible.
20. Which of the following will not be correct for adsorption if 'm' is amount of adsorbent and x is amount of adsorbate ?
 (A) at constant temperature (T) $\frac{x}{m} = f(P)$ (B) at constant pressure (P) $\frac{x}{m} = f(T)$
 (C) at constant $\left(\frac{x}{m}\right)$, $P = f(T)$ (D) $\frac{x}{m} = P \times T$
21. Which force is responsible for adsorption of gas on solid surface in physical adsorption ?
 (A) Chemical force (B) Electrostatic attraction force
 (C) Gravitational Force (D) Van der Waal's attraction force

Answers : 1. (A), 2. (D), 3. (B), 4. (A), 5. (C), 6. (B), 7. (A), 8. (D), 9. (C),
 10. (D), 11. (B), 12. (C), 13. (A), 14. (C), 15. (C), 16. (B), 17. (B), 18. (B),
 19. (A), 20. (D), 21. (D)

● **Factors effecting adsorption of gas on solid Adsorbent-Freundlich and Langmuir isotherm**

Adsorption of gases on adsorbent depends upon the following factors :

(1) Nature of adsorbate (2) Nature of adsorbent (3) Specific area of adsorbent (4) The pressure on the gas which is adsorbed (5) Temperature (6) activation of adsorbent.

(1) Nature of adsorbate

● At given temperature and pressure gases like, NH_3 , HCl , CO_2 which can be easily liquefied. Such gases are adsorbed to a greater extent.

● Permanent gases like H_2 , O_2 , N_2 which can not be liquefied easily are adsorbed to a less extent.

- Liquefaction of gas has relation with critical temperature (T_c). Gases with higher critical temperature are adsorbed to a greater proportion.

(2) Nature of adsorbent

- Substances like carbon, animal charcoal, metal oxides, silica gel, alumina, clay etc. act as adsorbents.
- They have their characteristic adsorption properties on the basis of their structure.

(3) Specific area of adsorbent

- Specific area of adsorbent is defined as the surface area available for adsorption per gram of adsorbent.
- More is the surface area, more will be adsorption.
- More porosity of adsorbent offers more specific area which ultimately leads to more adsorption.

(4) Pressure on the gas that is adsorbed (adsorption isotherm)

- Generally magnitude of adsorption of an adsorbate

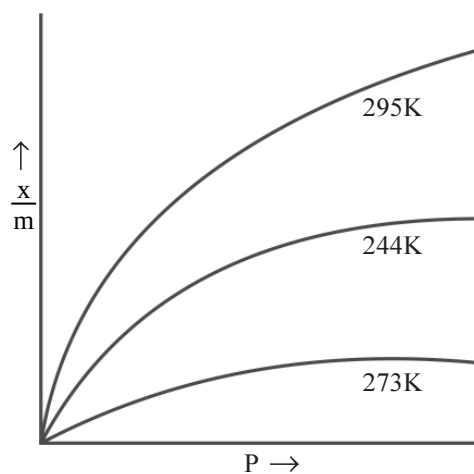
gas is expressed as $\frac{x}{m}$

where, m = mass of the adsorbent

x = concentration at definite temperature.

- Experimentally $\frac{x}{m}$ is determined at definite

temperature. If we plot $\frac{x}{m} \rightarrow$ against pressure ' p ' of the gas at constant temperature we get a curve this curve is known as adsorption isotherm curve.



(5) **Temperature** : Adsorption is exo thermic. According to Le-chatelier's principle, increase in temperature will decrease the process of adsorption.

• Freundlich adsorption isotherm

• Adsorption of gaseous adsorbate on solid adsorbent at definite temperature is proportional to the pressure of the absorbed gas. This relation can be written as :

$$\frac{x}{m} \propto P^{\frac{1}{n}} \text{ or } \frac{x}{m} = KP^{\frac{1}{n}} \quad (n > 1)$$

where, $\frac{x}{m}$ = is adsorption of the gas per gram of adsorbent.

$x = 0$ number of moles of Adsorbate gas

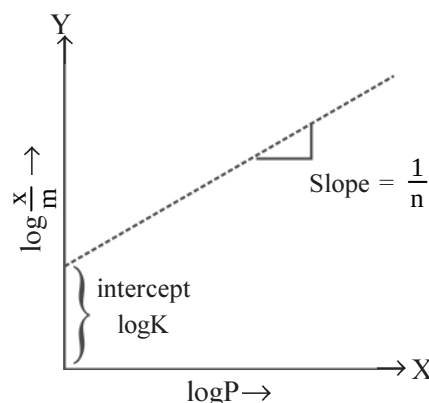
K and n = constants, m = mass of adsorbent,

P = atmospheric pressure

- Taking log on both side of above equation,

$$\log \frac{x}{m} = \log K + \frac{1}{n} \log P. \text{ If we plot,}$$

$\log \frac{x}{m} \rightarrow \log P$, a straight line is obtained as shown below :



- $\frac{1}{n}$ indicates slope of the graph and $\log k$ is given by the intercept. Thus n and k can be calculated.

● **Limitations of Freundlich Adsorption isotherm**

- (1) The isotherm is applicable within certain limit of pressure. It shows deviation at higher pressure and the curve of isotherm is changed.
- (2) K and n are constants but for the same adsorbent and adsorbate they change with temperature.
- (3) Freundlich adsorption isotherm is empirical i.e. there is no theoretical proof of it.
- (4) If the value of $\frac{1}{n}$ is 1, then $\frac{x}{m} = KP$ so adsorption will be directly proportional to the pressure. If the value of $\frac{1}{n}$ becomes 0, then $\frac{x}{m} = Kp^0$ so adsorption will be independent of pressure.

● **Langmuir Adsorption Isotherm**

- Irving Langmuir derived a simple adsorption isotherm on basis of theoretical considerations on the basis of kinetic theory of gases.
- In this isotherm both opposite process condensation and evaporation are taken in consideration.
- Langmuir adsorption isotherm can be expressed as :

$$\frac{x}{m} = \frac{ap}{1+bp}$$

where, $\frac{x}{m}$ = the adsorption of gas per gram of adsorbent, P = pressure, a and b = constant
For this equation, two situations can be considered

(1) **At low pressure** : $\frac{x}{m} = ap$.

Thus, at low pressure, adsorption of gas is directly proportional to the pressure.

(2) **At High Pressure** : $\frac{x}{m} = \frac{a}{b} = \text{constant}$

Thus, at high pressure adsorption will be almost constant.

To determine constants 'a' and 'b', equation $\frac{x}{m} = \frac{ap}{1+bp}$ may be written by inverting it.

$$\text{i.e. } \frac{m}{x} = \frac{1}{ap} + \frac{b}{a}.$$

● This equation is the equation for a straight line so if we plot the graph of $\frac{m}{x} \rightarrow \frac{1}{p}$ a straight line is obtained. The value of slope will be $\frac{1}{a}$ and the value of intercept will be $\frac{b}{a}$ thus 'a' and 'b' can be calculated.

22. Which of the following value of the slope obtained when graphs of $\log \frac{x}{m} \rightarrow \log P$ is plotted in Freundlich adsorption isotherm ?

- (A) $\frac{1}{p}$ (B) $\frac{1}{n}$ (C) $\frac{1}{a}$ (D) -K

23. Langmuir derived isotherm on what basis ?

- (A) On gaseous kinetic principles (B) On Thermodynamics principles
(C) On collision principles (D) On wave mechanics principles

24. From the following which one is the equation of Langmuir adsorption isotherm ?

- (A) $\frac{m}{x} = \frac{1+bp}{ap}$ (B) $\frac{x}{m} = \frac{ab}{1+bp}$ (C) $\frac{x}{m} = \frac{ap}{1+bp}$ (D) $\frac{x}{m} = \frac{ap}{1+bc}$

25. Which one of following is correct form of Langmuir adsorption isotherm ?
- (A) $\frac{x}{m} = \frac{a}{b}$ (B) $\frac{x}{m} = ap$ (C) $\frac{x}{m} = \frac{ap}{1+bp}$ (D) $\frac{x}{m} = \frac{b}{a}$
26. What is the value of slope obtained when graphs of $\frac{m}{x} \rightarrow \frac{1}{p}$ is plotted in Langmuir adsorption isotherm ?
- (A) $\frac{1}{a}$ (B) $\frac{b}{a}$ (C) $\frac{a}{b}$ (D) K
27. Which of the following factor does not effect on adsorption of gase on solid adsorbent ?
- (A) Specific area of adsorbent (B) Pressure of gas
(C) Temperature (D) Volume of adsorbent
28. Which of the following statement is not correct for Freundlich adsorption isotherm ?
- (A) Applies within certain range of pressure.
(B) Constants K and n change with temperature.
(C) Freundlich adsorption isotherm is empirical. It has no theoretical basis.
(D) Shows deviation at low pressure.
29. For the phenomenon of adsorption of gas on solid surface, Langmuir adsorption isotherm indicates that...
- (A) many molecules of gas combine with every single molecule of exterior monomolecular layer on solid surface.
(B) the rate at which molecules of gas colloid at specific sites on solid surface is proportional to pressure of the gas.
(C) rate of colliding molecules of gas on solid surface is independant of pressure of the gas.
(D) the rate of desorption of gas molecules from surface of solid does not depend on the surface of the solid.
30. What is the relation between solid adsorbent and gaseous adsorbate in adsorption at constant temperature ?
- (A) $\frac{x}{m} = KP^{\frac{1}{n}}$ (B) $\frac{m}{x} = KP^n$ (C) $\frac{x}{m} = KP^n$ (D) $\frac{x}{m} = PK^{\frac{1}{n}}$
31. In Freundlich adsorption isotherm value of $\frac{1}{n}$ is
- (A) 1 in physical adsorption (B) 1 in chemical adsorption
(C) between 0 and 1 in all cases (D) between 2 and 4 in all cases
32. Which of the following assumption is for Langumir adsorption isotherm ?
- (A) This adsorption is multimolecular layer.
(B) All adsorption site are equal and it have tendency to adsorbe molecules.
(C) Value of adsorption enthalpy is very low.
(D) Adsorbed molecules/atom attract each other.
33. Which one of following is true for Freundlich adsorption isotherm ?
- (A) $\frac{x}{m} = KP^{\frac{1}{n}}$ (B) $x = m \cdot KP^{\frac{1}{n}}$ (C) $\frac{x}{m} = KP^{-n}$ (D) above all
34. Why the value of $\frac{x}{p} \rightarrow P$ is not changes in freuindlich adsorption isotherm if we increase value of pressure 'p' ?
- (A) Because of value of $\frac{x}{m}$ is low (B) Because it is unimolecular adsorption
(C) Because it is multimolecular adsorption (D) Because it is not multimolecular adsorption

35. Which is the equation for Freundlich adsorption isotherm ?

(A) $\log \frac{x}{m} = \log K + \frac{1}{n} \log P$

(B) $\log \frac{m}{x} = \log K + \frac{1}{n} \log P$

(C) $\log \frac{x}{m} = \log R + \frac{1}{K} \log P$

(D) $\log \frac{x}{m} = \log C + \frac{1}{n} \log K$

36. Which of the following equation is true for Langmuir adsorption isotherm, at high pressure ?

(A) $\frac{x}{m} = \frac{a}{b}$

(B) $\frac{x}{m} = ap$

(C) $\frac{x}{m} = \frac{1}{a \cdot p}$

(D) $\frac{x}{m} = \frac{b}{a}$

37. On the basis of which of the following assumptions Langmuir adsorption isotherm is derived?

(A) Adsorption possess multi molecular layer.

