Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Adsorption

A-1. Why adsorption is always exothermic ?

A-2. What is the difference between physical adsorption and chemisorption ?

A-3. What are the factors which influence the adsorption of a gas on a solid ?

A-4. What is an adsorption isotherm ?

A-5. What do you understand by activation of adsorbent ? How is it achieved ?

A-6. Which will be adsorbed more readily on the surface of charcoal and why– NH_3 or CO_2 ?

A-7. In an Adsorption experiment a graph between log x/m versus log P was found to be linear with a slope of 45º the intercept of the log x/m was found to be 0.3010. Calculate the amount of gas adsorbed per gram of charcoal under a pressure of 0.6 bar.

A-8. 1 gm of charcoal adsorbs 100 mL of 0.5 M CH_3COOH to form mono layer and there by the molarity of CH_3COOH reduces to 0.49 M. Calculate the surface area of the charcoal adsorbed by each molecule of CH_3COOH. Surface area of charcoal = 3.01×10^2 m^2/g.

A-9. What role does adsorption play in heterogeneous catalysis ?

A-10. How many grams of gas would be adsorbed per gram of a substance at 8 atm by assuming Freundlich adsorption isotherm.

$$\frac{x}{m} = kp^{1/n} \quad \text{and} \quad k = 10^{-2}\ atm^{-1/3} \quad \& \quad n = 3.$$

A-11. 10 mg of an adsorbate gets adsorbed on a surface. This causes the release of 3J of heat at constant pressure and at 27ºC. [Molar mass of adsorbate = 100 g/mol].
(i) Find $\Delta H_{adsorption}$.
(ii) Argue whether the adsorption is physical or chemical ?
(iii) If 20 mg of adsorbate is adsorbed at temperature T_0. Then compare T_0 and 27ºC :

Section (B) : Catalysis

B-1. Give two examples of heterogeneous catalysis.

B-2. Identify the correct order of steps in hetereogeneous catalysis.
(i) Adsorption of reactant molecules on the surface of the catalyst.
(ii) Diffusion of reactant to the surface of the catalyst.
(iii) Formation of reactions product on the catalyst surface.
(iv) Diffusion of reactions product from the catalyst surface or desorption.
(v) Formation of activated intermediate.

Section (C) : Classification and Preparation of Colloid

C-1. How are the colloidal solutions classified, on the basis of physical states of the dispersed phase and dispersion medium ?

C-2. Explain the following terms with suitable examples.
(a) Gel (b) Liquid Aerosol (c) Hydrosol

C-3. How are associated colloids different from multimolecular and macromolecular colloids ?

C-4. Give one example of multimolecular and macromolecular colloids.

C-5. Describe a method each for the preparation of sols of sulphur and platinum in water

Section (D) : Purification and Properties of Colloid

D-1. Explain the following terms :
(a) Peptization (b) Electrophoresis (c) Dialysis (d) Brownian movement

D-2. Why the sun looks red at the time of setting ?

D-3. Why is osmotic pressure of a colloidal solution less than that of true solution ?

Section (E) : Coagulation, Protection And application of colloid

E-1. Which one of the following electrolytes is most effective for the coagulation of $Fe(OH)_3$ sol and why ? NaCl, Na_2SO_4, Na_3PO_4.

E-2. What do you understand by "isoelectric point" of a colloid ?

E-3. Rivers form delta on meeting with ocean, why ?

E-4. Artificial rain is made by spraying salt over clouds, why ?

Section (F) : Emulsion and Gel

F-1. Name two demulsifier.

F-2. What is the difference between sols and emulsions.

F-3. What is demulsification ?

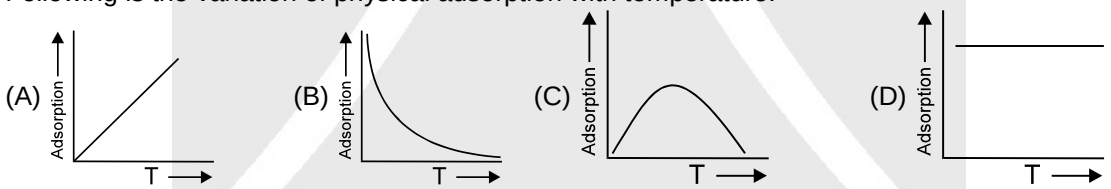
F-4. What is phase inversion in emulsion ?

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Adsorption

A-1. Which of the following statements about chemisorption is not applicable?
(A) It involves chemical forces between adsorbent and absorbate
(B) It is irreversible in nature
(C) It involves high heat of adsorption
(D) It does not require activation energy

A-2. Following is the variation of physical adsorption with temperature:



A-3. Adsorption is the phenomenon in which a substance:
(A) accumulates on the surface of the other substance
(B) goes into the body of the other substances
(C) remains close to the other substance
(D) none of these

A-4. Finely divided catalyst has greater surface area and has greater catalytic activity than the compact solid. If a total surface area of 6291456 cm^2 is required for adsorption in a catalysed gaseous reaction, then how many splits should be made to a cube of exactly 1 cm in length to achieve required surface area. (Given : One split of a cube gives eight cubes of same size)
(A) 60 (B) 80 (C) 20 (D) 22

A-5. Volume of N_2 at NTP required to form a mono layer on the surface of iron catalyst is 8.15 ml/gram of the adsorbent. What will be the surface area of the adsorbent per gram if each nitrogen molecule occupies 16×10^{-22} m^2.
(A) 16×10^{-16} cm^2 (B) 0.35 m^2/g (C) 39 m^2/g (D) 22400 cm^2

A-6. There is desorption of physical adsorption when :
(A) temperature is increased (B) temperature is decreased
(C) pressure is increased (D) concentration is increased

A-7. The rate of chemisorption :
(A) decreases with increase of pressure (B) increases with increase of pressure
(C) is independent of pressure (D) is independent of temperature

A-8. Softening of hard water is done using sodium aluminium silicate (zeolite). This causes :
(A) adsorption of Ca^{2+} and Mg^{2+} ions of hard water replacing Na^{+} ions.
(B) adsorption of Ca^{2+} and Mg^{2+} ions of hard water replacing Al^{3+} ions
(C) both (A) and (B)
(D) none of these

Section (B) : Catalysis

B-1. Which one is false in the following statement ?
(A) A catalyst is specific in its action
(B) A very small amount of the catalyst can alter the rate of a reaction.
(C) The number of free valencies on the surface of the catalyst increases on sub-division
(D) Ni is used as a catalyst in the manufacture of ammonia

B-2. A catalyst increases rate of reaction by :
(A) Decreasing enthalpy (B) Decreasing internal energy
(C) Decreasing activation energy (D) Increasing activation energy

Section (C) : Classification and Preparation of Colloid

C-1. Colloidal solution of gold prepared by different methods of different colours because of :
(A) different diameters of colloidal gold particles
(B) variable valency of gold
(C) different concentration of gold particles
(D) impurities produced by different methods

C-2. At CMC, the surfactant molecules :
(A) Decomposes (B) Become completely soluble
(C) Associate (D) Dissociate

Section (D) : Purification and Properties of Colloid

D-1. A colloidal solution can be purified by the following method :
(A) dialysis (B) peptization (C) filtration (D) oxidation

D-2. Peptisation is :
(A) conversion of a colloidal into precipitate form
(B) conversion of precipitate into colloidal sol
(C) conversion of metal into colloidal sol by passage of electric current
(D) conversion of colloidal sol into macromolecules

D-3. Bleeding is stopped by the application of ferric chloride. This is because :
(A) the blood starts flowing in opposite direction
(B) the blood reacts and forms a solid, which seals the blood vessel
(C) the blood is coagulated and thus the blood vessel is sealed
(D) the ferric chloride seals the blood vessel.

