SURFACE CHEMISTRY

Section "A"

I. Adsorption

- The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is known as adsorption. It is surface phenomena.
- The substance on which adsorbate (gas or liquid or solute) gets adsorbed is known as adsorbent.
- The substance which is adsorbed on adsorbent is known adsorbate.
- The process of removing an adsorbed substance from a surface on which it is adsorbed is called desorption.
- If a gas like CO_2, H_2O, CO, Cl_2, NH_3, SO_2 is taken in a closed vessel congaing powdered chart coal, the pressure of the gas in the closed vessel decreases due to adsorption of gas on charcoal.
- A solution containing methylene blue or any organic dye or sugar cane juice on passing through animal charcoal or activated charcoal becomes colorless due to adsorption.
- The air becomes dry in the presence of silica gel due to adsorption of water molecules/humidity by silica gel.

II Adsorption:

- Adsorption is the phenomena in which the molecules of a substance are uniformly distributed through out the body of other substance. Absorption is a bulk phenomenon.
- Calcium chloride adsorbs water.
- If both adsorption and absorption takes place simultaneously then it is known as adsorption.

III Difference between and adsorption and adsorbs.

Absorption	**Adsorption**
1.It is the phenomenon in which the particles of gas or liquid get uniformly distributed throughout the body of the solid. 2. The concentration is the same throughout the material. Therefore, it is a bulk phenomenon. 3. Absorption occurs at uniform rate.	1.it is the phenomenon of higher concentration of particles of gas or liquid on the surface than in the bulk of the solid. 2. The concentration on the surface of the adsorbent is different from that in the bulk. 3. Adsorption is rapid in the beginning and its rate slowly decreases.

IV. Thermodynamics behind adsorption

- Adsorption of a gas liquid is a ways exothermic process, ΔH=-Ve.
- Adsorption lowers the degree of randomness of adsorbate (adsorbed substance gas/liquid). So ΔS=-Ve.
- *For a process to be spontaneous. ΔG=-Ve.
- As the adsorption proceeds, ΔH becomes less –Ve and slowly ΔH becomes equal to $T\Delta S$, which leads to zero value of ΔG, at this state equilibrium is attend.

V Types of Adsorption

- Based on the inter particle force of attraction between adsorbate and adsorbent, adsorption is of two types.

a) Physical adsorption (Physisorption). b) Chemical Adsorption. (Chemisorption).

Difference between physisorption and Chemisorptions

Physisorption	**Chemisorption**
1) It arises because of Vander Waals'forces. 2) It is not specific in nature. 3) It is reversible in nature 4) It depends on the nature of gas. More easily liquefiable gases are adsorbed readily 5) Enthalpy of adsorption is low (20-40) kJ mol-1) in this case. 6) Low temperature is favorable for adsorption. It decreases with increases of temperature. 7) No appreciable activation energy is needed. 8) It depends on the surface area. It increases with an increase of surface are 9) It results into multimolecular layers on adsorbent surface under high pressure.	1)It is caused by chemical bond formation 2.it is highly specific in nature 3).It is irreversible 4).It also depends on the nature of gas. Gases which can react with the adsorbent show chemisorptions. 5.Enthalpy of adsorption is high (80-240kJ mol^{-1} In this case. 6). High temperature is favorable for adsorption. It increases with the increase of temperature. 7) High activation energy is sometimes needed. 8) It also depends on the surface area. It too increases with an increase of surface area. 9. It results into unimolecular layer.

VI.Adsorption of gases on solids:

- Almost of all solids absorb gas to some extent, but the extent of adsorption is not same in the all gases.
- The extent of adsorption of gas on solid surface depends on the following factors.
  a) Nature of adsorbent and adsorbate.
  b) Specific area / Surface area of adsorbent.
  c) Effect of temperature.
  d) Effect of pressure.
  e) Activation energy.
  f)

VII.Adsorption Isotherm:

- The amount of gas adsorbed on given mass of adsorbent increases with increase of pressure at given temperature up to maximum extent and then remains constant.
- A graph drawn between extent of adsorption $\frac{x}{m}$ and pressure at constant temperature is adsorption isotherm

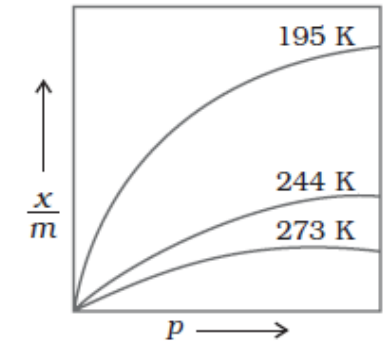

Fig. 5.1: Adsorption isotherm

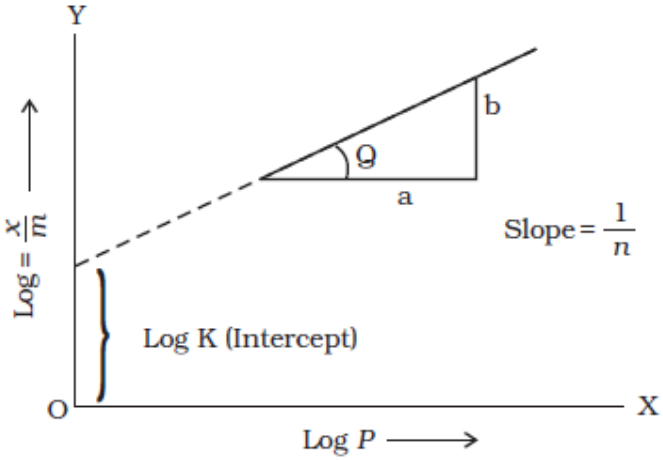

Fig. 5.2: Freundlich isotherm

- In the above diagram (graph) at low pressure region $\frac{x}{m} \ \alpha \ P^1$
- At high pressure region $\frac{x}{m} \ \alpha \ P^0$
- At inter intermediate pressure $\frac{x}{m} \ \alpha \ P^{0\text{-}1}$ or $\frac{x}{m} \ \alpha \ p^{\frac{1}{n}}$

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

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

Log k and $\frac{1}{n}$ values are obtained by plotting $\log \frac{x}{m}$ along Y axis and log p along X axis.