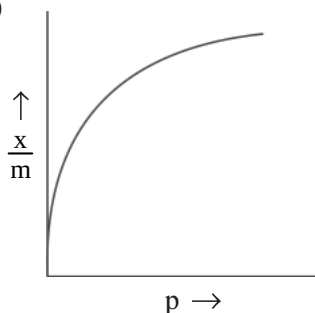
(B) All adsorption sites are equal and have equal adsorption capacity.

(C) Adsorption enthalpy value is related to adsorption.

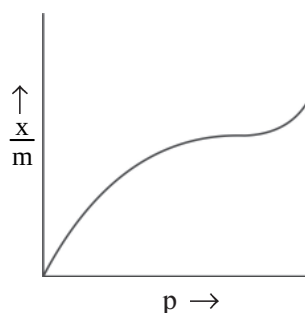
(D) Adsorption molecules settle over each other.

38. Which of the following curves does not correspond to adsorption isotherm ?

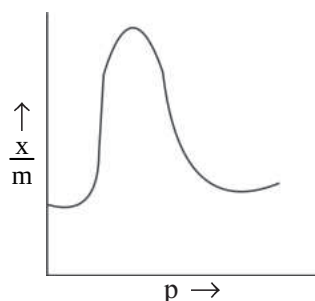
(A)



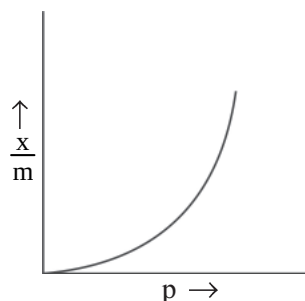
(B)



(C)



(D)



39. Which of the following statement is false for Freundlich and Langmuir adsorption isotherm ?

(A) Adsorption can be unimolecular or multimolecular.

(B) Volume of adsorbent molecule doesn't effect on adsorption.

(C) Adsorption increases by increasing pressure.

(D) Adsorption decreases by increasing temperature.

40. Which of the following statement is wrong for Langmuir adsorption isotherm ?

(A) at high pressure $\frac{x}{m} = Kp$

(B) graph of $\log \left(\frac{x}{m} \right) \rightarrow \log P$ will be straight line

(C) at low pressure $\frac{x}{m} = Kp$

(D) at ordinary pressure $\frac{m}{x} = KP^{\frac{1}{n}}$

Answers : 22. (B), 23. (A), 24. (C), 25. (A), 26. (A), 27. (D), 28. (C), 29. (B), 30. (A), 31. (C), 32. (B), 33. (D), 34. (C), 35. (A), 36. (A), 37. (B), 38. (C), 39. (B), 40. (B).

● **Adsorption from solutions and Catalysis and its different types**

Adsorption from solution

Adsorption isotherm is also applicable to liquid systems as gaseous system.

Freundlich and Langmuir adsorption isotherm can be write as below for adsorption from solution.

Freundlich Adsorption	Langmuir adsorption isotherm
(1) Physical adsorption $\frac{x}{m} = KP^{\frac{1}{n}} \text{ or } \log \frac{x}{m} = \log K + \frac{1}{n} \log P$	$\frac{x}{m} = \frac{ap}{1+bp} \text{ or } \frac{m}{x} = \frac{1}{ap} + \frac{b}{a}$
(2) Chemical adsorption $\frac{x}{m} = KC^{\frac{1}{n}} \text{ or } \log \frac{x}{m} = \log K + \frac{1}{n} \log C$	$\frac{x}{m} = \frac{ac}{1+bc} \text{ or } \log \frac{m}{x} = \log \frac{b}{a} + \log \frac{1}{ac}$

● **Catalysis**

The substance which is not consumed in the chemical reaction and is obtained in its original form at the end of the reaction and increases the rate of reaction or decreases the time required for getting product is called catalyst.

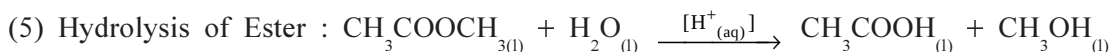
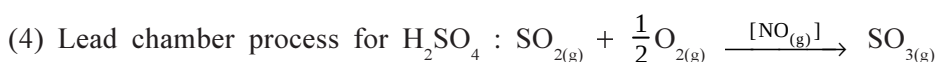
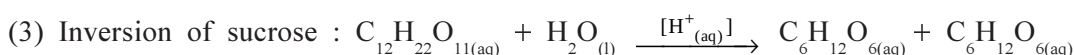
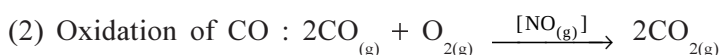
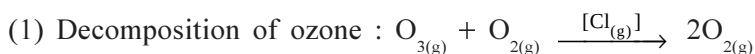
Increase in rate of reaction with the help of catalyst that phenomenon is called **catalysis**.

A catalyst increases equally both the rate of forward reaction as well as the rate of reverse reaction. It does not affect equilibrium constant i.e. more product is not obtained.

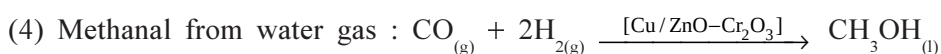
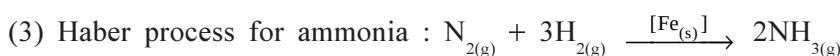
A catalyst decreases activation energy by providing a different path way of reaction. It lowers the potential energy barrier, hence reaction occurs in less time.

Types of catalysis : There are two main type of catalysis :

(1) Homogeneous catalysis : If the catalyst is in same phase as the reactants are, it is called homogeneous catalyst and the phenomenon is called **homogeneous catalysis**."



(2) Heterogeneous Catalysis : "When the catalyst is in different phase from that of reactants the catalyst is called heterogeneous catalyst and the phenomenon is called heterogeneous catalysis." Example,



● Shape-selective Catalysis by Zeolite

When catalytic reaction depends upon size of pore of the catalyst; size of molecules of reactant and product; it is known as shape-selective catalysis”

Zeolites are good shape selective catalysts because of their structure like Honey comb.

They are alumino silicates $[\text{Na}_2\text{Al}_2\text{Si}_4\text{O}_{12}]$.

They occur naturally or they are prepared synthetically.

Before using zeolites are heated in vacuum to remove water of hydration.

Reaction of Zeolite catalyst depends upon the size and shape of reactant and products that is why they are shape selective catalysts.

Zeolites are mainly used in petro chemical industries for isomerisation and cracking of hydrocarbons.

One important zeolite is ZSM-5 that directly converts alcohol into petrol by hydrolysis reaction.

● Enzyme Catalysis

Large number of organic reactions occur in the body of plants and animals to sustain life processes. They occur in dilute solution at ordinary temperature and pressure. Like this process. So many other biological processes are catalysed by biochemical catalyst that's called **Enzyme Catalysis.**”

Such Biochemical catalyst are called **Enzyme.**

Enzyme increases the rate of reaction by 10^8 to 10^{20} times and those are specific.

The rate of reaction increases as the concentration of substrate increases. The reaction changes from first order to zero order reaction as concentration of substrate increases at high temperature its activity is destroyed.

One Enzyme molecule may transform one million molecules of the reactant per minute.

41. Which of the following formula is applicable to the Freundlich Adsorption isotherm for solution ?

- (A) $\frac{x}{m} = K \cdot C^{\frac{1}{n}}$ (B) $\frac{x}{m} = \frac{ac}{1+bc}$ (C) $\frac{m}{x} = \frac{1}{K} \cdot C^{\frac{1}{n}}$ (D) $\frac{m}{x} = \frac{1+bc}{ac}$

42. Which one of the following is true Equation for Langmuir adsorption isotherm for solutions ?

- (A) $\frac{x}{m} = K \cdot C^{\frac{1}{n}}$ (B) $\frac{x}{m} = \frac{ac}{1+bc}$ (C) $\frac{m}{x} = \frac{1}{K} \cdot \frac{1}{C^{\frac{1}{n}}}$ (D) $\frac{m}{x} = \frac{1+bc}{ac}$

43. 20 % N_2 gas is adsorbed on a solid surface. If we provide heat on surface then some of gaseous molecules leave surface and deposit in a container of volume 2.43 cm^3 at 0.001 atmospheric pressure and 298 K temperature. If density of surface is $6.023 \times 10^{14} \text{ cm}^{-2}$ and area of surface is 1000 cm^2 then calculate site of surface which covered by N_2 gas ?

- (A) 5 (B) 4 (C) 2 (D) 8

44. If we stir 0.5 gm dust of wood and 1 M 50 ml oxalic acid then adsorption phenomenon is possible. Concentration of solution becomes 0.6 M after adsorption, what is amount of oxalic acid adsorbed by per gram wood dust ?

- (A) 5.04 gram (B) 4.05 gram (C) 7.05 gram (D) 2.08 gram

45. At 27°C temperature in 1 litre volume container if we pass gas over activated charcoal, then pressure of gas decreases by 700 to 400 mm then calculate volume of gas ? (Density of charcoal = 1.5 gm/m^3)

- (A) 30 ml (B) 60 ml (C) 90 ml (D) 120 ml

46. Which of the following reaction is of Heterogeneous catalysis ?
- (I) $2\text{SO}_{2(g)} + \text{O}_{2(g)} \xrightarrow{\text{NO}_{(g)}} 2\text{SO}_{3(g)}$
- (II) $2\text{SO}_{2(g)} \xrightarrow{[\text{Pt}_{(s)}]} 2\text{SO}_{3(g)}$
- (III) $\text{N}_{2(g)} + 3\text{H}_{2(g)} \xrightarrow{[\text{Fe}_{(s)}]} 2\text{NH}_{3(g)}$
- (IV) $\text{CH}_3\text{COOCH}_{3(l)} + \text{H}_2\text{O}_{(l)} \xrightarrow{[\text{H}^+_{(aq)}]} \text{CH}_3\text{COOH}_{(aq)} + \text{CH}_3\text{OH}_{(aq)}$
- (A) (IV) (B) (I), (II), (III) (C) (II), (III) (D) (II), (III), (IV)
47. In catalytic reactions explain contribution of catalyst.
- (A) decreases activation Energy. (B) increases activation energy
- (C) effect on change in free Energy. (D) effect on change in enthalpy
48. Which of the following factor is responsible for increasing rate of reaction of surface catalysis?
- (I) Catalyst will provide proper orientation of reactant molecule for Reaction.
- (II) Catalyst decreases activation energy of reactant molecule with the help of reactant molecule's adsorption enthalpy.
- (III) Catalyst increases activation energy of reactant.
- (IV) Due to active centre on surface of catalyst concentration increases of reactant molecule due to adsorption phenomenon.
- (A) (I) and (II) (B) (I), (II) and (III) (C) (I), (II) and (IV) (D) (II) and (IV)
49. For reversible process catalyst is
- (A) increasing in rate of forward reaction.
- (B) decreasing in value of change in reaction enthalpy.
- (C) decrease time to get equilibrium state.
- (D) decreases rate of reversible process.
50. Which of the following convert directly Alcohol into petrol by dehydration method in petrochemicals ?
- (A) Pt (B) ZSM-5 (C) Fe (D) Ni
51. Which catalyst is used for preparation of vegetable ghee by hydrogenation of oil.
- (A) Pt (B) Mo (C) Raney Ni (D) Fe
52. Which of the following is example of surface catalyst ?
- (A) inversion of sucrose (B) Haber process for NH_3
- (C) Lead chamber process for H_2SO_4 (D) Hydrolysis of Ester
53. On which of the following shape selective catalysis will depend ?
- (A) Size of Reactant (B) Pore structure of catalyst
- (C) Product molecule (D) given all
54. Which of the following statement is true for preparation of Hydrogen gas from $(\text{CO} + \text{H}_2)$?
- (A) To remove 'CO' it has to adsorbed on CaCl_2 .
- (B) To remove ' H_2 ' it has to adsorbed on Pd.
- (C) Convert CO into CO_2 by oxidation with water vapour then adsorbed CO_2 gas in alkali.
- (D) Separating CO and H_2 by minor difference in their density.
55. Which of the following catalyst is used for preparation of aldehyde from α -olefin, CO and H_2 ?
- (A) Ni / Pd complex compound (B) Rh / Pd complex compound
- (C) $[\text{Rh}(\text{CO})_2\text{I}_2]^-$ (D) Mo(VI) complex