Section (E) : Coagulation, Protection And application of colloid

E-1. Gold number of a lyophilic sol is such property that:
(A) the larger its value, the greater is the peptising power
(B) the lower its value, the greater is the peptising power
(C) the lower its value, the greater is the protecting power
(D) the larger its value, the greater is the protecting power

E-2. Protective sols are :
(A) lyophilic (B) lyophobic (C) both (A) and (B) (D) none of (A) and (B)

E-3. For the coagulation of 200 mL of As_2S_3 solution, 10 mL of 1 M NaCl is required. What is the coagulating value (number of milli moles of solute needed for coagulation of 1 liter of solution) of NaCl.
(A) 200 (B) 100 (C) 50 (D) 25

E-4. Which of the following ions is most effective in the coagulation of an arsenious sulphide solution ?
(A) K^+ (B) Mg^{2+} (C) Al^{3+} (D) C

E-5. Which of the following ions is most effective in the coagulation of ferric hydroxide solution ?
(A) Cl^- (B) Br^- (C) NO_2^- (D) SO_4^{2-}

Section (F) : Emulsion and Gel

F-1. Small liquid droplets dispersd in another liquid is called :
(A) Suspension (B) Emulsion (C) Gel (D) True solution

PART - III : MATCH THE COLUMN

1. Match list I with list II and select the correct answer :

	List-I		List-II
(P)	Mechanical property of colloid	(1)	Dialysis
(Q)	Purification	(2)	Peptization
(R)	Gold number	(3)	Brownian movement
(S)	Formation of a sol	(4)	Protection

Code:

	P	Q	R	S		P	Q	R	S
(A)	3	4	1	2	(B)	1	2	4	3
(C)	3	1	4	2	(D)	2	3	1	4

2. Match list I with list II and give the correct answer :

	List-I		List-II
(A)	Gold sol	(p)	Bredig's Arc method
(B)	Purification of colloidal solution	(q)	Negatively charged
(C)	As_2S_3 sol	(r)	Dialysis
(D)	Zeta potential	(s)	Electro kinetic potential
(E)	Casein	(t)	Double decomposition reaction
		(u)	Protective colloid

Exercise-2

Marked questions are recommended for Revision

PART - I : ONLY ONE OPTION CORRECT TYPE

1. Which of the following statements is correct for a lyophilic solution ?
(A) It is not easily solvated (B) The coagulation of this sol is irreversible in nature
(C) It is unstable (D) It is quite stable in a solvent

2. Liquid-liquid colloidal system is known as
(A) aerosol (B) foam (C) emulsion (D) gel

3. The colloidal system consisting of a liquid dispersed in a solid dispersion medium is termed as :
(A) aerosol (B) foam (C) emulsion (D) gel

4. Which of the following statements is not correct ?
(A) A colloidal solution is a heterogeneous two-phase system
(B) Silver sol in water is an example of lyophilic solution.
(C) Metal hydroxides in water are examples of lyophobic solution
(D) Liquid-liquid colloidal solution is not a stable system

5. Size of colloidal particles may range from :
(A) 1 to 1000 nm (B) 10 to 100 pm (C) 1 to 100 µm (D) 1 to 10 mm

6. Which of the following represents a multimolecular colloidal particles?
(A) Starch (B) A sol of gold (C) Proteins (D) Soaps

7. Which of the following anions will have minimum flocculation value for the ferric oxide solution ?
(A) Cl^- (B) Br^- (C) SO_4^{2-} (D) $[Fe(CN)_6]^{3-}$

8. Which of the following represents a macromolecular colloidal particles ?
(A) Solution of gold (B) Cellulose (C) Soaps (D) Synthetic detergents

9. Gold number of some lyophilic sols are :

I	Casein	0.01
II	Haemoglobin	0.03
III	Gum arabic	0.15
IV	Sodium oleate	0.40

Which has maximum protective power :
(A) I (B) II (C) III (D) IV

10. Arsenic (III) sulphide forms a sol with a negative charge. Which of the following ionic substances should be most effective in coagulating the sol ?
(A) KCl (B) $MgCl_2$ (C) $Al_2(SO_4)_3$ (D) Na_3PO_4

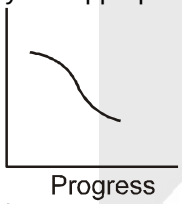
11. Smoke is a dispersion of :
(A) gas in gas (B) gas in solid (C) solid in gas (D) liquid in gas

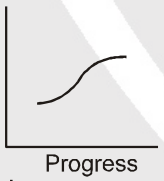
12. Smoke has generally blue tinge. It is due to :
(A) scattering (B) coagulation (C) Brownian motion (D) electro-osmosis

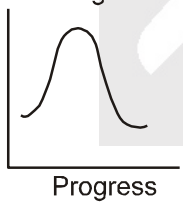
13. Which one of the following statements is false for hydrophilic sols ?
(A) they do not require electrolytes for stability
(B) their viscosity is of the order of that of water
(C) their surface tension is usually lower than that of dispersion medium.
(D) none of these

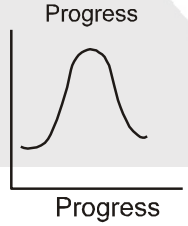
14. Soaking of sponge by water is an example of :
(A) Simple adsorption (B) Physical adsorption
(C) Chemisoption (D) Absorption

15. Identify the appropriate graph between enthalpy and progress of physical adsorption.

(A) 

(B) 

(C) 

(D) 

16. Hydrolysis of ester in catalysed by acid. Rate of hydrolysis of ester were obtained initially and after some ester has been hydrolysed as R_0 and R_t then (same temp.)
(A) $R_0 = R_t$ (B) $R_0 < R_t$ (C) $R_0 > R_t$ (D) Cannot be determined

PART - II : SINGLE OR DOUBLE INTEGER TYPE

1. When a graph is plotted between log x/m and log p, it is straight line with an angle 45° and intercept 0.3010 on y-axis. If initial pressure is 0.3 atm, what will be the amount of gas adsorbed per gram of adsorbent : (Report your answer after multiplying by 10)

2. The volume of nitrogen gas (measured at STP) required to cover a sample of silica gel with a mono-molecular layer is 129cm^3/g of gel. Calculate the surface area per gram of the gel if each nitrogen molecule occupies $16.2 \times 10^{-20} m^2$. (Report your answer after dividing by 10).

3. How many of these reactions are homogeneously catalyzed?

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

(ii) $C_{12}H_{22}O_{11}(aq) + H_2O(\ell) \xrightarrow{H_2SO_4(\ell)} \underset{\text{Glucose}}{C_6H_{12}O_6(aq)} + \underset{\text{Fructose}}{C_6H_{12}O_6(aq)}$

(iii) $2SO_3(g) + O_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

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

(v) $4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$

(vi) $CH_3COOCH_3(\ell) \xrightarrow{HCl(\ell)} CH_3COOH(aq)$

(vii) Vegetable oils $(\ell) + H_2(g) \xrightarrow{Ni(s)}$ Vegetable ghee (s).