VIII. Adsorption isobar:

- The amount of gas adsorbed on a given adsorbent depends on temperature at given pressure.
- A graph drawn between extent of adsorption ($\frac{x}{m}$) and temperature (T) at constant pressure is Isobar.
- In physisorption extent of adsorption ($\frac{x}{m}$) decreases with increase of temperature (T) A graph drawn between extent of adsorption ($\frac{x}{m}$) and temperature (T) at constant pressure is physisorption Isobar.
- In chemisorption extent of adsorption ($\frac{x}{m}$) increase with increase of temperature (T), up to maximum extent and then starts decreasing with increasing of temperature. A graph drawn between extent of adsorption ($\frac{x}{m}$) and temperature (T) at constant pressure is Chemisorption Isobar.

IX.Applications of adsorption:

- **Gas Mask**
- **Humidity control**
- **Removal of colored impurities**
- **Heterogeneous catalysis**
- **Separation of inert gases**
- **Curing diseases**
- **Froth floatation process**
- **Adsorption indicators**
- **Chromatographic analysis.**

X. Catalyst

- Catalyst is a substance which alters the rate of reaction(may increase or decrease the rate of reaction)
- If a catalyst increases the rate of reaction then it is called the +ve catalyst.
- If a catalyst decreases the rate of reaction then it is called the -ve catalyst.
- If the catalyst, reactants and products all are in the same phase, then that is homogeneous catalyst. Examples are as follows

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

- If the catalyst, reactants and products all are in different phase, then that is homogeneous catalyst. Examples are as follows

$$2SO_2(g) + O_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$$

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

- A substance which enhances the efficiency of a catalyst is known as **promoter.** Mo (molybdenum) acts as promoter in Haber's manufacture of Ammonia.

$$N_2(g) + 3H_2(g) \xrightarrow[Mo(\,promoter)]{Fe(catlyst)} 2NH_3$$

- A substance which lowers the efficiency of a catalyst is known as **catalytic poison.** Arsenic and its compounds like $\mathbf{As_2O_5}$ act as poison contact processes for manufacture of sulphuric acid.

I. How catalyst alters the rate of reaction:

Catalyst alters the rate of reaction by altering the activation energy (E_a) of reactants.

- Catalyst offers an alternate path to the reactants in which they need less activation energy in the case of + ve catalyst.

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- The energy profile diagram for a catalyst which increases the rate of a reaction is as shown below.

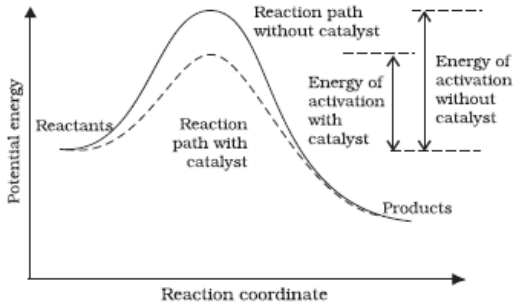

Fig. 4.11: Effect of catalyst on activation energy

XII. Important features of solid catalysis:

- **Activity of a catalyst:** the ability of a catalyst to increase the rate of a reaction is called activity of a catalyst. The catalytic activity increases as we move from group 5 to group11.Maximum activity is shown by groups 7 -9 elements of modern periodic table.

  "A catalyst may accelerate the rate of reaction up to 10_{10} times". For example mixture of H_2 and O_2 can react violently in the presence of Platinum (pt) even it may cause explosion due to release of more amount of heat.

- **Selectivity of a catalyst:**

$$CH \equiv CH + H_2 \xrightarrow{Pt} CH_3 - CH_3$$

$$CH \equiv CH + H_2 \xrightarrow{Linderscatalyst} CH_2 = CH_2$$

- Lindler's catalyst is Palladium (Pd) and Barium sulphate ($BaSO_4$) poisoned by quinoline.

XIII.Zeolites as catalysts:

- Zeolites are micro porous aluminosilicates with 3D net work of silicates in which some silica (Si) atoms are replaced by aluminum (Al) atoms.
- The pore size in zeolites varies from 260pm to 740pm.
- Depending on the molecular size of reactants, products and pores size of zeolites (which acts as catalyst) reaction will proceed in a particular direction to yield specific product(S).
- ZSM-5, Zeolite is used to convert alcohols to gasoline by dehydration of alcohols.
- Zeolites are found in nature as well as synthesized.

XIV. Enzyme catalysis:

- Enzymes are Nitrogenous organic compounds mostly proteins acts as catalyst in biochemical reactions so they are also referred as Biocatalysts.
- Numerous chemical reactions that occur in plants and animals are catalyzed by enzymes. Some of the examples are
- "An average meal requires nearly 40 – 45 years for complete digestion in an average human being with out taking the help of an enzyme".
- The following table gives the list of many enzymes which act as a catalyst in our body.

XV. Characteristics of enzyme catalysis:

- Highly efficient
- Highly specific
- Highly active under optimum temperature, pH
- Activated by co-enzymes
- Affected by inhibitors and poisons

XVI. Mechanism of enzyme catalysis: (Lock and Key Mechanism):

Various steps involved in enzyme catalysis are

$$E + S \rightarrow ES$$

ES → EP
EP → E + P
E = Enzyme. S = Substrate. P = Product.

XVII. COLLOIDS

- Colloid is heterogeneous system in which dispersed phase particles with 1nm to 1000 nm size are distributed in dispersion medium.
- Colloidal particles have enormous surface area per unit mass as a result of their tiny size; this enormous surface area is responsible for its special properties.
- Colloids are classified on the basis of following criteria.
  a) Physical state of dispersion media and dispersion phase.
  b) Nature of interaction between dispersion media and dispersion phase.
  c) Type of dispersed phase particles.
- Colloids are classified on the basis of dispersion medium and dispersion phase.