56. On which of the following activity of catalyst will depend ?
 (A) On type of chemical adsorption. (B) On type of physical adsorption.
 (C) On Tendency of chemical adsorption. (D) On selectivity of catalyst.
57. at 300 K temperature and 0.7 atmosphere pressure 3.0 gm O_2 gas adsorbed on 1.2 gm charcoal. So 300 K temperature and 0.7 atmosphere pressure what is the volume of O_2 gas ?
 (A) 2741 cm^3 (B) 1746 cm^3 (C) 4127 cm^3 (D) 4617 cm^3
58. Which of the following biochemical process require Urease Enzyme ?
 (A) In digestion of lipid (B) In digestion of starch
 (C) Hydrolysis of urea (D) Hydrolysis of maltose

Answers : 41. (A), 42. (B), 43. (C), 44. (A), 45. (B), 46. (C), 47. (A), 48. (C), 49. (C),
 50. (B), 51. (C), 52. (B), 53. (D), 54. (C), 55. (B), 56. (C), 57. (A), 58. (C)

● Colloids

Difference between True Solution, Colloid and Suspension

A system between true solution and suspension is called colloidal dispersion.

Colloid : 'Colloid is a heterogeneous system. In which one substance is called dispersion medium which contain very small particles.

True solution and colloid contain very large difference in their particle size.

In below table difference between true solution, colloid and suspension is given.

True Solution	Colloid	Suspension
(1) diameter of particle is very low even microscope can't measure it. diameter of particles are < 1 nm or $< 10^{-9}$ meter.	(1) Diameter of colloid particle is bigger than suspension particle and lower than true solution. It can be measure by ultra microscope. Partical diameter is 1 nm – 1000nm means 10^{-9} to 10^{-6} meter.	(1) Diameter of this particle are very high even can measured by eyes. diameter of particle is > 100 nm or $> 10^{-9}$ meter.
(2) Homogeneous mixture.	(2) Heterogeneous mixture.	(2) Heterogeneous mixture.
(3) Can not be separated by simple filter paper and ultra filter paper.	(3) It can not be separated by simple filter paper but can be separated by ultra filter	(3) It can be separated by simple filter paper as well as ultra filter paper.
(4) Do not settle at bottom or aggregate.	(4) Do not settle under gravity but can be made to settle under centrifugation.	(4) Settle at bottom under gravity.
(5) Does not show tyndall effect and Brownian motion.	(5) Shows tyndall effect and sometimes it is observed Brownian motion.	(5) Shows tyndall effect and observe Brownian motion.
(6) e.g. Solution of sugar and salt in water.	(6) e.g. milk, starch, solution gold sol, sulfur sol, Muddy water.	(6) e.g. Sand in water or water and oil mixture organic liquid and water.

● Classification of Colloids

Classification of colloids based on following three types :

- (1) Physical state of dispersion phase and dispersing medium.
- (2) The nature of attraction between dispersing phase and dispersion medium.
- (3) Types of particles of dispersed phase.

(1) The classification of colloids on the basis of physical states of dispersed phase and dispersion medium :

Based on state of dispersing phase and dispersion medium as solid, liquid or gas.

There are 8 types of colloidal systems as follows :

No.	Dispersing phase	Dispersion Medium	Type of Colloid	Examples
(1)	Solid	Solid	Solid Sol	Some coloured glass, gemstone, ruby glass
(2)	Solid	Liquid	Sol	cell fluid, gold Sol
(3)	Solid	Gas	Aerosol	Smoke, dust haze
(4)	Liquid	Solid	Gel	Cheese, Butter Jelly
(5)	Liquid	Liquid	Emulsion	Milk, Hair cream
(6)	Liquid	Gas	Aerosol	Mist, Cloud, Fog, spray of pesticides
(7)	Gas	Solid	Solid Sol	Pumice stone, Foam Rubber
(8)	Gas	Liquid	Foam	Foam, Foam

(2) Classification on the Basis of nature of interaction between dispersing phase and dispersion Medium :

There are two types of colloids :

- (1) Lyophilic colloids
- (2) Lyophobic colloids

Following table shows difference between lyophilic colloids and lyophobic colloids :

Lyophilic Colloids	Lyophobic colloids
(1) They are Liquid attracting colloid. They can be directly obtained by mixing with solvent.	(1) They are liquid repelling by nature. Colloids are made by special method.
(2) If dispersion medium is removed from colloidal solution the dispersion system are obtained. If liquid is added again original lyophilic colloid is obtained.	(2) If dispersion medium is removed and again mixed with dispersion medium the precipitate obtained does not give sol again.
(3) They cannot be easily coagulated so they are called stable colloid.	(3) They can easily coagulated by addition of electrolytes. So, they are not stable colloid.
(4) This colloidal system possesses reversible property and are called reversible sols.	(4) If dispersion medium is removed and again mixed with dispersion medium the precipitate obtained does not give sol again. Hence they are irreversible sols.

(5) They are stable so they does not need any stabilizing agents.	(5) They need stabilizing agents for their preservation.
(6) Viscosity is much higher compared to that of solvent.	(6) Viscosity is nearly the same as that of solvent.
(7) Surface tension is usually lower than that of dispersion medium.	(7) Surface tension is nearly the same as that of dispersion medium.
(8) This colloids do not show tyndall effect.	(8) This colloids show tyndall effect.
(9) Examples : Gum, gelatin, starch, rubber, etc.	(9) Examples : Ag, Au, Al(OH) ₃ , Fe(OH) ₃ etc.

Dispersion of solid in Liquid → sols.

Dispersion of Liquid in solid → gel

Dispersion of Liquid in Liquid → emulsion.

If dispersion medium is water, those colloid are called → Aqua sol.

If dispersion medium is alcohol : those colloid called → Alcosol

-
59. What is the size of a colloid particle ?
 (A) $10^{-9} - 10^{-6}$ meter (B) $> 10^{-9}$ meter (C) $< 10^{-9}$ meter (D) 1 nm – 100 nm
60. Foam rubber is which type of colloid ?
 (A) Sol (B) Solid sol (C) Aerosol (D) Jell
61. Pumice stone is which type of colloid ?
 (A) Sol (B) Solid sol (C) Aerosol (D) Jell
62. Which of the following factors is responsible for more tendency of adsorption of colloid particle ?
 (A) Charge on colloid particle (B) Surface area of colloid particle
 (C) Brownian motion of colloidal particle (D) strong attraction of colloidal particle towards solvent
63. All colloidal dispersion...
 (A) contains very high osmotic pressure. (B) contains very low osmotic pressure.
 (C) does not contain any osmotic pressure. (D) contains high osmotic pressure.
64. Lyophilic colloids are....
 (A) irreversible colloids. (B) prepared from inorganic compound.
 (C) coagulated by addition of electrolytes. (D) self stabilizers.
65. Which substance's 4% solution is added to alcohol-ether mixture to make colloid ?
 (A) Nitroglycerin (B) Cellulose acetate (C) Glycodin nitrate (D) Nitro cellulose
66. What is the volume of colloidal particle of volume V_c if we dissolve it in true solution V_s ?
 (A) $\frac{V_c}{V_s} \simeq 1$ (B) $\frac{V_c}{V_s} \simeq 10^{23}$ (C) $\frac{V_c}{V_s} \simeq 10^{-3}$ (D) $\frac{V_c}{V_s} \simeq 10^3$
67. If suspension particle radius of 1 mm is converted into colloidal particle of radius 1000 Å then what is the surface area of this colloidal particle compare to suspension particle ?
 (A) 10^3 (B) 10^4 (C) 10^5 (D) 10^6
68. In saturated solution of Calcium acetate if we add alcohol then it first forms Sol then if we add heavy gelatin in it; becomes solid alcohol than what will be it ?
 (A) gel (B) Solid foam (C) liquid sol (D) Aerosol
-

69. Which of the following characteristic is not correct for hydrophilic sol ?
 (A) Dispersed phase is obtained easily at high concentration.
 (B) Its coagulation is reversible.
 (C) Viscosity and surface tension are nearly the same as those of water.
 (D) The charge on the particles depends on pH of the medium and it can be positive, negative or zero.
70. Which of the following species colloidal system is irreversible in dispersing medium ?
 (A) Soil (B) Pt (C) Fe(OH)_3 (D) mentioned all
71. Which of the following characteristics is not true for lyophilic and lyophobic colloid ?
 (A) Lyophobic colloid contains high hydration energy, while lyophilic colloid does not.
 (B) Viscosity and Surface tension of lyophobic colloid is less than that of dispersion medium.
 (C) lyophobic colloid easily coagulate where as lyophilic colloid is not easily coagulated.
 (D) Colloid of gold is irreversible because gold cannot be obtained from the sol.
72. Which of the following characteristic is of colloid solution ?
 (A) Colloid particle moves slowly from semipermeable membrane.
 (B) Colloid particle does not settle down under gravitational force.
 (C) Colloid particle is not observed even by the microscope.
 (D) above all statement are true.
73. If dispersion phase is liquid and dispersion medium is solid, then that colloid is called
 (A) sol (B) emulsion (C) gel (D) foam
74. Stability of lyophilic colloid is due to
 (A) charge on particle (B) dispersion medium on particle.
 (C) particle size is small (D) particle size is big.
75. Which of the following is Hydrophobic sol ?
 (A) Starch solution (B) Gum solution
 (C) Protein solution (D) As_2S_3 solution
76. Milk is
 (A) dispersion of fat in oil. (B) dispersion of fat in water.
 (C) dispersion of water in fat. (D) dispersion of gas in liquid.
77. Fog is which type of colloidal system ?
 (A) Dispersion of gas in liquid. (B) Dispersion of gas in gas.
 (C) Dispersion of solid in gas. (D) Dispersion of gas in liquid.
78. Which of the following statement is wrong ?
 (A) Every solid substance can convert into colloid.
 (B) Colloid particle has charge.
 (C) Every solid substance have tendency to become lyophilic colloid.
 (D) Flocculation occurs if we add electrolyte in colloid particle.
79. Which of the following pairs is wrong ?
 (i) Starch solution - Sol
 (ii) Aqueous NaCl = True solution
 (iii) Milk - Emulsion
 (iv) Aqueous BaSO_4 - True Solution
 (A) (i) (B) (ii) (C) (iii) (D) (iv)

Answers : 59. (A), 60. (C), 61. (B), 62. (A), 63. (B), 64. (D), 65. (D), 66. (D), 67. (B), 68. (A), 69. (C), 70. (D), 71. (C), 72. (D), 73. (C), 74. (B), 75. (D), 76. (C), 77. (A), 78. (C), 79. (C)

● **Multimolecular colloids, Macromolecular colloids and Associated colloids (micelle)**

Colloids can be classified on the basis of the types of dispersing phases as follows :

(1) Multi Molecular colloids : On dissolution when a large number of atoms or small molecules associate together with one another. The species so formed is called multimolecular colloid. Such a cluster has diameter more than 1 nm i.e. with in the range of colloids. e.g., Gold sol and Sulphur sol.