4. Coagulation value of the electrolytes $AlCl_3$ and NaCl for As_2S_3 sol are 0.093 and 52 repectively. How many times $AlCl_3$ has greater coagulating power than NaCl.

5. Among the following number of correct statements are :
(i) Stability of lyophilic colloids is mainly due to the strong interaction between dispersed particle and dispersion medium.
(ii) Entropy change for adsorption of gases over solid is positive.
(iii) Gelatin has considerably low value of gold number and is effective protective colloid.
(iv) Zeta potential is also responsible for stability of lyophobic colloid solution.
(v) Surface tension of lyophilic colloidal solution is lesser than that of dispersion medium.

6. For the just coagulation of 250 mL of $Fe(OH)_3$ sol, 2 mL of 1 M Na_2SO_4 electrolyte is required. What is the coagulating value of Na_2SO_4 electrolyte.

7. The minimum concentration of an electrolyte required to cause coagulation of a sol is called its flocculation value. It is expressed in millimoles per litre. If the flocculation value of $MgSO_4$ for standard As_2S_3 sol is 3.33. How many milligrams of $MgSO_4$ is to be added to 20 ml standard As_2S_3 sol so that flocculation just starts ?

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which of the following statements about physical adsorption is correct ?
(A) It is always monolayer
(B) It is reversible in nature
(C) It involves van der Waals interactions between adsorbent and adsorbate
(D) It involves small enthalpy of adsorption as compared to chemisorption.

2. Which of the following statements regarding adsorption is correct ?
(A) Extent of adsorption of gases on charcoal increases with increase in pressure of the gas
(B) Extent of adsorption is independent of temperature
(C) Extent of chemisorption by a given mass of adsorbent is limited
(D) Extent of adsorption is dependent on the nature of adsorbent

3. Which of the following is characteristic of chemisorption?
(A) it is irreversible (B) it is specific
(C) it is multilayer phenomenon (D) heat of adsorption is generally around 80 – 240 kJ

4. Which is/are a purely surface phenomena :
(A) surface tension (B) adsorption (C) absorption (D) none of these

5. Which of the following are correct statements ?
(A) Spontaneous adsorption of gases on solid surface is an exothermic process as entropy decreases during adsorption
(B) Formation of micelles takes place when temperature is below Kraft Temperature (T_k) and concentration is above critical micelle concentration (CMC)
(C) Longer the length of hydrophobic chain, smaller is the value of critical micelle concentration (CMC)
(D) According to Hardy-Schulze rule the coagulation (flocculating) value of Fe^{3+} ion will be more than Ba^{2+} or Na^+.

6. Which of the following statements are true for physisorption?
(A) Extent of adsorption increases with increase in pressure.
(B) It needs activation energy
(C) It can be reversed easily
(D) It occurs at high temperature.

7. Identify the reactions that includes inhibtors in the reactions mixture.
(A) $N_2 + 3H_2 \xrightarrow[Mo]{Fe} 2NH_3$ (B) Vegetable Oil + $H_2 \xrightarrow[Cu]{Ni}$ Vegetable ghee.
(C) $N_2 + 3H_2 \xrightarrow[CO/H_2S]{Fe} 2NH_3$ (D) $RCOCl + H_2 \xrightarrow[BaSO_4]{Pd} RCHO + HCl$

8. Which of the following are the correct :
(A) A Catalyst remains unchanged in mass and chemical compositions at the end of reactions.
(B) Finely devided state of catalyst is more efficient for the reactions.
(C) Catalyst change equilibrium state of the reaction.
(D) A catalyst changes the entropy and the free energy of a reaction.

9. The diameter of colloidal particle is of the order :
(A) 10^{-3} m (B) 10^{-6} m (C) 10^{-15} m (D) 10^{-7} m

10. Which of the following are examples of aerosols?
(A) Whipped cream (B) Cloud (C) Fog (D) Soap lather

11. Which of the following are hydrophobic sols ?
(A) Protein sol (B) Gold sol (C) Gum sol (D) $Fe(OH)_3$ sol.

12. Which of the following are multimolecular colloids ?
(A) Sulphur (B) Egg albumin in water
(C) Gold sol (D) Soap solution

13. The origin of charge on colloidal solution is
(A) Self dissociation (in soaps and detergents) (B) Electron capture during Bredig's arc method
(C) Selective adsorption of ion on their surface (D) It is due to addition of protective colloids

14. Which of the following is/are not true for lyophilic colloid ?
(A) These are prepared by special indirect methods.
(B) The particles must travel towards the anode or cathode under the influence of an electric field.
(C) These are called on intrinsic colloid
(D) Small quantity of electrolyte is sufficient to cause precipitation of these.

15. Which of the following are based on Tyndall effect.
(A) Tail of comets (B) Deltas
(C) Blue colour of sky (D) Coagulation

16. Which of the following statements is correct?
(A) Peptization is the process by which some fresh precipitates are converted into the colloidal state by addition of little suitable electrolyte.
(B) Metal sols of gold, silver and platinum can be prepared by Bredig's arc method.
(C) Impurities present in a solution makes it more stable.
(D) Dialysis is a process to remove impurities of ions and molecules from a solution.

17. Which is an example of coagulation?
(A) curdling of milk (B) purification of water by addition of alum
(C) formation of deltas at the river beds (D) formation of ice

18. When negatively charged colloids like As_2S_3 sol is added to positively charged $Fe(OH)_3$ sol in suitable amounts
(A) Both the sols are precipitated simultaneously.
(B) This process is called mutual coagulation.
(C) They become positively charged colloids.
(D) They become negatively charged colloids.

19. Which of the following are incorrect statements ?
(A) Hardy schulz rule is related to coagulation
(B) Brownian movement and Tyndall effect are the characteristic of colloids.
(C) In gel, the liquid is dispersed in liquid
(D) Higher the gold number, more is the protective power of lyophillic sols.

20. Which of the following sols is positively charged?
(A) Arsenious sulphide (B) Aluminium hydroxide
(C) Ferric hydroxide (D) Silver iodide in silver nitrate solution

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

Many lyophilic sols and few lyophobic sols when coagulated under some special conditions changes into semi rigid mass, enclosing whole amount of liquid within itself, it is called gel and the process is called gelation. Gelatin Agar-agar, gum-Arabic can be converted into gels by cooling them under moderate concentration conditions. Hydrophobic sols like silicic acid. $Al(OH)_3$ are prepared by double decomposition and exchange of solvent method.

Types of Gel :

(i) **Elastic gel :** Those gel which have elastic properties.
Ex : Gelatin, Strach, Agar-Agar etc.

(ii) **Non- elastic gel :** Those gel which are rigid.
Ex: Silica gel.

Properties of Gel :

1. **Syneresis/weeping of gel :** The spontaneous liberation of liquid from a gel is called syneresis or weeping of gels. It is reverse of swelling.
Ex: Gelatin, Agar-Agar show syneresis at low concentration while sillicic acid shows it at high concentration.

2. **Imbibition or swelling of gel :** When gel is kept in a suitable liquid (water) it absorb large volume of liquid. The phenomenon is called imbibition or swelling of gel.

3. **Thixotropic :** Some gels when shaken to form a sol, on keeping changes into gel are termed as thixotropic gel and phenomenon is called thixotropy.
Ex: Gelatin and silica liquify on shaking changing into corresponding sol and the sol on keeping changes back into gel.