- Colloids are classified on the basis of interaction between dispersion medium and dispersion phase are a) Lyophilic and lyophobic colloids. Lyophilic means solvent loving-can be directly prepared by mixing a suitable dispersion phase with dispersion medium-these are reversible-examples-starch sol etc.
- Lyophobic means solvent-hating. Can be prepared by indirect methods. Not so stable and ireversible. Eg. Ferric hydroxide sol, aluminium hydroxide sol, arsenic sulphide sol, sulphur sol and all metal sols.

- Colloids are classified on the basis of size of the dispersion phase particle.
  a) Multimolecular colloids b) Macromolecular colloids c) Associated colloids

Multimolecular colloids: On dissolution, a large number of atoms or smaller molecules of a substance aggregate together to form species having size in the colloidal range (diameter<1nm). The species thus formed are called multimolecular colloids. For example, a gold sol may contain particles of various sizes having many atoms. Sulphur sol consists of particles containing a thousand or more of S_8 sulphur molecules.

Macromolecular colloids: Macromolecules (Unit 15) in suitable solvents form solutions in which the size of the macromolecules may be in the colloidal range. Such systems are called macromolecular colloids. These colloids are quite stable and resemble true solutions in many respects. Examples of naturally occurring macromolecules are starch, cellulose, proteins and enzymes; and those of man-made macromolecules are polythene, nylon, polystyrene, synthetic rubber, etc.

Associated colloids (Micelles): There are some substances which at low concentrations behave as normal strong electrolytes, but at higher concentrations exhibit colloidal behaviour due to the formation of aggregates. The aggregated particles thus formed are called **micelles**. These are also known as **associated colloids**. The formation of micelles takes place only above a particular temperature called **Kraft temperature** (T_k) and above a particular concentration called **critical micelle concentration (CMC)**. On dilution, these colloids revert back to individual ions. Surface active agents such as soaps and synthetic detergents belong to this class. For soaps, the CMC is 10^{-4} to 10^{-3} mol L^{-1}. These colloids have both lyophobic and lyophilic parts. Micelles may contain as many as 100 molecules or more.

- The minimum concentration from which dispersed phase starts forming micelle is known as critical micelization constant.(CMC). It is generally 10^{-4} to 10^{-3} mol/lit.
- The optimum temperature from dispersion phase particles starts forming micelles is known as craft temperature (T_k).
- Micelle contains as many as hundred molecules are more.
- Soap solution or detergent acts as good conductors of electricity at low concentration but not at high concentration because at high concentration micelles are formed.

XVIII. CLEANSING ACTION OF SOAPS.

Soap when applied on an oily/greasy skin surface along with water hydrophobic alkyl part Penetrates into oil/grease. Whereas $-COO^-$ remains in water. This disparity leads to the formation of micelle above CMC. Each micelle possess negative charge and repels its neighboring micelle are easily washed away by water.

XIX. PREPARATION OF COLLOIDS.

Colloids are prepared by
a) Chemical methods
b) Electrical disintegration or Bredig's arc method
c) Peptization.

(a) Chemical methods

Colloidal solutions can be prepared by chemical reactions leading to formation of molecules by double decomposition, oxidation, reduction or hydrolysis. These molecules then aggregate leading to formation of sols.

$$As_2O_3 + 3H_2S \xrightarrow{\text{Double decompostion}} As_2S_3(sol) + 3H_2O$$

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

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

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

(b) Electrical disintegration or Bredig's Arc method

This process involves dispersion as well as condensation. Colloidal sols of metals such as gold, silver, platinum, etc., can be prepared

by this method. In this method, electric arc is struck between electrodes of the metal immersed in the dispersion medium (Fig. 5.8). The intense heat produced vapourises the metal, which then condenses to form particles of colloidal size.

C. Peptization

The process of converting precipitate into colloidal solution by shaking it with small Amount of electrolyte and sufficient amount of dispersion medium is known as peptization. Generally colloidal particles adsorbs common ion from added electrolyte either positive or negative.

Examples:

Precipitate of $Fe(OH)_3$ + $FeCl_3$ gives $Fe(OH)_3$ ferric hydroxide sol.

Precipitate of As_2S_3 + H_2S gives As_2S_3arsenius sulphide sol.

Precipitate of AgI + $AgNO_3$ gives AgI Silver iodide sol.

XX. SOURCES OF CHARGE ON COLLOIDAL PARTICLES.

a) Adsorption of ions from electrolyte
b) Adsorption of electrons due to friction.

XXI. PROPETIES OF COLLOIDS.

Generally colloids possess the following properties.

i) colligate properties
ii) Tyndall effect
iii) Color
iv) Brownian movement
v) Charge on colloidal particle
vi) Electrophoresis.

Tyndal effect: The scattering of light by colloidal particles is known as Tyndall effect, the scattered light is in the form of a cone so it is called tyndal cone. Zigmondy design the first microscope based on tyndal effect.

Tyndal effect is observed only when the following conditions are satisfied.

i) The diameter of the dispersed particles is not much smaller than the wavelength of the light used.
ii) The refractive indices of the dispersed phase and the dispersion medium differ greatly in magnitude.

Brownian movement: the zig-zag motion of colloidal particles in dispersion medium is known as Brownian movement. Which was observed by British Botanist Robert Brown when pollein grains are left in water.

The primary reason for Brownian movement is constant collision between dispersion medium particles and dispersion phase particles, the secondary is that in general all colloidal particles have similar charge and they may repel with each other.

Electrophoresis: the movement of colloidal particles in eclectic field is know as electrophoresis. If they move towards anode than it is called anaphoresis. If the they move towards cathode it is called cataphoresis.

Electrophoresis is totally different from electro osmosis.

XXII. COAGULATION.

The process of separation of dispersion phase from dispersion medium is known as coagulation or precipitation or flocculation. This can be done by any of the following base.