(2) Macromolecular colloids : “Molecular mass of macromolecules are very large when such molecules are dissolved in proper solvent a solution is obtained in which the small size of macro molecules may change to the size of colloidal particles. Such a system is called macromolecular colloid.”

e.g. Organic polymers like : gum, protein, cellulose, enzymes

Manmade macromolecular substances like : nylon, polystyrene, polyethylene synthetic rubber, plastic etc.

(3) Associated Colloids : “Substances whose molecules aggregate spontaneously in a given solvent to form particles of colloidal dimensions are called associated colloids”

- Formation of micelle takes place at a definite temperature called Kraft temperature (T_k).
- The minimum concentration required for micelle formation is called Critical Micelle Concentration (CMC).
- On dilution these colloids change into their original ions.
- Micelle possess both lyophilic part as well as lyophobic part.
- Micelle contain more than 100 atom/particle.
- e.g. surface active substance : soap and detergent.

● **Mechanism of micelle formation**

Soap is sodium salt of higher fatty acids. So, by taking example of soap solution to explain the mechanism of micelle formation.

Sodium Stearate - $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^-\text{Na}^+$ Or RCOO^-Na^+ where, $\text{R} = \text{CH}_3(\text{CH}_2)_{16}$

When dissolved in water, it dissociates into RCOO^- and Na^+ ions.

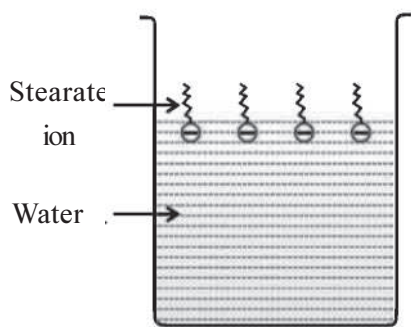
There are two parts in the ion RCOO^- ion (1) R is known as non-polar tail which is hydrophobic.

(2) The polar group COO^- is known as polar ionic head which is hydrophilic.

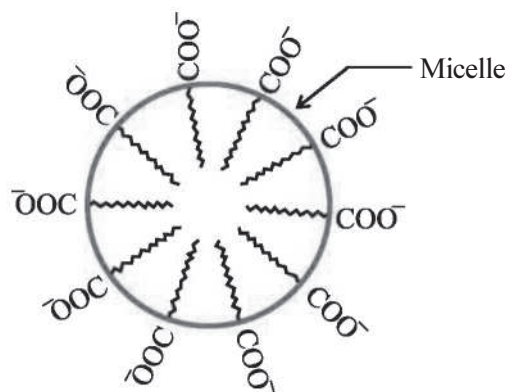
RCOO^- ions are present on the surface the COO^- part remains in water. Hydrocarbon part R, remains away from it on the surface.

At high concentration, they are dragged in the bulk of the solution. They associate in spherical form. The hydrocarbon chains remain attracted towards the centre of the sphere. At this time COO^- part remains outside the surface. This type of formation association of ions is called **Ionic Micelle**.

Ex. Sodium lauryl Sulphate $[\text{CH}_3(\text{CH}_2)_{11}\text{SO}_4^-\text{Na}^+]$



Initial state



Micelle

80. Starch solution is which type of colloid ?
 (A) Multi molecular colloid (B) Macromolecular colloid
 (C) Associated colloid (D) Micelle
81. Which of the following statement is wrong for $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^-\text{Na}^+$?
 (A) Size of atom/ions is in range of colloid particle.
 (B) It forms micelle at more than certain concentration.
 (C) In micelle form polar part arranged towards water and hydrocarbon part is arranged towards centre.
 (D) There are total 100 ions/atoms in this micelle.
82. Which of the following is correct for sodium stearate Micelle ?
 (A) Head and tail both are hydrophobic. (B) Hydrophobic head and hydrophilic tail.
 (C) Hydrophilic Head and hydrophobic tail. (D) Both head and tail are hydrophilic.
83. Which of the following saturated solution forms micelle at higher concentration ?
 (A) Urea (B) Sodium acetate
 (C) Sodium dodecyl sulphate (D) Cetyl trimethyl ammonium bromide
84. Under which of the following conditions will the micelle be formed ?
 (A) Below critical Micelle concentration and below Kraft temperature
 (B) Above critical Micelle concentration and below Kraft temperature
 (C) Above critical Micelle concentration and above Kraft temperature
 (D) Below critical Micelle concentration and above Kraft temperature
85. Potassium stearate is formed by Saponification of oil or fat. Formula will be $\text{CH}_3-(\text{CH}_2)_{16}-\text{COO}^-\text{K}^+$. In this equation (CH_3) is lyphobic end and COO^-K^+ is lyophilic end. So, Potassium stearate is example of what ?
 (A) Lyophilic colloid (B) Multimolecular colloid
 (C) Macromolecular colloid (D) Micelle
86. At constant/fixed condition and lower molar concentration which of the following surface active substances form micelle in its aqueous solution ?
 (A) $\text{CH}_3(\text{CH}_2)_{15}\text{N}^+(\text{CH}_3)_3\text{Br}^-$ (B) $\text{CH}_3(\text{CH}_2)_{11}\text{OSO}_3^-\text{Na}^+$
 (C) $\text{CH}_3(\text{CH}_2)_6\text{COO}^-\text{Na}^+$ (D) $\text{CH}_3(\text{CH}_2)_{11}\text{N}^+(\text{CH}_3)_3\text{Br}^-$

87. Consider following statement for micelle :

- (i) Drastically changing properties like molar conductivity, surface tension, osmotic pressure etc. at critical micelle concentration for surface active substance.
- (ii) Surface active substance cannot form micelle at lower temperature.
- (iii) Enthalpy will be negative for micelle of Aqueous solution.

Which of the above statement is true ?

- (A) (i) (B) (i) and (ii) (C) (i), (ii), and (iii) (D) (i) and (iii)

88. Which of the following method is used to remove grease with the help of soap?

- (A) Adsorption (B) Emulsification (C) Coagulation (D) Flocculation

89. Removal of oil by soap is which type of process ?

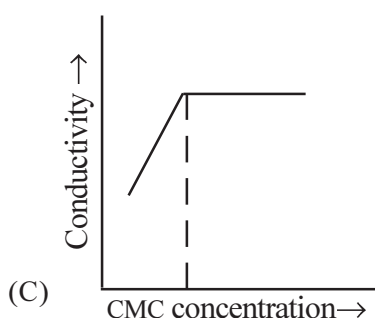
- (A) Adsorption (B) Emulsification (C) Coagulation (D) Flocculation

90. At what temperature micelle is possible ...

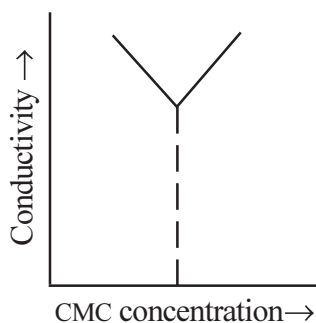
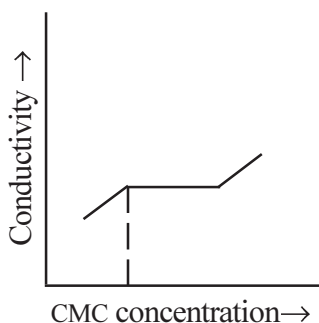
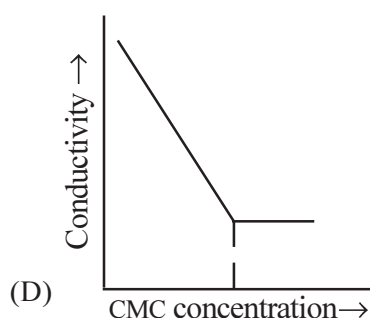
- (A) at inversion temperature. (B) at boil temperature.
(C) at critical temperature. (D) at kraft temperature.

91. Which of the following graph is true for critical micelle temperature ?

(A)



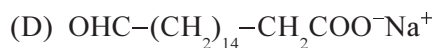
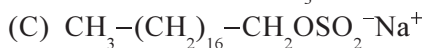
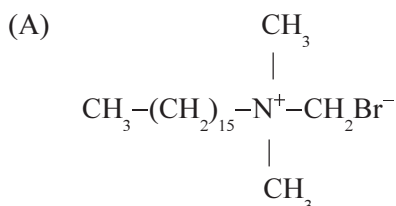
(B)



92. Which of the following example of multimolecular colloid ?

- (A) Dispersion of soap in water (B) Dispersion of protein in water
(C) Dispersion of gold in water (D) Dispersion of glue in water

93. Which of the following substance is not surface active substance ?



94. Sulphur sol is which type of colloid ?

(A) Multimolecular colloid

(B) Macro molecular colloid

(C) Associated colloid

(D) Micelle

95. During formation of micelle...

(A) $\Delta H = -Ve$, $\Delta S = -Ve$

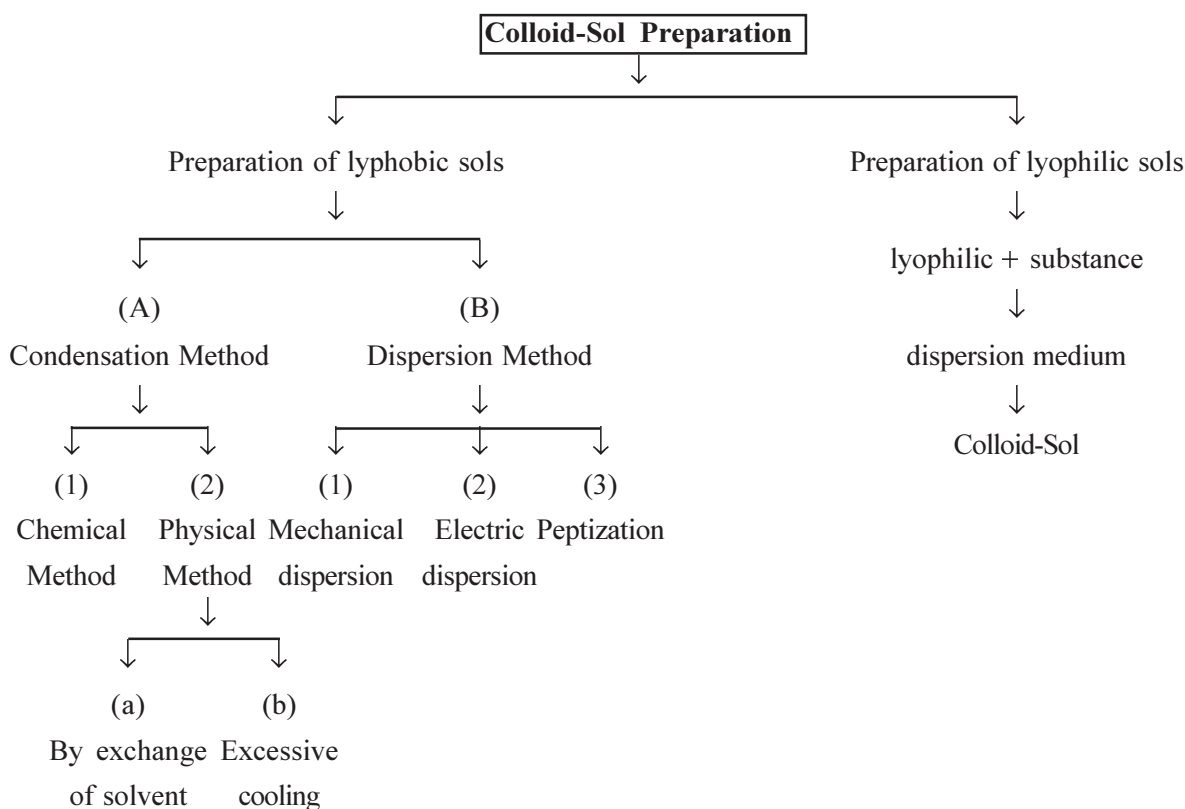
(B) $\Delta H = +Ve$, $\Delta S = -Ve$

(C) $\Delta H = +Ve$, $\Delta S = +Ve$

(D) $\Delta H = -Ve$, $\Delta S = +Ve$

Answers : 80. (B), 81. (A), 82. (C), 83. (D), 84. (B), 85. (D), 86. (A), 87. (B), 88. (B), 89. (D), 90. (D), 91. (B), 92. (C), 93. (B), 94. (A), 95. (C)