1. Which of the following is used to adsorb water ?
(A) Silica gel (B) Calcium acetate (C) Hair gel (D) Cheese

2. The process of imbibing water when elastic gel are placed in water is called :
(A) imbibition (B) synerisis (C) coagulation (D) thixotropy

3. Some types of gels like gelatin and silica liquify on shaking thereby changing into sols. The sols on standing change back into gels. This process is know as
(A) syneresis (B) thixotropy
(C) double decompostion (D) peptization

Comprehension # 2

The clouds consist of charged particles of water dispersed in air. Some of them are +vely charged, others are –vely charged. When +vely charged clouds come closer they cause lightening and thundering whereas when +ve and –ve charged colloids come closer they cause heavy rain by aggregation of minute particles. It is possible to cause artificial rain by throwing electrified sand or silver iodide from an aeroplane and thus coagulating the mist hanging in air.
Smoke screen is a cloud of smoke used to hide military, naval police etc. it consists of fine particles of TiO_2.

4. When excess of $AgNO_3$ is treated with KI solution, AgI forms
(A) +ve charged sol (B) –ve charged sol (C) neutral sol (D) true solution

5. AgI helps in artificial rain because :
(A) it helps in ionisation of water (B) it helps in dispersion process
(C) it helps in coagulation (D) all of them

6. Smoke screens consist of
(A) fine particles of TiO_2 dispersed in air by aeroplanes
(B) fine particles of AgI dispersed in air by aeroplanes
(C) fine particles of Al_2O_3 dispersed in air by aeroplanes
(D) None of these

Comprehension # 3

Answer Q.7, Q.8 and Q.9 by appropriately matching the information given in the three columns of the following table.

Column-1		Column-2		Column-3	
(I)	Positively charged colloid	(i)	Can be coagulated by adding metal sulphide sol	(P)	During electrophoresis coagulation will take place at anode
(II)	Negatively charged colloid	(ii)	Can be coagulated by adding metal oxide sol	(Q)	During electro-osmosis level of dispersion medium will increase on anode side.
(III)	Can be prepared by Bredig's Arc method	(iii)	Coagulation value of Na_2SO_4 > $MgCl_2$ for this colloid	(R)	During Electro-phoresis coagulation will take place at cathode.
(IV)	Can be prepared by peptisation	(iv)	Coagulating power of $MgSO_4$ > NaCl for this colloid.	(S)	During electro-osmosis level of dispersion medium will increase on cathode side.

7. Select the only incorrect option for AgI / I^- sol.
(A) (II) (ii) (P) (B) (IV) (iv) (P) (C) (II) (iii) (S) (D) (IV) (iii) (Q)

8. Select the only correct option $Fe(OH)_3$ sol.
(A) (I) (iii) (Q) (B) (IV) (i) (Q) (C) (I) (iii) (R) (D) (IV) (iv) (S)

9. Select the only incorrect option for gold sol.
(A) (II) (ii) (P) (B) (II) (iii) (S) (C) (III) (iv) (S) (D) (II) (iii) (Q)

Exercise-3

*** Marked Questions are having more than one correct option.**

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. Rate of physisorption increases with **[JEE 2003, 3/60]**
(A) decrease in temperature (B) increase in temperature
(C) decrease in pressure (D) decrease in surface area

2. Adsorption of gases on solid surface is generally exothermic because **[JEE 2004, 3/84]**
(A) enthalpy is positive (B) entropy decreases
(C) entropy increases (D) free energy increases

3. Lyophilic sols are **[JEE 2005, 3/84]**
(A) Irreversible sols (B) They are prepared from inorganic compound
(C) Coagulated by adding electrolytes (D) Self-stabilizing

4. Among the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambinent condition is : **[JEE 2008, 3/163]**
(A) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$ (B) $CH_3(CH_2)_{11}OSO_3^-Na^+$
(C) $CH_3(CH_2)_6COO^-Na^+$ (D) $CH_3(CH_2)_{11}N^+(CH_3)_3Br^-$

5. Among the electrolytes Na_2SO_4, $CaCl_2$, $Al_2(SO_4)_3$ and NH_4Cl, the most effective coagulating agent for Sb_2S_3 sol is : **[JEE 2009, 3/160]**

(A) Na_2SO_4 (B) $CaCl_2$ (C) $Al_2(SO_4)_3$ (D) NH_4Cl

6. Silver (atomic weight = 108 gm mol^{-1}) has a density of 10.5 gm cm^{-3}. The number of silver atoms on a surface of area 10^{-12} m^2 can be expressed in scientific notation as $y \times 10^x$. The value of x is : **[JEE 2010, 3/163]**

7.* The correct statement(s) pertiaining to the adsorption of a gas on a solid surface is (are) **[JEE 2011, 4/180]**

(A) Adsorption is always exothermic

(B) Physisorption may transform into chemisorption at high temperature

(C) Physisorption increases with increasing temperature but chemisorption decreases with increasing temperature

(D) Chemisorption is more exothermic than physisorption, however it is very slow due to higher energy of activation.

8.* Choose the correct reason(s) for the stability of the **lyophobic** colloidal particles. **[JEE 2012, 4/168]**

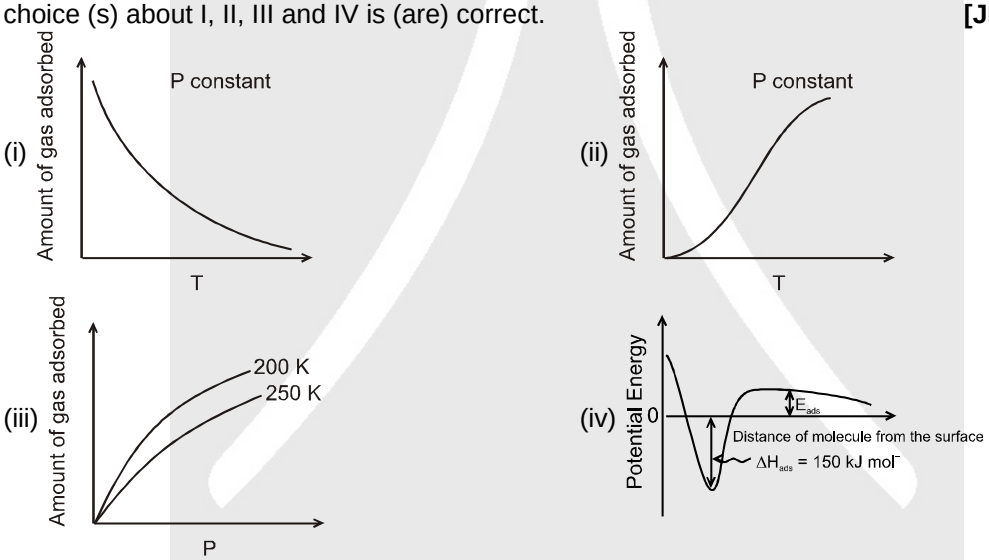
(A) Preferential adsorption of ions on their surface from the solution.

(B) Preferential adsorption of solvent on their surface from the solution.

(C) Attraction between different particles having opposite charges on their surface.

(D) Potential difference between the fixed layer and the diffused layer of opposite charges around the colloidal particles.