- By Electrophoresis
- By mixing two oppositely charged sols
- By boiling
- By persistent Dialysis
- Addition of electrolyte
-

XXIII.HARDY-SCHULZE RULES OF COAGULATION.

i) coagulation is cause by ion which is having opposite charge to that of charge present on colloidal particles. This ion which causes coagulations is known as effective ions.
Example:
$Fe(OH)_3$ sol can be coagulated by adding NaCl, in this contest Cl^- is effective ion which causes coagulation of positive $Fe(OH)_3$ sol .

ii) The coagulating power of effective ion is directly proportional to its charge (valency).
Example:
$Fe(OH)_3$ sol can be coagulated more effectively by Na_2SO_4 than NaCl. Because the effective ion of Na_2SO_4 is SO^{-2} which has more charge.
The coagulating power of Al^{3+} , Ba^{2+}, Na^+ in coagulation negative sols like As_2S_3 is in the order of $Al^{3+} > Ba^{2+} > Na^+$.

XXIV.EMULSION.

Emulsions are special type of colloidal solutions in which both dispersion medium and dispersion phase are in liquid state. There are two types of emulsions

a) Oil dispersed in water (O/W) type.
b) Water dispersed in oil (W/O) type.

The above two emulsions are distinguished are by using dye test or dilution test.

- If an emulsion is diluted by water then it will be oil in water type emulsion otherwise it is water in oil type.
- The conductivity of oil in water type emulsion increases by adding any ionic compound which is soluble in water.
- If a dye is added to oil in water type emulsion color droplets are noticed because added dye is soluble only in oil but not in water.

XXV: APPLICATIONS OF COLLOIDS.

- Electrical precipitation of smoke
- Tanning
- Cleansing Action of Soaps
- Photographic Plates and Rubber Industry
- Industrial Products like ink, paints
- Purification of drinking water
- Medicines

XVI.COLLOIDS WHICH WE WILL COME ACROSS IN OUR DAILY LIFE.

- **Blue color of the sky**
- **Artificial rains**
- **Food articles like milk, butter and halwa**
- **Blood**
- **Formation of deltas**

SECTION "B"(SURFACE CHEMISTRY)

Q1. How is the adsorption of a gas related to its critical temperature?
Solution:
Higher is the critical temperature of a gas; greater is the ease of liquefaction of gas i.e, Larger are the Vanderwall's forces of attraction. Therefore, grater is the adsorption.

Q2. Which of the two: absorption or adsorption is a surface phenomenon?
Solution:
Adsorption.

Q3. Compare the heat of adsorption for physical and chemical adsorption?
Solution:
The heat of adsorption for chemical adsorption is high (of the order of 200-400 kJ/mol) while the heat of adsorption for physical adsorption is low(of the order of 20-40 kJ/mol).

Q4. In case of chemisorption, why adsorption first increases and then decreases with temperature?
Solution:
Chemisorption involves activation energy. The initial increase in chemisorption is due to the fact the heat supplied acts as activation energy and more and more molecules of adsorbate gain energy and posses energy greater than activation energy, Therefore, adsorption increase with increase in temperature. Further increase will increase the energy of the molecules absorbed and will increase the rate of desorption. Therefore, extent of adsorption decreases.

Q5. Give reason why a finely divided substance is more effective as and adsorbent?
Solution:
This is because a finely divided substance has larger surface area and, hence, larger adsorption occurs.

Q6. A small amount of silica gel and a small amount of anhydrous calcium chloride are placed separately in two corners of a vessel containing water vapour. What phenomena will occur?
Solution:
Adsorption of water will occur on silica gel and absorption of water will occur on calcium chloride.

Q7. How is adsorption of a gas related to its critical temperature?
Solution:
Higher is the critical temperature of the gas, greater is the ease of liquefaction i.e., the

Greater are the Vanderwall's forces of attraction and, hence, larger adsorption will occur.

Q8. What form Freundlich adsorption isotherm equation take at high pressure?
Solution:

$\frac{x}{m}$=K_a i.e., it becomes independent of pressure at constant temperature.

Q9. Why are lyophilic colloidal sols. More stable than lyophobic colloidal sols?
Solution:
The Lyophilic colloidal sols. Are more stable because3 they are highly hydrated in Solution.

Q10. Give one test to distinguish whether the given emulsion is oil in water typoe or water in oil type emulsion.
Solution:
It can be identified by dilution test. In this method, the emulsion is diluted with water. If the emulsion gets diluted with water, this means that water acts as the dispersion medium and it is an example of oil in water emulsion. If, it is not diluted than oil acts as dispersion medium and it is an example of water in oil emulsion.

Q11. Give an example of i) micelles system ii) macromolecular colloid
Solution:
i) Sodium stearate ($C_{17}H_{35}COO^-Na^+$) ii) Proteins.

Q12. What is the difference in the nature of a dilute soap solution and a concentrated soap solution?
Solution:
Dilute soap solution behaves like a true solution whereas concentrated soap solution Behaves like a colloidal solution.

Q13. What happens when a colloidal sol of $Fe(OH)_3$ and As_2O_3 are mixed?
Solution:
Their mutual precipitation takes place.

Q14. The conductance of an emulsion increases on adding common salt. What type of Emulsion is this?
Solution:
Oil in water type emulsion.

Q15. Give two examples of colloidal solutions of liquid dispersed in solid. What is the Name of the colloidal solution?
Solution:
Jelly. Cheese.
The name of this colloidal solution is gels.

Q16. What does reciprocal of gold number indicate?
Solution:
Reciprocal of gold number is a measure of protective power of colloid. Smaller the value of gold number greater will be its protecting power.

Q17. What is the charge on the colloidal particles in the following?
i) $Fe(OH)_3$ sol ii) As_2S_3 sol iii) colloidal sol of silver?

Solution:

i) $Fe(OH)_3$ sol : +ve

ii) As_2S_3 sol : -ve

iii) Colloidal sol of silver : -ve.