● Methods of preparing colloid-sol

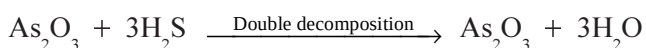


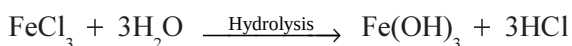
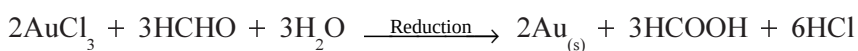
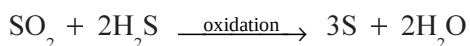
● Preparation of lyophobic sol

This type of sol can be prepared by two method :

(A) Condensation Method : In this type of method atoms or molecules are attracted towards each other to form a colloid. It contain main two types

(1) Chemical Method : Colloidal solutions can be prepared by chemical processes like double decomposition, oxidation-reduction or hydrolysis.





(2) Physical Methods :

(a) By exchange of solvent : When a true solution is mixed with other solvent in excess in which the dissolved solute is insoluble but the solvent is soluble a colloidal solution is formed. e.g. colloidal sol of sulphur is obtained when excess of water is added to the solution of Sulphur prepared in alcohol.

(b) Excessive cooling : Colloidal solution of ice in an organic solvent like ether, chloroform can be obtained by freezing the solution of water in that solvent. The molecules of water which can not remain separate in this solution tend to associate and form particles of colloidal size. Thus sol of water is obtained in the organic solvent.

(B) Dispersion Methods : “In this type of method to large size molecules are broken into small size particle in presence of dispersion medium.

(1) Mechanical dispersion : In this method particles of original suspension are made smaller in presence of dispersion medium by grinding with colloidal mill and are turned into colloidal state. Such mills are ball mills, ultrasonic disperser colloid mill.

(2) Bredig's Arc Method or Electrodispersion : This method is suitable for the preparation of colloidal solution of metals like Au, Ag, Pt, Cu etc.

This method involves both condensation and dispersion.

Electric spark is applied between the electrodes of the metal kept in dispersion medium. High degree of heat is produced due to the spark which evaporates the metal. Hence particles of the size of the colloids of the metals are obtained in the medium.

(3) Peptization : “The process of converting a freshly prepared precipitate into colloidal form by addition of a suitable electrolyte is called **peptization**.”

e.g., When aqueous solution of FeCl_3 is added to freshly prepared precipitates of $\text{Fe}(\text{OH})_3$ and the mixture is stirred, Fe^{3+} ions are adsorbed on the surface of $\text{Fe}(\text{OH})_3$ precipitates. Due to repulsion between like charged particles of precipitates. They are changed to the size of colloidal particles and sol is obtained. FeCl_3 acts as peptizing agent.

● Preparation of lyophilic Sol

“Lyophilic sols are quite stable and can be easily prepared by shaking or warming lyophilic substance with dispersion medium.” eg. Gelatin, gum, starch, egg albumin etc.

● Purification of colloidal Solution

(1) Dialysis : “By using semipermeable membrane like parchment or cellophane bag to remove ionic and other soluble impurities from sols is called **dialysis**”

Sol containing impurities is filled in a bag of semipermeable membrane. It is dipped in a trough filled with distilled water. Particles of electrolyte come out but the colloidal particles can not come out.

Distilled water may be purified. Distilled water is changed regularly to avoid accumulation of diffused out impurities. A **Siphon system** can be arranged so that continuous purification can be carried out.

If two electrodes are kept outside the bag and electric current is passed cation and anions of the electrodes will be attracted. Rapidly to the electrodes of opposite charges. This way impurity is removed very fast. Such dialysis is called **electrodialysis**.

In hospital kidney dialysis works on this phenomenon.

(2) **Ultra filtration** : Special type of filter paper known as ultrafilter is used for filtration.

(3) **Ultra Centrifugation** : Filtration is done by ultracentrifuge machine.

● **Important properties of colloidal Sol**

(1) **Colligative Properties** : As the average molecular mass of colloidal particles is very large its mole fraction is very low in the solution. Hence noticeable change is not observed in colligative properties. Only osmotic pressure method is used to determine the molecular mass of polymer molecules like colloids as the changes are measurable.

(2) **Optical Properties**

Tyndall effect : Tyndall observed that if a strong beam of light is passed through colloidal solution kept in a dark place, the path of the beam of light is illuminated. This phenomenon is called Tyndall effect.

True solutions do not show Tyndall effect because the particles are so small that they can not scatter the rays of light.

e.g., (1) when a beam of sunlight enters through a hole in dark room, the illuminated path of the light can be seen due to presence of dust particles like colloids. (2) At night when the head light of a vehicle is on, an illuminated path of light on the road can be seen.

(3) **Mechanical Properties**

Brownian movement : A British botanist named Robert Brown first observed that pollen grains of flowers when placed on water continuously and randomly move in zigzag direction. Later on this phenomenon was in case of colloidal particles. When observed under ultra microscope colloidal particles were also noticed moving continuously and randomly in zigzag direction. This movement is known as **Brownian movement** after the name of Robert Brown”

The following are the important results obtained from the phenomenon of Brownian motion :

(1) It provides a direct demonstration of continuous motion of the dispersion medium as postulated by kinetic theory.

(2) Brownian movement opposes gravitational force and that is why colloid particles never settle down in bottom that is why colloid particles get stability.

(4) **Electrical Properties : Electrophoresis** : Existence of positive or negative charge on colloids is displayed by the phenomenon of electrophoresis.

A colloidal particle possesses positive or negative electric charge.

Negatively charged Colloid solution of : Metals metal sulphides, arsenious sulphide, gold, silver platinum acidic dyes, clays etc.

Positively charged colloid solution of : Metal oxides hydroxides like $\text{Fe}(\text{OH})_3$, $\text{Al}(\text{OH})_3$, Zirconium hydroxide $\text{Zr}(\text{OH})_4$ basic dyes, haemoglobin etc.

Colloidal particles get attracted towards negative or positive electrode according to their charge.

● **Coagulation of Colloids**

‘The formation of association of colloidal particle by addition of an electrolyte to form an insoluble precipitate is called coagulation.’

Flocculation : “If concentration of electrolyte is less association of particle occurs but they do not get precipitated and they can go back to the colloidal form. This phenomenon is called **Flocculation**.”

● **Coagulation value or precipitation value of an electrolyte**

“The minimum amount of an electrolyte that must be added to one litre of colloidal solution so as to cause complete **coagulation** is called coagulation value or precipitation value.”

● **Hardy-Schulze rules**

(1) The effective ion for coagulation of sol is the one that possesses opposite electric charge compared to that on colloidal particles.

(2) The coagulation power of an electrolyte is in the fourth power of the valency of the coagulating ion.

The order of coagulating power of positively charged ions is

monovalent ion < bivalent ion < trivalent ion

Na^+ < Ba^{2+} < Fe^{3+}

Similarly the order of coagulating power of negatively charged ions is

monovalent ion < bivalent ion < trivalent ion

Cl^- < SO_4^{2-} < PO_4^{3-}

96. Digestion of fat in body is which type of process ?
 (A) Emulsification (B) Peptization (C) Flocculation (D) Brownian motion
97. The process of converting a freshly prepared. Precipitate into colloidal form by addition of suitable electrolyte is called
 (A) Coagulation (B) Flocculation (C) Tyndall effect (D) Brownian motion
98. Peptization process is...
 (A) conversion of colloid into precipitation.
 (B) conversion of precipitate into colloid.
 (C) formation of true solution by coagulated particle.
 (D) making true solution by dissolving precipitation.
99. Which one of the following is useful for coagulation of $\text{Fe}(\text{OH})_3$ colloid solution ?
 (A) Na_3PO_4 (B) Na_2SO_4 (C) KCl (D) K_2CO_3
100. Transfer of colloidal particle in colloidal solution is done by which of the following process ?
 (A) Brownian movement (B) Electro dialysis (C) Electrophoresis (D) Tyndall effect
101. Which of the following process is useful for making gold colloid ?
 (A) Oxidation (B) Reduction
 (C) Hydrolysis (D) Double-decomposition
102. Bredig's arc method is not useful for making which of the following colloidal solution ?
 (A) Gold (B) Silver (C) Iron (D) Pt
103. Which of the following colloid is made by both electronic dispersion and reduction process ?
 (A) Sulphur (B) $\text{Fe}(\text{OH})_3$ (C) Gold (D) As_2S_3
104. Placing a colloid sol under electric field then particle moving towards Anode. Study of coagulation of this colloid is done by NaCl , BaCl_2 and AlCl_3 solution then what is true order of coagulation strength ?
 (A) $\text{NaCl} > \text{BaCl}_2 > \text{AlCl}_3$ (B) $\text{BaCl}_2 > \text{AlCl}_3 > \text{NaCl}$
 (C) $\text{AlCl}_3 > \text{BaCl}_2 > \text{NaCl}$ (D) $\text{BaCl}_2 > \text{NaCl} > \text{AlCl}_3$
105. Which of the following has highest value of coagulation for $\text{Fe}(\text{OH})_3$ colloidal solution ?
 (A) NaCl (B) Na_2S (C) $(\text{NH}_4)_3\text{PO}_4$ (D) K_2SO_4