9.* The given graph / data I, II, III and IV represent general trends observed for different physisorption and chemisorption processes under mild conditions of temperature and pressure. Which of the following choice (s) about I, II, III and IV is (are) correct. **[JEE 2012, 4/168]**



(A) I is physisorption and II is chemisorption (B) I is physisorption and III is chemisorption

(C) IV is chemisorption and II is chemisorption (D) IV is chemisorption and III is chemisorption

10. Methylene blue, from its aqueous solution, is adsorbed on activated charcoal at 25° C. For this process, the correct statement is **[JEE(Advanced)-2013, 2/120]**

(A) The adsorption requires activation at 25°C.

(B) The adsorption is accompanied by a decreases in enthalpy.

(C) The adsorption increases with increase of temperature.

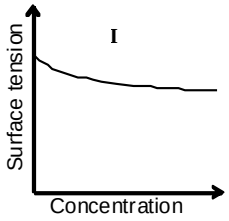
(D) The adsorption is irreversible.

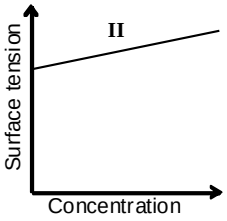
11.* When O_2 is adsorbed on a metallic surface, electron transfer occurs from the metal to O_2. The **TRUE** statement(s) regarding this adsorption is(are) **[JEE(Advanced)-2015, 4/168]**

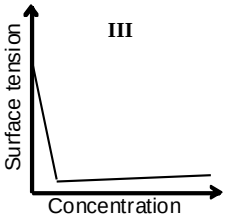
(A) O_2 is physisorbed (B) heat is released

(C) occupancy of π^*_{2p} of O_2 is increased (D) bond length of O_2 is increased

12. The qualitative sketches I, II and III given below show the variation of surface tension with molar concentration of three different aqueous solution of KCl, CH_3OH and $CH_3(CH_2)_{11}\ OSO_3^-\ Na^+$ at room temperature. The correct assignment of the sketches is : **[JEE(Advanced)-2016, 3/124]**







(A) I : KCl	II : CH_3OH	III : $CH_3(CH_2)_{11}\ OSO_3^-\ Na^+$
(B) I : $CH_3(CH_2)_{11}\ OSO_3^-\ Na^+$	II : CH_3OH	III : KCl
(C) I : KCl	II : $CH_3(CH_2)_{11}\ OSO_3^-\ Na^+$	III : CH_3OH
(D) I : CH_3OH	II : KCl	III : $CH_3(CH_2)_{11}\ OSO_3^-\ Na^+$

13.* The correct statement(s) about surface properties is(are) **[JEE(Advanced)-2017, 4/122]**

(A) The critical temperatures of ethane and nitrogen are 563 K and 126 K, respectively. The adsorption of ethane will be more than that of nitrogen of same amount of activated charcoal at a given temperature.

(B) Cloud is an emulsion type of colloid in which liquid is dispersed phase and gas is dispersion medium.

(C) Adsorption is accompanied by decrease in enthalpy and decrease in entropy of the system.

(D) Brownian motion of colloidal particles does not depend on the size of the particles but depends on viscosity of the solution.

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) ONLINE PROBLEMS

1. Which one of the following characteristics is not correct for physical adsorption? **[AIEEE 2003, 3/225]**

(1) Adsorption on solids is reversible

(2) Adsorption increases with increase in temperature

(3) Adsorption is spontaneous

(4) Both enthalpy and entropy of adsorption are negative.

2. The disperse phase in colloidal iron (III) hydroxide and colloidal gold is positively and negatively charged, respectively. Which of the following statements is NOT correct ? **[AIEEE 2005, 3/225]**

(1) Coagulation in both sols can be brought about by electrophoresis

(2) Mixing the sols has no effect

(3) Sodium sulphate solution causes coagulation in both sols

(4) Magnesium chloride solution coagulates, the gold sol more readily than the iron (III) hydroxide sol.

3. The volume of collodial particle V_C as compared to the volume of a solute particle in a true solution V_S could be : **[AIEEE 2005, 3/225]**

(1) ~ 1 (2) ~ 10^{23} (3) ~ 10^{-3} (4) ~ 10^3

4. In langmuir's model of adsorption of a gas on a solid surface : **[AIEEE 2006, 3/165]**

(1) the rate of dissociation of adsorbed molecules from the surface does not depend on the surface covered

(2) the adsorption at a single site on the surface may involve multiple molecules at the same time

(3) the mass of gas striking a given area of surface is proportional to the pressure of the gas

(4) the mass of gas striking a given area of surface is independent of the pressure of the gas

5. Gold numbers of protective colloids A, B, C and D are 0.50, 0.01, 0.10 and 0.005, respectively. The correct order of their protective powers is **[AIEEE 2008, 3/105]**

(1) C < B < D < A (2) A < C < B < D (3) B < D < A < C (4) D < A < C < B

6. Which of the following statements is incorrect regarding physiosorptions ? **[AIEEE 2009, 4/144]**

(1) More easily liquefiable gases are adsorbed readily.

(2) Under high pressure it results into multi molecular layer on adsorbent surface.

(3) Enthalpy of adsorption ($\Delta H_{adsorption}$) is low and positive.

(4) It occurs because of van der Waal's forces.

7. According to Freundlich adsorption isotherm which of the following is correct? **[AIEEE 2012, 4/120]**

(1) $\frac{x}{m} \propto p^0$ (2) $\frac{x}{m} \propto p^1$ (3) $\frac{x}{m} \propto p^{1/n}$

(4) All the above are correct for different ranges of pressure

8. The coagulating power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphide sol increases in the order : **[JEE(Main) 2013, 4/120]**

(1) $Al^{3+} < Ba^{2+} < Na^+$ (2) $Na^+ < Ba^{2+} < Al^{3+}$ (3) $Ba^{2+} < Na^+ < Al^{3+}$ (4) $Al^{3+} < Na^+ < Ba^{2+}$

9. 3 gram of activated charocoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the fitrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is : **[JEE(Main)-2015, 4/120]**

(1) 18 mg (2) 36 mg (3) 42 mg (4) 54 mg

10. For a linear plot of log(x/m) versus log p in a Freundlich adsorption isotherm, which of the following statements is correct? (k and n are constants) **[JEE(Main)-2016, 4/120]**

(1) 1/n appears as the intercept (2) Only 1/n appears as the slope.

(3) log(1/n) appears as the intercept. (4) Both k and 1/n appear in the slope term.

11. The Tyndall effect is observed only when following conditions are satisfied : **[JEE(Main)-2017, 4/120]**

(a) The diameter of the dispersed particles is much smaller than the wavelength of the light used.

(b) The diameter of the dispersed particles is not much smaller than the wavelength of the light used

(c) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.