Q18. Which of the following is most effective in coagulating ferric hydroxide sol?

i) KCl ii) $FeCl_3$ iii) Na_2SO_4 iv) $K_3[Fe(CN)_6]$

Solution:

Since $Fe(OH)_3$ sol is positively charged, the anion having highest charge will be moste Effective i.e., $[Fe(CN)_6]^{3-}$

Q19. What is desorption and occlusion?

Solution :

The process of removing adsorbed substance from the surface of solid is desorption.

The adsorption of a gas on metal is known as occlusion.

Q20. The extent of physical adsorption decreases with rise in temperature why?

Solution :

i)The physisorption shows the features of physical process .As physisorption is generally exothermic, the extent of physisorption decreases with rise in temperature.

ii) The physisorption is due to weak wander wall bond between absorbent and adsorbate which starts breaking with rise in temperature.

Q21. How to prepare colloidal solution by chemical method?

Solution :

i) Double decomposition: $As_2O_3 + {}_3H_2S \rightarrow As_2S_3 + 3H_2O$

ii)Oxidation : $SO_2 + H_2S \rightarrow 3S + 2H_2O$

iii)Reduction $2AuCl_3 + HCHO + 3H_2O \rightarrow 2Au + 3HCOOH + 6HCl$

iv) Hydrolysis: $FeCl_3 + 3H_2O \rightarrow Fe(OH)_3 + 3HCl$

Q22. What is sorption?

Solution:

It is a process in which both Adsorption as well as desorption takes place simultaneously.

Q23. Explain the peptization.

Solution:

It is the process of conversion of precipitate in to a colloidal solution by shaking the Precipitate with suitable electrolyte. Electrolyte used is also called as peptizing agent.

Example: Shaking c Precipitate with $FeCl_3$ solution gives + sol

Shaking As_2S_3 Precipitate with H_2S solution gives – sol

Q24. What is the pore size in zeolite? Give two examples of Zeolites.

Solution: The pore size in zeolite is 260 – 740 pm.

Applications are i) Isomerisation of hydrocarbons ii) Cracking of hydrocarbons.

Q25. Write down the homogeneous catalyst involved in the polymerization of ethane.

Solution:

Zeigler –Natta catalyst $(C_2H_5)_3 Al + TiCl_4$

Q26. Why are colloids good adsorbents?

Solution:

Colloids have enormous surface area.

Q27. Give two examples of – vely charged sol and + vely charged sols.

Solution:

i) $Fe(OH)_3$ ferric hydroxide sol has +ve charge due adsorption of Fe^{+3} ions.

ii) As_2S_3 arsenious sulphide sol has - ve charge due adsorption of S^{-2} ions.

iv) Gold sol is –vely charged.

Q28. Which of the following more effective in coagulating $Fe(OH)_3$ and why ? Na_2PO_4,Na_2SO_4, NaCl.

Solution:i) $Fe(OH)_3$ sol is +vely charged so it will be coagulated by –ve ionic of added electrolyte. ii) Coagulating power is directly proportional to charge , so PO^{-4} is more effective.

Q29. Give the formula of ZSM-5.

Solution:

ZSM-5 stands for Zeolite sieve of molecular porosity-5,it is aluminosilicate.

$H_x[(AlO_2)_x(SiO_2)_{96-x}].16H_2O$

Q30. Under what conditions a molecular solution becomes colloidal solution?

Solution: i) If a molecular has less than 1nm size, is subjected to Reduction. Hydrolysis, Oxidation ,double decomposition which leads to association of molecules/atoms formed in this processes leads to formation colloidal solution .

ii) If a (single) molecule it self has colloidal dimension then also molecular solution becomes colloidal solution.

Q31. How will you distinguish two types of emulsions oil in water & water in oil?

Solution:

1) Dye test: A small amount of oil soluble dye is added to it. i) if it is water in oil type the background become colored. i) if it is oil in water type colored droplets can be seen.

2) Dilution test: Water is added to the emulation i) If it is diluted by water then it is oil in water type.ii) If it is not diluted by water and forming two separate layers then it is oil in water type .

Q32. Which will be adsorbed more readily on the surface of charcoal and why NH_3 or CO_2?

Solution:

NH_3 because it is more easily liquefiable. Hence, NH_3 has greater intermolecular force and will be adsorbed more readily.

Q33. How does the catalyst work in a chemical reaction?

Solution:

A catalyst provides alternative path to the reactants in which they need less activation energy.

Q34. What is the flocculation?

Solution:

At lower concentration of electrolytes the aggregation of colloidal particles is called Flocculation.

Q35. Give the Hardy-Schulze Rule?

Solution:

i) The ions carrying charge opposite to that of sol. Particles are more effective in causing coagulation of colloidal solution. These ions are called active ions.

ii) Coagulation power of electrolyte is directly proportional to the valency of active ions causing coagulation.

Q36. Give four applications of colloids?
Solution:

i) Rubber plating
ii) Sewage disposal
iii) In making disinfectants
iv) In making pharmaceutical preparations.
v) For purifying water.
vi) For precipitating carbon from smoke. (Cottrell smoke precipitator)
vii) Artificial rains.
viii) Delta formation at the place where river joins with sea.

Q37. How Cottrell smoke precipitator use to purify smoke from colloidal particles?
Solution:
When smoke is passed through Cottrell smoke precipitator the carbon particles get discharged And precipitated by applying high voltage, while smoke comes out of chimney of industrial plant.

Q38. What is meant by Kraft temperature (T_k) and critical micelle concentration (CMC)?
Solution:
The optimum temperature from which micelle formation starts is Kraft temperature (T_k). The optimum concentration from which micelle formation starts is critical micelle concentration (CMC).

Q39. Delta is generally formed when river meets the Ocean. Why?
Solution:
River water is a colloidal solution of negatively charged silicates, clay and other earthly Impurities. Sea water consists of Ca^{2+} ions and Mg^{2+} ions. So coagulation takes place at the place where Sea water and river water meets each other which leads to delta formation.