106. Addition of 0.73 gm of HCl into 200 ml positive charge colloid without changing its volume than what is coagulation value of HCl ?
 (A) 0.365 (B) 36.5 (C) 100 (D) 150
107. Coagulation value of AlCl_3 and NaCl is 0.093 and 52. What is coagulation tendency of AlCl_3 in comparison to NaCl ?
 (A) (52×0.093) times (B) $(52/0.093)$ times (C) $(0.093/52)$ times (D) $(52 - 0.093)$ times
108. Blue colour of sky is due to ?
 (A) Scattering of light by dust particle. (B) Scattering of Sun light.
 (C) Scattering of light by ozone layer. (D) Above all
109. Which of the following process is not useful in making colloidal sol ?
 (A) Electronic dispersion (B) Peptization
 (C) Coagulation (D) Mechanical dispersion
110. To precipitate 10 litre solution in 2 hour required 0.585 gm of NaCl, then what is coagulation value of NaCl ?
 (A) 0.585 (B) 0.0585 (C) 0.1 (D) 1.0
111. Tyndall effect will be maximum effective on ?
 (A) Hydrophilic sol (B) Hydrophobic sol (C) Starch sol (D) (B) and (C) Both
112. Hardy-Schulz rules prove that....,
 (A) the coagulation power of an electrolyte is in the fourth power of the valency of the coagulating ion.
 (B) gold number of solution should be zero.
 (C) dispersion medium and dispersion phase both contain same charge.
 (D) micelle will coagulate only in presence of surface active substance.
113. Which of the following factor is responsible for delta where river meets the sea ?
 (A) Emulsification (B) Preparation of colloid
 (C) Coagulation (D) Peptization
114. To stop the bleeding FeCl_3 is used because
 (A) Fe^{3+} ion coagulate negative charge in blood.
 (B) Fe^{3+} ion coagulate positive charge in blood.
 (C) Cl^- ion coagulate positive ion in blood.
 (D) Cl^- ion coagulate negative charge in blood.
115. Which of the following shows Tyndall effect ?
 (A) Soap solution at lower critical Micelle temperature.
 (B) Soap solution at high critical Micelle temperature.
 (C) Aqueous solution of NaCl .
 (D) Aqueous solution of $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.
116. Which of the following electrolyte's coagulation value is maximum for solution of $\frac{\text{AgI}}{\text{Ag}^+}$?
 (A) Na_2S (B) Na_3PO_4 (C) Na_2SO_4 (D) NaCl
117. How will you write KI in AgNO_3 solution ?
 (A) AgI I^- (B) AgI Ag^+ (C) AgI NO_3^- (D) $\text{NO}_3^- \text{AgI Ag}^+$

118. Particles of a colloidal solution moves towards cathode by attraction to cathode. What is the correct order of colloidal strength if we study those colloids by K_2SO_4 (I), Na_3PO_4 (II), $\text{K}_4[\text{Fe}(\text{CN})_6]$ (III) and NaCl (IV) ?

- (A) (I) > (II) > (III) > (IV) (B) (III) > (II) > (I) > (IV)
- (C) (III) > (I) > (II) > (IV) (D) (IV) > (III) > (I) > (II)

119. Which of the following is not included into coagulation ?

- (A) Coagulation of blood by FeCl_3 sol
(B) Formation of Delta
(C) Purification of water by potash alum
(D) Peptization

Answers : 96. (B), 97. (A), 98. (B), 99. (A), 100. (C), 101. (B), 102. (C), 103. (C), 104. (C), 105. (A), 106. (C), 107. (B), 108. (A), 109. (C), 110. (D), 111. (B), 112. (A), 113. (C), 114. (A), 115. (B), 116. (B), 117. (B), 118. (B), 119. (D)

● Protecting Colloid and Gold Number

Protecting Colloid : Lyophobic colloid like gold and silver metal can be prepared by adding lyophilic colloid like gelatin and albumin in it.

Added lyophilic colloid make a layer over lyophobic colloid and protecting it by electrolytes.

By adding lyophilic colloid into lyophobic colloid precipitation process stops that is called protection.

Colloid which stops the coagulation of sol that colloid is called **Protecting Colloid**.

Gold Number : Protective power of colloids is measured by **gold number**.

Gold number of some protective colloids are given below :

Colloid	gold number
Gelatin	0.005 – 0.01
casein	0.01 – 0.02
Haemoglobin	0.03 – 0.07
egg albumin	0.1 – 0.2
Gum orabic	0.15 – 0.25
starch	20 – 25
Dextrin	6 – 20

Value of gold number smaller, higher is value of protective power

So, gold number is in reciprocal of protective power.

120. Gold number is

- (A) to prevent coagulation of 10 ml $\text{Fe}(\text{OH})_3$ sol by adding 10% NaCl, that is called gold number.
- (B) to prevent coagulation of 10 ml gold sol by adding 10% NaCl solution, the required protective colloid's concentration is called gold number.
- (C) ammount of gold required in milligram for coagulation of lyophilic colloid is called gold number.
- (D) ammount of colloid required for coagulation of electrolyte is called gold number.

121. Gold number of protective colloid A,B, C and D is respectivity 0.50, 0.04, 0.10 and 0.005. then which of the following order of protective power of colloid is true ?

- (A) $C < B < D < A$ (B) $A < C < B < D$ (C) $B < D < A < C$ (D) $D < A < C < B$

122. 0.25 gm starch is required to prevent coagulation of 100 ml gold sol by 1 ml 10% NaCl solution. What is the gold number of starch ?

- (A) 25 (B) 250 (C) 2.5 (D) 0.25

123. Gold number of some protective colloids are given below :

Colloid sol.	Gold number
A	0.01
B	2.5
C	2.0

Which of the following is true for protective colloid.

- (A) $C > B > A$ (B) $A > B > C$ (C) $A = B = C$ (D) $B > A > C$

124. Gold number is related with which of the following ?

- (A) Colloid (B) Radio activity (C) gas equation (D) Kinetic energy

125. Gold number can measure...

- (A) protection of lyophilic colloid over lyophobic colloid.
- (B) protection of lyophobic colloid over lyophilic colloid.
- (C) miligrams of gold colloid in standard red gold sol.
- (D) stability of gold colloid sol

126. Gold number of gelatin, haemoglobin and sodium acetate is 0.005, 0.05 and 0.7 respectively then what will be the correct order of their protective power.

- (A) Gelatin < Heamoglobin < Sodium acetate (B) Gelatin > Heamoglobin > sodium acetate
(C) Heamoglobin > Gelatin > Sodium acetate (D) Sodium Acetate > gelatin > Heamoglobin

127. 0.25 gm starch is required to prevent coagulation of gold sol, then what is the gold number of starch ?

- (A) 0.025 (B) 0.25 (C) 2.55 (D) 250

128. Gold number of A, B, C and D is respectivity 0.04, 0.002, 10 and 25 which of the following order is true for protective power of A, B, C and D ?

- (A) $A > B > C > D$ (B) $B > A > C > D$ (C) $D > C > B > A$ (D) $C > A > B > D$

129. Gold number is related with which of the following ?

- (A) Only lyphobic colloid.
- (B) Only lyophilic colloid.
- (C) lyophilic and lyophobic colloid both.
- (D) None of above.

130. Which of the following is a very good colloid ?

- (A) Gelatin (gold no = 0.005) (B) Gum arabic (gold number = 0.15)
(C) Egg albumin (gold no. = 0.008) (D) None of above

131. Which of the following has least gold number ?

- (A) Gelatin (B) Starch (C) Albumin (D) Blood

Answers : 120. (B), 121. (B), 122. (A), 123. (B), 124. (A), 125. (A), 126. (B), 127. (D),
128. (B), 129. (B), 130. (A), 131. (A)

● Emulsion and their characteristics

Emulsion : Emulsions are colloids in which dispersion medium and dispersed phase both are in liquid form.

Emulsion can be classified into two types :

(1) **Oil in water emulsion :** In this type of emulsions oil acts as dispersed phase and water acts as dispersion medium. e.g. milk, vanishing cream, hair cream, most of the ointments.

(2) **Water in oil emulsion :** In this type of emulsions, water is the dispersed phase and oil acts as dispersion medium.

● Tests of emulsions

(1) **Dye test :** Certain dyes soluble in oil are added to emulsion. If the back ground becomes coloured it is water in oil type emulsion. If coloured droplets or small coloured particles are formed it is oil in water type emulsion.

(2) **Dilution Test :** If dilution of emulsion with water is possible, then it can be concluded, that dispersion medium is water and hence it is oil in water type emulsion. If water added forms a separate layer, it is water in oil type emulsion.

Emulsification : The method of preparing emulsion is called emulsification.

Emulsifying Agent : For stabilizing an emulsion, a third substance is added in small portion. It is called emulsifier or emulsifying Agent.

e.g., soaps, detergents, protein etc.

In presence of soluble soap oil in water type emulsion is favoured.

In presence of insoluble soap, water in oil type emulsion is favoured.

In presence of insoluble soap like emulsifier favour water in oil emulsion.

De-emulsification : Separation of an emulsion into its constituent liquid is called de-emulsification.
e.g., freezing, boiling, centrifugation and electrostatic precipitator.

Uses of colloids : Colloids and emulsions are extensively used in everyday life and industries. Some of them are as follows :

(1) Rubber plating (2) disposal (3) cottrell smoke precipitator (4) preparation of nano materials
(5) In medicines (6) Germicides (7) In metallurgy (8) Construction of roads.

132. Vanishing cream is which type of emulsion ?

- (A) oil/oil (B) water/water (C) oil/water (D) water/oil

133. Which of the following is emulsifying agent ?

- (A) Milk (B) Agar (C) Cream (D) Coodliver oil

134. Emulsifying agent is ...
 (A) to stabilize emulsion (B) to make emulsion homogeneous
 (C) to make coagulation (D) to inspire liquid to liquid dispersion
135. Butter is what type of colloid ?
 (A) Liquid in solid (B) Solid in Liquid (C) Liquid in Liquid (D) Liquid in gas
136. Cow milk is a natural emulsion. Which is stabilized by which of the following ?
 (A) fat (B) water (C) protein (D) Mg^{2+}
137. Which of the following is used for making water/oil emulsion ?
 (A) Protein (B) Gum (C) Insoluble soap (D) Soluble soap
138. Which of the following is used to preserve milk for long time ?
 (A) Formic acid solution (B) Formaldehyde solution
 (C) Acetic acid solution (D) Acetaldehyde solution
139. If gelatin is added to ice cream then precipitation occurs. So what is the role of gelatin in it ?
 (A) Coagulating agent (B) Precipitating agent (C) Emulsifying agent (D) Flocculating agent
140. By and we can divide Emulsion.
 (I) By heating it (II) Adding dispersion medium in more proportion
 (III) By cooling (IV) By adding emulsifier
 Which of the following will be correct?
 (A) (I) and (II) (B) (II) and (III) (C) (II) and (IV) (D) (I), (II) and (III)
141. Hair cream is an example of ?
 (A) Gel (B) Foam (C) Aerosol (D) Emulsion
142. Which of the following pair is appropriate ?
 (A) Emulsion - Smoke (B) Gel - Butter (C) Aerosol - Hair cream (D) Foam - Fog
143. Which of the following used as emulsifying agent ?
 (A) Soap (B) Detergent (C) Lyophilic sol (D) Above all
144. Which of the following is oil/water emulsion ?
 (A) Milk (B) Vanishing cream (C) Butter (D) Codliver oil
145. Which of the following is not an emulsion ?
 (A) Butter (B) ice cream (C) Milk (D) Cloud
146. Whipped cream is example of ?

	dispersion medium	dispersion phase
(A)	Gas	Liquid
(B)	Liquid	Gas
(C)	Liquid	Liquid
(D)	Liquid	Solid

147. Which of the following is uses of colloid ?
 (A) Making of nano compound (B) Rubber plating
 (C) Sewage system (D) All above
148. Which of the following is respectively example of dispersion medium and dispersion phase in soap ?
 (A) Gas and liquid (B) Liquid and gas (C) Gas and solid (D) Solid and liquid

Answers : 132. (C), 133. (B), 134. (A), 135. (C), 136. (B), 137. (C), 138. (B), 139. (C), 140. (C), 141. (D), 142. (B), 143. (D), 144. (A), 145. (D), 146. (B), 147. (D), 148. (A)

- The questions given below consist of an 'Assertion' (A) and the 'Reason' (R). Use the following keys to choose the appropriate answer :

(A) If both (A) and (R) are correct and (R) is the correct explanation of (A).