(d) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

(1) (b) and (d) (2) (a) and (c) (3) (b) and (c) (4) (a) and (d)

JEE(MAIN) ONLINE PROBLEMS

1. The following statements relate to the adsorption of gases on a solid surface. Identify the incorrect statement among them : **[JEE(Main) 2015 Online (10-04-15), 4/120]**

(1) On adsorption decrease in surface energy appears as heat

(2) Enthalpy of adsorption is negative

(3) On adsorption, the residual forces on the surface are increased

(4) Entropy of adsorption is negative

2. Under ambient conditions, which among the following surfactants will form micelles in aqueous solution at lowest molar concentration ? **[JEE(Main) 2015 Online (11-04-15), 4/120]**

(1) $CH_3–(CH_2)_8–COO^- Na^+$ (2) $CH_3(CH_2)_{11}\overset{\oplus}{N}(CH_3)_3Br^-$

(3) $CH_3–(CH_2)_{13}–OSO_3^- Na^+$ (4) $CH_3(CH_2)_{15}\overset{\oplus}{N}(CH_3)_3Br^-$

3. The most appropriate method of making egg-albumin sol is:**[JEE(Main) 2016 Online (09-04-16), 4/120]**

(1) Keep the egg in boiling water for 10 minutes. After removing the shell, transfer the yellow part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

(2) Break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well.

(3) Keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

(4) Break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.

4. A particular adsorption process has the following characteristics: (i) It arises due to vander Waals forces and (ii) it is reversible. Identify the correct statement that describes the above adsorption process: **[JEE(Main) 2016 Online (09-04-16), 4/120]**

(1) Enthalpy of adsorption is greater than 100 kJ mol^{-1}.

(2) Adsorption is monolayer.

(3) Adsorption increases with increase in temperature.

(4) Energy of activation is low.

5. Gold numbers of some colloids are :
Gelatin : 0.005 - 0.01; Gum Arabic : 0.15 - 0.25; Oleate : 0.04 - 1.0; Starch : 15 - 25.
Which among these is a better protective colloid ? **[JEE(Main) 2016 Online (10-04-16), 4/120]**
(1) Gelatin (2) Starch (3) Gum Arabic (4) Oleate

6. Among the following, **correct** statement is : **[JEE(Main) 2017 Online (08-04-17), 4/120]**
(1) One would expect charcoal to adsorb chlorine more than hydrogen sulphide
(2) Sols metal sulphides are lyophilic
(3) Hardy Schulze law states that bigger the size of the ions, the greater is its coagulating power.
(4) Brownian movement is more pronounced for smaller particles than for bigger-particles.

7. Adsorption of a gas on a surface follows Freundlich adsorption isotherm. Plot of $\log \frac{x}{m}$ versus log p gives a straight line with slope equal to 0.5, then : **[JEE(Main) 2017 Online (09-04-17), 4/120]**
($\frac{x}{m}$ is the mass of the gas adsorbed per gram of adsorbent)
(1) Adsorption is proportional to the pressure.
(2) Adsorption is proportional to the square root of pressure.
(3) Adsorption is proportional to the square of pressure.
(4) Adsorption is independent of pressure.

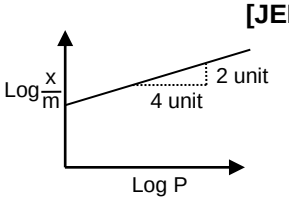
8. Which of the following statements about colloids is **False** ? **[JEE(Main) 2018 Online (15-04-18), 4/120]**
(1) When silver nitrate solution is added to potassium iodide solution a negatively charged colloidal solution is formed.
(2) Freezing point of colloidal solution is lower than true solution at same concentration of a solute.
(3) Colloidal particles can pass through ordinary filter paper.
(4) When excess of electrolyte is added to colloidal solution, colloidal particle will be precipitated.

9. If x gram of gas is adsorbed by m gram of adsorbent at pressure P, the plot of $\log \frac{x}{m}$ versus log P is linear. The slope of the plot is : (n and k are constants and n > 1)
[JEE(Main) 2018 Online (15-04-18), 4/120]
(1) 2 k (2) log k (3) n (4) $\frac{1}{n}$

10. Two compounds I and II are eluted by column chromatography (adsorption of I > II). Which one of the following is a correct statement? **[JEE(Main) 2018 Online (15-04-18), 4/120]**
(1) I moves faster and has higher R_f value than II
(2) II moves faster and has higher R_f value than I
(3) I moves slower and has higher R_f value than II
(4) II moves slower and has higher R_f value than I

11. Which one of the following is not a property of physical adsorption ?
[JEE(Main) 2018 Online (16-04-18), 4/120]
(1) Higher the pressure, more the adsorption (2) Greater the surface area, more the adsorption
(3) Lower the temperature, more the adsorption (4) Unilayer adsorption occurs

12. Adsorption of a gas follows Freundlich adsorption isotherm. In the given plot, x is the mass of the gas adsorbed on mass m of the adsorbent at pressure p. $\frac{x}{m}$ is proportional to :
[JEE(Main) 2019 Online (09-01-19), 4/120]



(1) p^2 (2) p (3) $p^{1/2}$ (4) $p^{1/4}$

13. For coagulation of arsenious sulphide sol, which one of the following salt solution will be most effective? **[JEE(Main) 2019 Online (09-01-19), 4/120]**

(1) Na_3PO_4 (2) $AlCl_3$ (3) $BaCl_2$ (4) NaCl

14. Which of the following is not an example of heterogeneous catalytic reaction ? **[JEE(Main) 2019 Online (10-01-19), 4/120]**

(1) Ostwald's process (2) Haber's process
(3) Combustion of coal (4) Hydrogenation of vegetable oils

15. Haemoglobin and gold sol are examples of: **[JEE(Main) 2019 Online (10-01-19), 4/120]**

(1) negatively charged sols
(2) positively charged sols
(3) positively and negatively charged sols, respectively
(4) negatively and positively charged sols, respectively

16. An example of solid sol is: **[JEE(Main) 2019 Online (11-01-19), 4/120]**

(1) Butter (2) Hair cream (3) Paint (4) Gem stones

17. Among the colloids cheese (C), milk (M) and smoke (S), the correct combination of the dispered phase and dispersion medium, respectively is : **[JEE(Main) 2019 Online (11-01-19), 4/120]**

(1) C : liquid in solid; M : liquid in liquid; S : solid in gas
(2) C : solid in liquid; M : liquid in liquid; S : gas in solid
(3) C : solid in liquid; M : solid in liquid; S : solid in gas
(4) C : liquid in solid; M : liquid in solid; S : solid in gas

18. Given

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

On the basis of data given above, predict which of the following gases shows least adsorption on a definite amount of charcoal ? **[JEE(Main) 2019 Online (12-01-19), 4/120]**

(1) CH_4 (2) H_2 (3) CO_2 (4) SO_2

19. Among the following, the false statement is : **[JEE(Main) 2019 Online (12-01-19), 4/120]**

(1) It is possible to cause artificial rain by throwing electrified sand carrying charge opposite to the one on clouds from an aeroplane.
(2) Lyophilic solution can be coagulated by adding an electrolyte
(3) Latex is a colloidal solution of rubber particles which are positively charged
(4) Tyndall effect can be used to distinguish between a colloidal solution and a true solution

Answers

EXERCISE - 1

PART - I

A-1. Adsorption is accompanied by decrease of randomness, i.e. this factor opposes the process, i.e. ΔS is –ve. For the process to be spontaneous, ΔG must be –ve. Hence, according to eqn, $\Delta G = \Delta H - T\Delta S$, ΔG can be –ve only if ΔH is –ve.