Q40. State an important use of elecrodialysis in human beings?
Solution:
Human blood is a colloidal solution which consists of sum unwanted impurities which are produced by various bio chemical reactions takes place which also posses some electrolytes, these electrolytes may cause coagulation of blood. So they can be removed before they causes damage to the human blood. This can be done by electro dialysis .
It is used in the purification of blood in the case of Kidney failure.

Q41. What phenomenon will occur when silica gel and anhydrous calcium chloride are placed separately in two corners of a vessel containing water vapour.
Solution:
Adsorption of water takes place in the case of silica gel. Whereas absorption of water takes place in the case of anhydrous calcium chloride.

Q42. Artificial rain can be caused by spraying common salt on the clouds. How?
Solution:
Clouds are colloidal dispersion of water particles in air. These colloidal water particles carry some charge on applying salt in the cloud , coagulation of water particles takes place , which causes artificial rains.

Q43. Explain the modern adsorption theory heterogeneous catalysis?

Solution:

i) Diffusion of reactant to the surface of catalyst.
ii) Adsorption of molecules of reactant at the active site.
iii) Formation of intermediate on the surface of catalyst.
iv) Desorption of product molecules.
v) Diffusion of products from the surface of catalyst and allowing new reactant molecules.

Q44. What are catalytic poisons and catalytic promoters?

Solution:

The substances which decreases the activity of catalyst is catalytic poison. Eg. Arsenic, acts as catalytic poison in contact process for the manufacture of H_2SO_4.
The substances which increases the activity of catalyst is promoter. Eg. Molybdenum acts as promoter for iron catalyst in the manufacture of NH_3 by Haber's process.

Q45. What is colloidon ?

Solution:

Colloidon is a sol. Of cellulose nitrate in ethyl alcohol.

Q46. what is electro kinetic potential or Zeta potential?

Solution:

The potential difference between fixed layer and diffused layer of opposite charges is called Zeta potential.

Q47. The conductance of an emulsion by adding common salt? What type of emulsion is this?

Solution:

It is oil in water type emulsion.

Q48. How charges develop on colloidal particles?

Solution:

A charge on the colloidal particles is due to

i) Electron capture by sol. Particles during electro dispersion of metal by Bridge's-arc method
ii) Preferential adsorption of ions from solutions.
iii) Formation of electrical double layer.

Q49. How the nature of adsorbate affects the adsorption of gases on solids?

Solution:

Easily liquefiable gases like NH_3, CO_2, HCl get adsorbed to greater extent than permanent gases like H_2,O_2,N_2 etc,. the ease of liquefaction of a gas depends upon its critical temperature. Higher is the critical temperature more easily will be adsorbed on solid.

Q50. By the chemical reaction show the selectivity of a catalyst?

Solution:

The ability of a catalyst to direct reactants to form a particular product is know as selectivity .

$$CO + 3H_2 \xrightarrow{Ni} CH_4 + H_2O$$

$$CO + 2H_2 \xrightarrow[Cu]{Ca/ZnO/Cr_2O_3} CH_3OH$$

$$CO + H_2 \longrightarrow HCHO$$

Q51. Why the sun looks red at the time of setting? Explain on the basis of Colloidal properties.

Solution:

At the time of setting, 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.

Q52. "Action of soap is due to emulsification and micelle formation".Comment.

Solution:

Yes, action of soap is due to emulsification and micelle formation. Soaps are sodium salt of higher fatty acids like sodium stearate, $C_{17}H_{35}COO^-Na^+$

$$\underset{\text{Sod. Stearate}}{C_{17}H_{35}COO^-Na^+} \rightleftharpoons \underset{\text{Stearate ion}}{C_{17}H_{35}COO^-} + Na^+$$

Q53. Differentiate between homogeneous and heterogeneous catalysis. Give one example for each.

Solution:

Homogeneous catalysis:-A catalysis in which the catalysts are present in the same phase as the reactants. For example- oxidation of CO gas with O_2 gas in the presence of NO gas as catalyst.

Heterogeneous catalysis:-A catalysis in which a catalyst is present in different phase than that of the reactants. For example- manufacture of ammonia from nitrogen and hydrogen gases using solid iron as catalyst.

Q54. What are the important features of a solid catalyst?

Solution:

The important features of a solid catalyst are: -

i) Activity: - Its capacity to increase the speed of the chemical reaction.

ii) Selectivity: - Its ability to direct the reaction to form particular products.

iii) Specificity:-A given substance can act as a catalyst for a particular reaction only and not for all reactions.

Q55. Give any four factors on which adsorption of a gas on a solid depend?

Solution:

The factors on which the adsorption of a gas on a solid depends are:

i) Surface area of adsorbent :-Higher the surface area larger the adsorption

ii) Temperature :-Adsorption of a gas decreases with increase in temperature

iii)Pressure :-At a constant temperature the adsorption increases with increase in pressure

iv) Nature of adsorbed gas :-Different gases are adsorbed to different extents by the same adsorbent

Q56. Compare the coagulating power of $AlCl_3$ with that of NaCl. Given that their coagulation values are 0.0930 and 52 respectively.

Solution:

As coagulating power is inversely proportional to coagulating value,

Thus, $AlCl_3$ has 559 times greater coagulating power than NaCl.

Q57. Describe the preparation of the following colloidal solution.
(a) Silver sol
(b) Sulphur sol
Solution:
(**a) Preparation of Silver sol: -** By the reduction of very dilute solution of silver salts with a suitable reducing agent

$2AuCl_3 + 3SnCl_2$ ----------> $2Au + 3SnCl_4$

Gold sol
(b) Preparation of Sulphur sol: - By the oxidation of H_2S in the presence of suitable oxidizing agent like nitric acid, bromine water, etc.
$H_2S + Br_2$ ----------> $S + 2HBr$
$H_2S + 2HNO_3$ ----------> $2H_2O + 2NO_2 + S$

Q58. What is demulsification? Name two demulsifiers.
Solution:
The process of separation of the constituent liquids of an emulsion is called demulsification. Demulsification can be done by centrifugation or boiling.