(B) If both (A) and (R) are correct R is not the correct explanation of (A).

(C) If (A) is correct but (R) is incorrect.

(D) If (A) is incorrect but (R) is correct.

149. **Assertion (A)** : According to Freundlich adsorption isotherm, $\frac{x}{m} = K P^{\frac{1}{n}}$

Reason (R) : Isotherm shows that proportion of adsorbed gas on adsorbent is depends upon temperature.

150. **Assertion (A)** : Coagulation tendency of Al^{3+} is more than that of Na^+

Reason (R) : Charge on ion is more, more is its coagulation tendency.

151. **Assertion (A)** : ZSM-5 is used as catalyst in petrochemical.

Reason (R) : Zeolite is three dimensional silicate in which Al atoms substitute Si atoms.

152. **Assertion (A)** : Soap is used for preparation of stable emulsion.

Reason (R) : Soap decreases interfacial tension between oil and water.

153. **Assertion (A)** : $-COO-$ group is on surface of water in micelle of sodium stearate.

Reason (R) : Surface tension decreases by adding stearate in water.

154. **Assertion (A)** : Conversion of fresh precipitate into colloid is called peptization.

Reason (R) : It is possible by gathering same ions.

155. **Assertion (A)** : Aqueous solution of gold is of red colour.

Reason (R) : Colour of gold is due to light scattering.

156. **Assertion (A)** : for coagulation of As_2S_3 , Fe^{3+} ion is used.

Reason (R) : Fe^{3+} gives Fe_2S_3 by reacting with As_2S_3 .

157. **Assertion (A)** : Lyophilic colloid is reversible sol.

Reason (R) : Lyophilic sol is hydrophilic.

158. **Assertion (A)** : Colloid particle shows Brownian movement.

Reason (R) : Brownian movement are produced because of collision between colloid particle and particle in dispersion medium.

159. **Assertion (A)** : NH_3 is more adsorbed on charcoal than CO_2 .

Reason (R) : NH_3 is polar.

160. **Assertion (A)** : Physical adsorption is not possible on surface.

Reason (R) : In this process bonds of adsorbed molecules are broken.

161. Assertion (A) : Specific catalyst is for specific reaction, so use of any catalyst is useless.

Reason (R) : Rate of reaction of enzyme catalyst is more between 5 to 7 pH.

162. Assertion (A) : Coagulation of As_2S_3 is very fast with BaCl_2 instead of 0.1 M NaCl .

Reason (R) : BaCl_2 produces double Cl^- ion then NaCl .

163. Assertion (A) : Micelle of sodium stearate in water is due to COO^- group on surface.

Reason (R) : By adding sodium stearate surface tension of water decreases.

164. Assertion (A) : For coagulation positive colloid sol PO_4^{3-} is very useful than SO_4^{2-} and Cl^- .

Reason (R) : It follows Hardy and Schulze rule.

165. Assertion (A) : Viscosity of liquid decreases by increasing temperature.

Reason (R) : Evaporation increases by increasing temperature.

Answers : 149. (C), 150. (A), 151. (B), 152. (A), 153. (A), 154. (B), 155. (A), 156. (B), 157. (B), 158. (A), 159. (C), 160. (C), 161. (C), 162. (B), 163. (A), 164. (A), 165. (B)

● **Match the following :**

166. Match column - I with column-II by selecting correct options :

Column-I	Column-II
(1) Smoke	(p) Foam
(2) Butter	(q) Emulsion
(3) Hair cream	(r) Aerosol
(4) Whipped cream	(s) Jelly

(A) (1)-(r), (2)-(s), (3)-(q), (4)-(p)

(B) (1)-(r), (2)-(q), (3)-(s), (4)-(p)

(C) (1)-(p), (2)-(s), (3)-(q), (4)-(r)

(D) (1)-(s), (2)-(p), (3)-(r), (4)-(q)

167. Match column - I with column-II by selecting correct options :

Column-I	Column-II
(a) Stirring egg white in water	(p) Multimolecular colloid
(b) Mercury vapour passing through cold water	(q) Macromolecular colloid
(c) Stirring cellulose nitrate with water	(r) Associated colloid
(d) Dissolving detergent in water	(s) colloid

(A) (a)-(p), (b)-(q), (c)-(r), (d)-(s)

(B) (a)-(r), (b)-(p), (c)-(s), (d)-(q)

(C) (a)-(s), (b)-(p), (c)-(r), (d)-(q)

(D) (a)-(q), (b)-(p), (c)-(s), (d)-(r)

168. Select proper catalyst for proper reactant and product :

Column-I	Column-II
(1) Methanol + CO $\rightarrow$ Acetic acid	(a) $[\text{Rh}(\text{CO})_2\text{I}_2]$
(2) Propylene + $\text{NH}_3 + \text{O}_2 \rightarrow$ Acrylonitrile	(b) Bismuth molybdenum
(3) Ethylene $\rightarrow$ High density polyethene	(c) Organochromium and Titanium
(4) Preparation of H_2SO_4 by lead chamber process	(d) No gas

(A) (1)-(a), (2)-(b), (3)-(c), (4)-(d)

(B) (1)-(d), (2)-(c), (3)-(b), (4)-(a)

(C) (1)-(a), (2)-(b), (3)-(c), (4)-(d)

(D) (1)-(b), (2)-(c), (3)-(d), (4)-(a)

169. Match column - I with column-II by selecting correct options :

Column-I	Column-II
(1) On handle of kitchenware and other things deposition of colloid.	(p) Cottrell smoke precipitator
(2) Dispersion of negative ion of carbon colloid particle	(q) rubber plating
(3) Reversible micelle as catalyst	(r) sewage system
(4) Removal of charge colloid particle of dirt with the help of electrodes	(s) preparation in nano substance.

(A) (1)-(p), (2)-(q), (3)-(r), (4)-(s)

(B) (1)-(q), (2)-(p), (3)-(s), (4)-(r)

(C) (1)-(s), (2)-(r), (3)-(q), (4)-(p)

(D) (1)-(r), (2)-(s), (3)-(p), (4)-(q)

170. Match column - I with column-II by selecting correct options :

Column-I	Column-II
(1) for separation of ideal gases in Dewar's process	(a) Activated charcoal
(2) for adsorption of moisture from electronic devices	(b) Silica gel
(3) for concentration of sulphide ore	(c) Turpentine or pine oil
(4) titration of AgNO_3 with Halide	(d) Fluorescent indicator

(A) (1)-(c), (2)-(d), (3)-(b), (4)-(a)

(B) (1)-(d), (2)-(a), (3)-(c), (4)-(b)

(C) (1)-(a), (2)-(b), (3)-(c), (4)-(d)

(D) (1)-(b), (2)-(c), (3)-(d), (4)-(a)

171. Select proper catalyst for proper reaction by matching Column-I and Column-II.

Column-I	Column-II
(1) $4\text{NH}_{3(g)} + 5\text{O}_{2(g)} \rightarrow 4\text{NO}_{(g)} + 6\text{H}_2\text{O}_{(g)}$ $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$ $4\text{NO}_{2(g)} + 2\text{H}_2\text{O}_{(l)} + \text{O}_{2(g)} \rightarrow 4\text{HNO}_{3(aq)}$	(a) Platinized asbestos.
(2) $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{SO}_{3(g)}$ $\text{SO}_{3(g)} + \text{H}_2\text{SO}_{4(l)} \rightarrow \text{H}_2\text{S}_2\text{O}_7(l)$ $\text{H}_2\text{S}_2\text{O}_7(l) + \text{H}_2\text{O}_{(l)} \rightarrow 2\text{H}_2\text{SO}_{4(aq)}$	(b) V_2O_5
(3) $\text{CO}_{(g)} + 2\text{H}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(l)}$	(c) $[\text{Cu} / \text{ZnO} - \text{Cr}_2\text{O}_3]$
(4) $2\text{HI}_{(s)} \rightarrow \text{H}_{2(g)} + \text{I}_{2(g)}$	(d) $\text{Au}_{(s)}$ (Solid gold)

(A) (1)-(a), (2)-(b), (3)-(c), (4)-(d)

(B) (1)-(b), (2)-(c), (3)-(d), (4)-(a)

(C) (1)-(c), (2)-(d), (3)-(a), (4)-(b)

(D) (1)-(d), (2)-(a), (3)-(b), (4)-(c)

Answers : 166. (A), 167. (D), 168. (A), 169. (B), 170. (C), 171. (A)

● Questions based on passage

Passage 1

At constant temperature adsorption of different gases on one adsorbent is different. Factors affecting on adsorption like nature of adsorbed gas and nature of adsorbent is depends upon critical temperature of gas or Van der waal's force 'a'. But adsorption may be physical phenomenon or chemical phenomenon. Concentration of solution depends upon amount of substance like adsorption value of gas depends upon pressure of adsorbed gas. Study of this topic is done by Freundlich and Langmuir. Mathematical equation given by them one known as Freundlich adsorption isotherm and Langmuir adsorption isotherm which is as follows :

(1) Freundlich adsorption isotherm

$$\frac{x}{m} = KP^{\frac{1}{n}}$$

(2) Langmuir adsorption isotherm

$$\frac{x}{m} = \frac{ap}{1+bp} \quad \text{where, } \frac{x}{m} = \text{ammount of adsorption, } p = \text{pressure of gas}$$

a and b are constant, m = weight of adsorbent,

172. Which of the following statement is true ?
 (A) Critical temperature low, Adsorption will be high.
 (B) Critical temperature high. Adsorption will be high.
 (C) For gas value of Van-der waal's force 'a' is low, adsorption will be low.
 (D) Adsorption is not possible at more than critical temperature.
173. Which of the following value will be zero during adsorption ?
 (A) ΔG (B) ΔS (C) ΔH (D) all of above
174. Which of the following statement is true ?
 (A) Physical adsorption is unimolecular while chemical adsorption is multi-molecular.
 (B) Physical adsorption is multi molecular while chemical adsorption is uni-molecular.
 (C) Both physical and chemical adsorption are uni molecular.
 (D) Both physical and chemical adsorption are multimolecular.
175. Graph of $\frac{m}{x} \rightarrow \frac{1}{p}$ will be linear. What is the value of slope and inter cept ?
 (A) $\frac{a}{b}, \frac{1}{a}$ (B) $\frac{1}{a}, \frac{b}{a}$ (C) $\frac{1}{b}, \frac{b}{a}$ (D) $\frac{1}{b}, \frac{a}{b}$

Passage 2

A colloidal particle possesses positive or negative electric charge. The polarity of the sol not only depends on the dispersing phase but also on dispersion medium which has equal but opposite charge. Hence, colloidal system is neutral. Colloidal particles possessing similar electric charge experience repulsion. Hence they are not able to form large molecule by combination. So the sol remains stable and the colloid particles according to their electric charge are attracted towards positive or negative electrode under the effect of electric field this phenomenon is called electrophoresis. But for the stability of the colloids presence of electrolyte in small proportion is essential if the concentration of electrolyte is increased, then the colloid particles in the solution attract the ions of opposite electric charge and become neutral. Neutral particles combine with each other and start forming association and become larger in size. As a result they get precipitated and separate from colloidal solution. The formation of association of colloid particles by addition of electrolyte to form an insoluble precipitate is called coagulation. The coagulation values of different electrolytes are different. Scientists Hardy and Schulze studied the behaviour of different electrolytes, the two laws that they have given are as follows :

(1) The effective ion for the coagulation of sol is that which possesses opposite electric charge compared to electric charge of colloidal particles.