A-2. **Difference between physical adsorption and chemical adsorption :**

Physical Adsorption	Chemical Adsorption
The forces between the adsorbate molecules and the adsorbent are weak van der Waal's forces.	The forces between the adsorbate molecules and the adsorbent are strong chemical forces.
Low heat of adsorption of the order of 20-40 kJ mol^{-1}	High heat of adsorption of the order 80-240 kJ mol^{-1}
Usually occurs at low temperature and decreases with increasing temperature.	It occurs at high temperature decreases with increasing temperature.
It is reversible.	It is irreversible.
The extent of adsorption depends upon the ease of liquefication of the gas.	There is no correlation between extent of adsorption and the ease of liquefication of gas.
It is less specific in nature, all gases are adsorbed on the surface of a solid to some extent adsorbent and adsorbate molecules.	It is highly specific in nature and occurs only when there is bond formation between extents.
It forms multimolecular layers.	It forms mono-molecular layer.

A-3. **(i) The nature of the gas (i.e. nature of the adsorbate).** The easily liquefiable gases such as HCl, NH_3, Cl_2 etc. are adsorbed more than the permanent gases such as H_2, N_2 and O_2. The ease with which a gas can be liquefied is primarily determined by its critical temperature. Higher the critical temperature (T_c) of a gas, the more easily it will be liquefied and, therefore, more readily it will be adsorbed on the solid.

Gas	SO_2	CH_4	H_2
T_C	330K	190 K	33 K

(ii) Nature of adsorbent. The extent of adsorption of a gas depends upon the nature of adsorbent. Activated charcoal (i.e. activated carbon), metal oxides (silica gel and aluminium oxide) and clay can adsorb gases which are easily liquified. Gases such as H_2, N_2 and O_2 are generally adsorbed on finely divided transition metals Ni and Co.

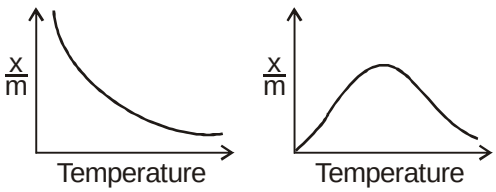
(iii) Activation of adsorbent.

(a) Metallic adsorbents are activated by mechanical rubbing or by subjecting it to some chemical reactions.

(b) To increase the adsorbing power of adsorbents, they are sub-divided into smaller pieces. As a result, the surface area is increased and therefore, the adsorbing power increases.

(iv) Effect of temperature.

Mostly the process of adsorption is exothermic and the reverse process or desorption is endothermic. If the above equilibrium is subjected to increase in temperature, then according to Le-Chaterlier's principle, with increase in temperature, the desorption will be favoured. Physical adsorption decreases continuously with increase in temperature whereas chemisorption increases initially, shows a maximum in the curve and then it decreases continuously.



The initial increase in chemisorption with increase in temperature is because of activation energy required.

This is why the chemical adsorption is also known as "**Activated adsorption".**

A graph between degree of adsorption (x/m) and temperature 't' at a constant pressure of adsorbate gas is known as **adsorption isobar.**

(v) Effect of pressure. The extent of adsorption of a gas per unit mass of adsorbent depends upon the pressure of the gas. The variation of extent of adsorption expressed as x/m (where x is the mole of adsorbate and m is the mass of the adsorbent) and the pressure is given as below. A graph between the amount of adsorption and gas pressure keeping the temperature constant is called an adsorption isotherm.

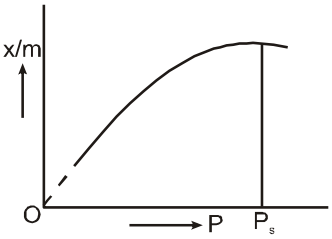


Figure-1

It is clear from the figure that extent of adsorption (x/m) increases with pressure and becomes maximum corresponding to pressure P_s called equilibrium pressure. Since adsorption is a reversible process, the desorption also takes place simultaneously. At this pressure (P_s) the amount of gas adsorbed becomes equal to the amount of gas desorbed.

A-4. It represents the variation of the mass of the gas adsorbed per gram of the adsorbent with pressure at constant temperature.

A-5. It means increasing the adsorption power of an adsorbent and is done by increasing the surface area of the adsorbent by a suitable method.

A-6. NH_3 has higher critical temperature than that of CO_2, i.e. NH_3 is more easily liquefiable than CO_2 because, NH_3 has greater intermolecular forces of attraction and hence will be adsorbed more readily.

A-7. 1.2

A-8. 5×10^{-19} m^2

A-9. In heterogeneous catalysis, generally the reactants are gaseous where as catalyst is a solid. The reactant molecules are adsorbed on the surface of the catalyst. As a result, the concentration of the reactant molecules on the surface increases and hence the rate of reaction increases.

A-10. 0.02 g

A-11. $T_0 < 27^oC$

B-1. (i) Mfg. of NH_3 (Haber's process) – using iron as catalyst
(ii) Mfg. of H_2SO_4 – using platinised asbestos or V_2O_5 as catalyst.

B-2. (ii) $\rightarrow$ (i) $\rightarrow$ (v) $\rightarrow$ (iii) $\rightarrow$ (iv)

C-1. On the bases of physical state of D.P. and D.M. colloidal solution may be divided into eight system.

Table : Type of Colloidal Systems

D P	D M	Type of colloid	Examples
Solid	Solid	Solid Sol	Some coloured glasses and gem stones
Solid	Liquid	Sol	Paints, cell fluids
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Liquid Aerosol	Fog, mist, cloud, insecticide sprays
Gas	Solid	Solid Sol	Pumice stone, foam rubber
Gas	Liquid	Foam	Froath, whipped cream, soap lather.

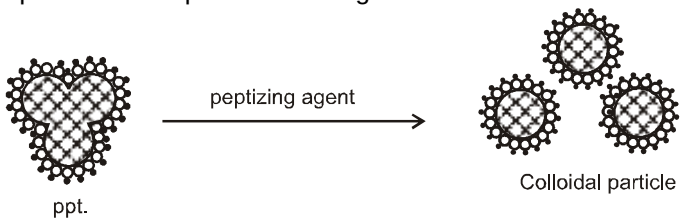
C-2. (a) Gel – a colloidal dispersion of a liquid in a soild, e.g., butter
(b) Liquid aerosol – a colloidal dispersion of a liquid in a gas, e.g., fog
(c) Hydrosol – a colloidal sol of a solid in water as the dispersion medium, e.g, starch sol or gold sol.

C-3. Associated colloids are formed by electrolytes so that they are dissociated into ions and these ions associate together to form ionic micelles whose size lies in the colloidal range, e.g. soaps.
Multimolecular colloids–formed by the aggregation of a large number of simple molecules.
Macromolecular colloids – due to large size of the molecules themselves.

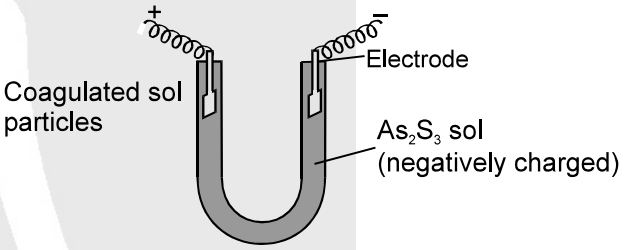
C-4. Multimolecular – S_8 ; Macromolecular – starch

C-5. Sol of sulphur – oxidation method or by exchange of solvent.
Sol of platinum – Bredig's electro–disintegration method.