Q59. Give any two reasons for the origin of electrical charge on the colloidal particles.
Solution:
The two reasons are:
i) Due to electron capture by sol particles during electro dispersion of metals, due to preferential adsorption of ions from solution
ii) Dissociation of colloidal sols.

Q60. How is Langmuir adsorption isotherm superior to Freundlich adsorption isotherm?
Solution:
Langmuir adsorption isotherm is superior to Freundlich adsorption isotherm because
a) The results obtained from this isotherm are in better agreement with experimental values.
b) It is applicable over a wider range of pressure.

Q61. How can a solid adsorbent be activated?
Solution:
A solid adsorbent can be activated by increasing the surface area of the adsorbent which can be done by :-
a)Making the surface of the adsorbent rough
b)By subdividing the adsorbent into smaller particles
c) By removing the gases already adsorbed

Q62. What are the steps involved in the enzyme catalyzed reactions?
Solution:
Steps involved in the enzyme catalyzed reactions are:-
i) Formation of enzyme substrate complex.
ii) Dissociation of the enzyme substrate complex to form the products.

Q63. What is the difference between the lock-key model and the induced-fit model of Enzyme action?
Solution:
In lock-key model the substrate fits into the already existing active sites on the enzyme as a key fits into a lock. But, in induced-fit model it's the substrate that induces changes in the active sites of the enzymes to adopt a perfect fit.

Q64. What is emulsion? What are their different types?

Solution:

An emulsion is the colloidal dispersion in which both the dispersed phase and the dispersion mediums are liquids. They can be of two types:-

i) Emulsion of oil in water.

ii) Emulsion of water in oil.

Q65. What is emulsion? What are their different types?

Solution:

A catalyst lowers the activation energy for the forward as well as the backward reaction. As a result the reaction follows an alternate path by which the equilibrium is attained quickly but the equilibrium constant remains unchanged.

Q66. Differentiate between electrophoresis and electro-osmosis?

Solution:

Electrophoresis is the movement of colloidal particles under the influence of an electrical field.

Electro-osmosis is the movement of dispersion medium molecules under the influence of electric field when colloidal particles are not allowed to move.

Q67. How can 'a' & 'b' be calculated for Langmuir adsorption isotherm: $x/m = aP/1+bP$?

Solution:

Dividing both sides by P and taking the reciprocal we get $P/(x/m) = 1/a + bP/a$. Plotting the graph of $P/(x/m)$ vs P gives slope equal to b/a and intercept 1/a from which 'a' and 'b' can be calculated.

Q68. How can 'a' & 'b' be calculated for Langmuir adsorption isotherm: $x/m = aP/1+bP$?

Solution:

Dividing both sides by P and taking the reciprocal we get $P/(x/m) = 1/a + bP/a$. Plotting the graph of $P/(x/m)$ Vs P gives slope equal to b/a and intercept 1/a from which 'a' and 'b' can be calculated.Q51

SECTION – C (SURFACE CHEMISTRY)

PREVIOUS YEARS' CBSE BOARD QUESTIONS

1. **How are the colloids classified on the basis of the nature of interaction between dispersed phase and dispersion medium? Describe an important characteristic of each class. Which of these sols need stabilizing agents for preservation?**

Solution:

On the basis of the nature of interaction between the dispersed phase and dispersion medium , colloidal sols are divided into two class, i.e., Lyophilic(Solvent attracting) and lyophobic(solvent repelling).Characteristic of Lyophilic sol. The dispersion medium is separated from the dispersed phase (by evaporation), the sol can be reformed by simply remixing with the dispersion medium. Lyophilic sols are reversible. Characteristic of Iyophobic sol. It is precipitated or coagulated, it cannot be formed. Lyophobic sols are irreversible.Lyophobic sols require stabilizing agent for preservation.

2. **What are detergents? Give their scheme of classification. Why are the detergents Preferred over soaps?**

Solution:

Detergents are the synthetic material of the type sodium alkyl benzene sulphonates used for cleansing clothes.

Classification

i) Anionic	**ii) cationic**	**iii) Nonionic**
(alkylbenzene-sulphonate) $CH_3(CH_2)_{16}\ CH_2OSO_3^-Na^+$	(Cetyltrimethyl ammonium chloride) $[CH_3(CH_2)_{15}\ 2N(CH_3)_3]^+Cl^-$	$CH_3(CH_2)_{16}COO(CH_2\ CH_2O)_n\ CH_2\ CH_2OH$

Detergents are preferred over soaps as its cleansing action is not affected by hard water.

3. Illustrate with examples:

i) Lyophilic and Lyophobic sols.

ii) Multimolecular and Macromolecular colloids.

iii) Homogeneous and Heterogeneous catalysis.

Solution:

(i) Lyophilic and Lyophobic sols. The word 'Lyophilic**'** means liquid-loving. Colloidal Sols directly formed by substances like gum, gelatin, starch, rubber, etc. On mixing with a suitable liquid (the dispersion medium) are called lyophilic sols for example, gelatin dissolved in water. The word 'Lyophobic' means liquid –hating. Substances like metals, their sulphides etc. When simply mixed with the dispersion medium do not form the colloidal sol. Their colloidal sols can be prepared only by special methods. Such sols are called lyophobic sols for example, arsenius sulphide sol.

(ii) Multimolecular and Macromolecular colloids. When on dissolution , a large number of atoms or smaller molecules of a substance aggregate together to form species having size(with diameters less than 1 nm)in the colloidal range, the species thus formed are called multimolecular colloids e.g., gold sol, sulphur sol.

(iii) Homogeneous and Heterogeneous catalysis. In Homogeneous catalysis reactants, products and catalyst all are in same phase e.g.,

$$2SO_2(g) + O_2(g) \xrightarrow{NO_2(g)} 2SO_3(g)$$

Whereas in heterogeneous catalysis reactants and products are in the same phase or different but the catalyst is in solid phase e.g.,

$$2SO_2(g) + O_2(g) \xrightarrow{V_2O_5(s)} 2SO_3(g)$$

4 Explain the following observations:

i) A beam of light passing through a colloidal solution has a visible path.

ii) Passing an electric current through a colloidal solution removes colloidal sulphate.

iii) Ferric hydroxide sol coagulates on addition of a solution of potassium sulphate.