(2) The coagulating power of the electrolytes is in the fourth power of the valency of the coagulating ions.

Similarly, precipitation due to common ion, due to electrophoresis, heating or cooling or dialysis coagulation does not occur.

176. Which of the following process is useful to decide charge of positive and negative of colloidal particle ?
 (A) Electrodialysis (B) Electrophoresis
 (C) Bredig's Arc Method (D) Electric adsorption
177. Coagulation value of As_2S_3 colloidal sol is respectively 53 and 0.093 millimol litre so,
 (A) coagulation tendency of $AlCl_3$ is 51 times more than $NaCl$.
 (B) coagulation tendency of $NaCl$ is 548 times more than $AlCl_3$.
 (C) coagulation tendency of $AlCl_3$ is 548 times more than $NaCl$.
 (D) ratio of coagulation tendency of $AlCl_3 : NaCl$, is 51 : 0.093.

178. Which of the following electrolyte is very effective for colloid sol of $[\text{Fe}(\text{OH})_3]$?

- (A) $\text{K}_3[\text{Fe}(\text{CN})_6]$ (B) $\text{Na}_2\text{C}_2\text{O}_4$ (C) K_2SO_4 (D) KCl

179. Stability of Colloidal sol depends on

- (A) size of colloidal particle
(B) charge of colloidal particle
(C) motion of colloidal particle under electric field
(D) tendency to show Tyndall effect.

180. Which of the following electrolyte is more effective for As_2S_3 colloid sol ?

- (A) AlCl_3 (B) MgSO_4 (C) $\text{K}_3[\text{Fe}(\text{CN})_6]$ (D) KCl

passage : 3

According to scientist Boradly Colloidal particles are classified into three types. Multimolecular, macromolecular and associated colloids. They are lyophilic or lyophobic colloids. Lyophilic colloid sol can be obtained directly while Lyophobic sol can be obtained by dispersion like method. The formation of association of colloid particles by addition of electrolyte to undergo coagulation. Generally lyophobic colloid is less stable; but protective tendency of lyophilic colloid is indicated by gold number.

181. Which of the following is not a macro molecular colloid ?

- (A) Protein in water (B) Rubber in benzene (C) Starch in water (D) Soap solution

182. What is range of critical micelle concentration of soap ?

- (A) $10^{-5} - 10^{-4}\text{M}$ (B) $10^{-4} - 10^{-3}\text{M}$ (C) $10^{-3} - 10^{-2}\text{M}$ (D) $10^{-2} - 10^{-1}\text{M}$

183. What is charge of colloidal particle of starch sol ?

- (A) Positive charge (B) Negative charge
(C) Neutral (D) Positive or negative charge

184. When SnO_2 is stirred with little NaOH sol sodium stannet sol is obtained, then which of the following will be effective for its coagulation ?

- (A) Na_3PO_4 (B) AlCl_3 (C) $\text{K}_3[\text{Fe}(\text{CN})_6]$ (D) HCl

185. 0.1 gram starch of potato is needed for preventing 50 ml gold colloid sol from coagulation then what is gold number of potato starch ?

- (A) 5 (B) 10 (C) 20 (D) 25

Answers : 172. (B), 173. (D), 174. (B), 175. (B), 176. (B), 177. (C), 178. (A), 179. (B), 180. (D), 181. (D), 182. (B), 183. (B), 184. (B), 185. (C)

● Questions based on true and false statements :

- 186.** (I) Cleaning by soap results into preparation of associated colloid.
 (II) To stabilize emulsion a compound is added such a compound is called emulsifier.
 (III) FeCl_3 is used in laboratory to coagulate blood from body because Fe^{3+} coagulates negative charge blood.
 (IV) By adding two-three drops of HCl into freshly prepared $\text{Fe}(\text{OH})_3$ solution, solution turns red such process is called peptization.
 (A) FFTT (B) TTTT (C) FFFF (D) TFTF
- 187.** (I) In Freundlich adsorption isotherm graph of $\log \frac{x}{m} \rightarrow \log p$ gives a straight line
 (II) Silica gel is used to generate high vacuum
 (III) Catalyst decreases activation energy means decrease gap of status energy that is why rate of reaction increases.
 (IV) Invertase enzyme is used for conversion of glucose into ethanol and CO_2 gas.
 (A) FTFT (B) TTFF (C) TFTF (D) FFTT
- 188.** (I) 298-310 K temperature is best for enzyme catalyst.
 (II) Foam rubber is solid sol colloid.
 (III) Sulfur colloid can be made up by hydrolysis.
 (IV) insoluble soap forms water in oil emulsion.
 (A) TTFF (B) FFTT (C) FFFF (D) TTTT
- 189.** (I) For dialysis going on adding pure water in the container and removing impure water is called syphen system.
 (II) Physical adsorption occurs at low temperature, on increasing temperature adsorption decreases.
 (III) Chemical adsorption enthalpy value, is between 20 to 40 KJ mole^{-1} and it is negative.
 (IV) Butter is oil in water type emulsion.
 (A) FTFT (B) FFTT (C) TFTF (D) TTFF
- 190.** (I) Because of Tyndall effect colloid particles resist against gravitational force
 (II) Colloidal solution of $(\text{Zr}(\text{OH})_3)$ is negative charge.
 (III) Metals and their sulphide can be mixed with dispersion medium and form lyophobic colloid.
 (IV) Reaction can be done in specific way then specific product can be formed that is called selectivity.
 (A) FFTT (B) TFTF (C) TTFF (D) FTFT

Answers : 186. (B), 187. (C), 188. (A), 189. (D), 190. (A)

● **More than one answer :**

191. Match column-I with column-II by selecting correct options :

Column-I	Column-II
(A) Whipped cream	(p) Emulsion
(B) Medicines	(q) Sol
(C) Cell fluids	(r) Colloid in which gas is in dispersion phase
(C) Foam	(s) Colloid in which liquid is in dispersion phase

- (A) (A)-(s), (B)-(p)(s), (C)-(q)(s), (D)-(r) (B) (A)-(r)(p), (B)-(q), (C)-(p)(s), (D)-(r)
 (C) (A)-(s), (B)-(s)(r), (C)-(q), (D)-(s) (D) (A)-(p), (B)-(q)(r), (C)-(p)(q), (D)-(s)

192. Match column-I with column-II by selecting correct options :

Column-I	Column-II
(A) Lyophobic colloid	(p) fat dispersed in water
(B) Lyophilic colloid	(q) at lower concentration act as electrolyte and high concentration act as colloid particle.
(C) Micelle	(r) electrolyte
(D) Emulsion	(s) Tyndall effect

- (A) (A)-(p), (B)-(q), (C)-(r) (D)-(r)(s) (B) (A)-(r)(s), (B)-(r), (C)-(q), (D)-(p)
 (C) (A)-(s)(p), (B)-(p), (C)-(q), (D)-(p)(q) (D) (A)-(q)(r), (B)-(p)(s), (C)-(B), (D)-(p)

193.

Column-I	Column-II
(A) Salicylic acid	(p) Produced negative charged colloid sol
(B) As_2S_3	(q) Macromolecular colloid
(C) Glue	(r) Prepare lyophobic colloid sol
(D) Gold	(s) Non-elastic gel

- (A) (A)-(r)(s), (B)-(q)(r), (C)-(p)(s), (D)-(q)(r)
 (B) (A)-(q)(r), (B)-(p)(s), (C)-(r), (D)-(p)(q)
 (C) (A)-(s)(r), (B)-(p)(q), (C)-(q)(r), (D)-(p)(s)
 (D) (A)-(p)(s), (B)-(p)(r), (C)-(p)(q), (D)-(p)(r)

194.	Column-I	Column-II
(A)	Lead chamber process for production of H_2SO_4	(p) solid catalyst
(B)	Decomposition of (H_3PO_4) in negative catalyst presence of H_2O_2	(q) negative catalyst
(C)	Catalytic hydrolysis of ester	(r) homogeneous catalyst
(D)	Bosch process in production of H_2 (Bosch Process)	(s) heterogeneous catalyst (t) auto Catalysis

(A) (A)-(p)(r), (B)-(q)(r), (C)-(r)(t), (D)-(p)(s)

(B) (A)-(q)(s), (B)-(p)(s), (C)-(s)(r), (D)-(p)(r)

(C) (A)-(r)(t), (B)-(p)(s), (C)-(r)(s), (D)-(s)(t)

(D) (A)-(p)(s), (B)-(r)(t), (C)-(q)(r), (D)-(p)(r)

195.	Column-I	Column-II
(A)	Lyophilic colloid	(p) light scattering
(B)	Lyophobic colloid	(q) naturally irreversible
(C)	Macromolecule colloid	(r) act as a protective colloid
(D)	Associated colloid	(s) act as a Emulcifying Agent

(A) (A)-(p)(r), (B)-(p)(q), (C)-(p)(r)(s), (D)-(p)(s)

(B) (A)-(q)(p), (B)-(p)(r), (C)-(q)(p)(s), (D)-(q)(r)

(C) (A)-(p)(s), (B)-(r)(s), (C)-(p)(s)(r), (D)-(q)(p)

(D) (A)-(s)(r), (B)-(p), (C)-(p)(s), (D)-(q)(p)(r)

Answers : 191. (A), 192. (B), 193. (D), 194. (A), 195. (A)

- **Question according to integer (0 to 9). Answers of following questions are between 0 to 9 number. By deciding answers give it proper method like answers of questions 1 to 4 are 4, 0, 9 and 2.**

196. 2 milligram glue is added to 100 ml red gold sol before 10 ml. 10% NaCl to prevent from coagulation then what is protective tendency ?

197. How many negative charged colloid sol in following example ?

gold sol, $\text{Fe}(\text{OH})_3$ sol, $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ sol, As_2S_3 sol, Starch colloid sol, salisilic sol, congoRed sol, Persian blue sol, Hemoglobin

198. 0.525 gram charcoal added in 1 M $\text{H}_2\text{C}_2\text{O}_4$ and stired well. So after adsorption concentration of solution is 0.5 M. So how many, kilogram Oxalic acid is adsorbed per gram of charcoal.?

199. How many of them are Aerosols from the following ?

Paints, Milk, Smoke, Dust, Foam rubber, Cheese, Fog, Clouds, Insecticides, Sprays, Mist.

200. 0.16 M electrolyte required for coagulation of 100 mili colloid sol than what is flocculation value for electrolyte ?

201. In one experiment of adsorption graph of $\left(\frac{x}{m}\right) \log p$ will be straight line, and slope will be 45° and then value of intercept will be 0.3010, than how much gram gas be adsorbed at 2 atmosphere pressure ?

202. Density of silver is 10.5 gram/cm^3 . Number of silver molecule on 10^{-12} m^{-2} surface is $y \times 10^x$. Then what is value of x ?

203. How many of them are emulsions from the following ?

cold cream, butter, codliver oil, hair cream, milk, protein, glue, agar, gelatin, rubber, soap foam, cataclysm, pyumic stone.

Answers : 196. (5), 197. (5), 198. (6), 199. (6), 200. (8), 201. (4), 202. (7), 203. (6).
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