D-1. **(a) Peptization:** The term has originated from the digestion of proteins by the enzyme pepsin. Peptization may be defined as (the process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of a small amount of electrolyte). The electrolyte used for this purpose is called peptizing agent. This method is applied, generally, to convert a freshly prepared precipitate into a colloidal sol. During peptization, the precipitate adsorbs one of the ions of the electrolyte on its surface. The ion adsorbed on the surface is common either with the anion or cation of the electrolyte. This causes the development of positive or negative charge on precipitates which ultimately break up into smaller particles having the dimensions of colloids.



(b) Electrical Properties (Electrophoresis) : The particles of the colloids are electrically charged and carry positive or negative charge. The dispersion medium has an equal and opposite charge making the system neutral as a whole. Due to similar nature of the charge carried by the particles, they repel each other and do not combine to form bigger particles. That is why, a sol is stable and particles do not settle down. Arsenious sulphide, gold, silver and platinum particles in their respective colloidal sols are negatively charged while particles of ferric hydroxide, aluminium hydroxide are positively charged. The existence of the electric charge is shown by the phenomenon of electrophoresis. It involves the 'movement of colloidal particles either towards the cathode or anode, under the influence of the electric field'. The apparatus used for electrophoresis as shown in fig.



(Fig. : A set up for electrophoresis.)

The colloidal solution is placed in a U-tube fitted with platinum electrodes. On passing an electric current, the charged colloidal particles move towards the oppositely charged electrode. Thus, if arsenic sulphide sol is taken in the U-tube, in which negatively charge particle of arsenic sulphide move towards the anode.

*Earlier this process was called cataphoresis because most of the colloidal sols studied at that time were positively charged and moved towards cathode.

(c) Dialysis : It is a process of removing a dissolved substance from a colloidal solution by means diffusion through suitable membrane. Since particles in true solution (ions or smaller molecules) can pass through animal membrane or parchment paper or cellophane sheet but colloidal particle do not, the appratus used for this purpose is called Dialyser.

A bag of suitable membrane containing the colloidal solutions is suspended in a vessel through which fresh water continously flow. The molecules and ions (crystalloids) diffuse through membrane into the outer water & pure colloidal solution is left behind.

(d) Mechanical Properties :

Brownian movement: Robert Brown, a botanist, discovered in 1827 that pollen grains placed in water do not remain at rest but move about continuously and randomly. Later on, this phenomenon was observed in case of colloidal particles when they were seen under an ultramicroscope. The particles were seen to be in constant zig-zag motion as shown in fig. This zig-zag motion is called Brownian movement

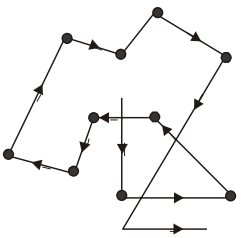


Figure
Brownian movement

D-2. At the time of settings, the sun is at the horizon. The light emitted by the sun has to travel a longer distance through the atmosphere. As a result, blue part of the light is scattered away by the dust particles in the atmosphere. Hence, the red part is visible.

D-3. Because colloidal solutions being bigger aggregate of a large number of molecule, the effective number of particles in colloidal solution is relative much smaller.

E-1. According to Hardy – schulze rule, greater the charge on the oppositely charged ion of the electrolyte added, more effective it is in bringing about coagulation. Hence Na_3PO_4 (PO_4^{-3}) is most effective.

E-2. **Isoelectric point :** The H^+ concentration at which the colloidal particles have no charge is known as the isoelectric point. At this point stability of colloidal particles becomes very less & do not move under influence of electric field.

E-3. **Formation of deltas :** The river water contains colloidal particles of sand and clay which carry negative charge. The sea water contains +ve ions such as Na^+, Mg^{2+}, Ca^{2+}, etc. As the river water meets sea water, these ions discharge the sand or clay particle which are precipitated in the form of delta.

E-4. **Artificial rain :** Cloud consists of charged particle of water dispersed in air. Rain is caused by aggregation of these minute particles. Artificial rain can be done by throwing electrified sand of AgI from aeroplanes, colloidal H_2O particle present in cloud will get coagulated by these sand or AgI particles to form bigger water drops causing rain.

F-1. Alcohol, phenol.

F-2. (i) Sols are dispersions of solids in liquids while emulsions are dispersions of liquids in liquids.
(ii) Sols are quite stable wheres as emulsions are less stable.

F-3. The process of separation of the constituent liquids of an emulsion is called demulsification.

F-4. Changing of W/O emulsion to O/W emulsion and vise-versa is known as phase inversion.

PART - II

A-1.	(D)	**A-2.**	(B)	**A-3.**	(A)	**A-4.**	(C)	**A-5.**	(B)
A-6.	(A)	**A-7.**	(B)	**A-8.**	(A)	**B-1.**	(D)	**B-2.**	(C)
C-1.	(A)	**C-2.**	(C)	**D-1.**	(A)	**D-2.**	(B)	**D-3.**	(C)
E-1.	(C)	**E-2.**	(A)	**E-3.**	(C)	**E-4.**	(C)	**E-5.**	(D)
F-1.	(B)								

PART - III

1. (C) **2.** (A – p, q) ; (B–r) ; (C – q, t) ; (D – s) ; (E – u)

EXERCISE - 2

PART - I

1.	(D)	**2.**	(C)	**3.**	(D)	**4.**	(B)	**5.**	(A)
6.	(B)	**7.**	(D)	**8.**	(B)	**9.**	(A)	**10.**	(C)
11.	(C)	**12.**	(A)	**13.**	(B)	**14.**	(D)	**15.**	(A)
16.	(B)								

PART - II

1.	6	**2.**	56	**3.**	3 (i, ii, vi)	**4.**	560	**5.**	4
6.	8	**7.**	8						

PART - III

1.	(BCD)	**2.**	(ACD)	**3.**	(ABD)	**4.**	(AB)	**5.**	(AC)
6.	(AC)	**7.**	(CD)	**8.**	(AB)	**9.**	(BD)	**10.**	(BC)
11.	(BD)	**12.**	(AC)	**13.**	(ABC)	**14.**	(ABD)	**15.**	(AC)
16.	(ABD)	**17.**	(ABC)	**18.**	(AB)	**19.**	(CD)	**20.**	(BCD)

PART - IV

1.	(A)	**2.**	(A)	**3.**	(B)	**4.**	(A)	**5.**	(C)
6.	(A)	**7.**	(D)	**8.**	(B)	**9.**	(D)		

EXERCISE - 3

PART - I

1.	(A)	**2.**	(B)	**3.**	(D)	**4.**	(A)	**5.**	(C)
6.	7	**7.***	(ABD)	**8.***	(AD)	**9.***	(AC)	**10.**	(B)
11.*	(BCD)	**12.**	(D)	**13.***	(AC)				

PART - II

JEE(MAIN) OFFLINE PROBLEMS

1.	(2)	**2.**	(2)	**3.**	(4)	**4.**	(3)	**5.**	(2)
6.	(3)	**7.**	(4)	**8.**	(2)	**9.**	(1)	**10.**	(2)
11.	(1)								

JEE(MAIN) ONLINE PROBLEMS

1.	(3)	**2.**	(4)	**3.**	(2)	**4.**	(4)	**5.**	(1)
6.	(4)	**7.**	(2)	**8.**	(2)	**9.**	(4)	**10.**	(2)
11.	(4)	**12.**	(3)	**13.**	(2)	**14.**	(3)	**15.**	(3)
16.	(4)	**17.**	(1)	**18.**	(2)	**19.**	(3)		