Solution:

i) Tyndall effect. When a beam of light is passed through a colloidal solution the path of light becomes visible. This phenomenon is known as Tyndall effect. Colloidal solution exhibits this property due to its heterogeneous nature.

ii) Electrophoresis. Migration of colloidal sol particles towards the electrode under the influence of electric current is called electrophoresis or cataphoresis. Negatively charged particles move towards anode and positively charged particles move towards cathode. In this way charged colloidal particles are removed. See figure given bellow.

iii) When potassium sulphate is added to ferric hydroxide sol, the sol gets precipitated. Ferric hydroxide sol is a multimolecular colloid.

5 What are the two classes of emulsions? Give one example of each class. State one activity to test the type of an emulsion.

Solution:

Emulsions are of two types:

(i) Oil in water emulsion.

Examples: Milk, Vanishing cream.

(ii) Water in Oil emulsion.

Examples: Butter, cod liver oil.

If the emulsion can be diluted with water, this indicates that water is the dispersion medium and the emulsion is of oil-in-water type. In case the added water forms a separate layer, the emulsion is water-in-oil type.

6 (a) How can a colloidal solution and true solution of the same color be distinguished from each other?

(b) List four applications of adsorption.

Solution:

(a) A strong beam of light is passed through both the solutions in the dark. The solution which makes the path of the beam illuminated with bluish light is a colloidal solution. The path becomes visible due to scattering of light by colloidal particles. It is called Tyndal effect. The true solution does not show Tyndal effect.

(b) Applications of Adsorption:

1. In heterogeneous catalysis, for example, manufacture of NH_3 by Haber's process.
2. In qualitative analysis, for example, lakes test for Al^{3+}.
3. In chromatography for separation of mixtures. It is based on selective adsorption of substances.
4. In ion exchange resins\s for softening of hard water.
5. Depolarization of cane sugar by animal charcoal.

7. Explain the following observations:

(a) Lyophilic colloid is more stable than lyophobic colloid.

(b) Coagulation takes place when sodium chloride solution is added to a colloidal solution of ferric hydroxide.

(c) Sky appears blue in color.

Solution:

(a) The strong force of attraction between the dispersed phase and the dispersion medium make Lyophilic sols more stable than lyophobic sols.

(b) When sodium chloride is added to a colloidal solution of ferric hydroxide, Cl^- ions from NaCl neutralize the positive charge on ferric hydroxide sol particles and thus cause coagulation of the sol.

(c) The dust particles in air exhibit Tyndal effect. They cause scattering of light due to which sky appears blue in color.

8 Explain the following terms giving a suitable example in each case:

(i) Emulsification

(ii) Homogeneous catalysis.

Or

Define adsorption. Write any two features which distinguish physisorption from chemisorption.

Solution:

i) Emulsification The process of making an emulsion is called emulsification by mixing dispersion phase and dispersion medium together with small amount of emulsifying agent. Example: water 10 ml + 2 drops oil along with few drops of soap solution.

ii) Homogeneous catalysis. Catalyst and reactant are in the same phase.

$$\xrightarrow{NO(g)}$$

e.g., $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

$$CH_3COOCH_3(l) + H_2O(l) \longrightarrow CH_3COOH(aq) + CH_3OH(aq)$$

Or

9 **Explain what is observed when:**

i) An electrolyte is added to ferric hydroxide sol.

ii) An emulsion is subjected to centrifugation.

iii) Direct current is passed through a colloidal sol.

Solution:

i) When an electrolyte is added to ferric hydroxide sol, the sol is destabilized, i.e., precipitate .is formed.

ii) When an emulsion is subjected to centrifugation emulsion is broken into constituent liquids.

iii) When a direct current is passed through colloidal sol, the migration of the colloidal

particles occurs towards electrodes. Negatively charged particles move towards anode and +vely charged particles move towards cathode. The movement of charged particles under the influence of electric current is called electrophoresis.

10. Explain the following terms:
i) Peptization
ii) Dialysis
iii) Hardy- Schulze rule.

Solution:

i) Peptization. The method of changing a precipitate into colloidal form by adding an electrolyte solution is called peptization, and the electrolyte used for this purpose, is called peptizing agent.

Example: Freshly precipitated ferric hydroxide can be peptized to a reddish brown sol by the addition of a small quantity of ferric chloride solution (a peptizing agent)

$Fe(OH)_3(s) + Fe^{3+} \longrightarrow Fe(OH)_3\ Fe^{3+}$

(peptizing agent) Sol

ii) Dialysis. Particles of true solutions can pass through parchment paper or cellophane membrane. On the other hand, sol particles cannot pass through these membranes. A bag made up of such a membrane is filled with the colloidal solution and is then suspended in fresh water. The electrolytic particles pass out leaving behind the colloidal sol.

Movement of ions across the membrane can be expedited by applying electric potential through two electrodes. This method is faster than simple dialysis and is known as Electro dialysis.

iii) Hardy- Schulze rule. Colloidal solutions are precipitated by addition of electrolytes. However precipitating power of different electrolytes is not the same. The precipitating power of an electrolyte is given by the generalization called Hardy-Schulze rule according to which the greater the valency of the active ion, the grater is its precipitating power. For example, in the precipitation of negatively charge sol such as muddy water, trivalent Al^{3+} ions are more effective than bivalent Ba^{2+}ions or monovalent Na^{+} ions. Similarly in the coagulation of positively charged sol such as $Fe(OH)_3$ sol, trivalent PO^{3-}_4 ions are more effective than bivalent So^{2-}_4 ions or monovalent Cl^{-} ion.

11. Explain the following terms giving an example in each case.
i) Emulsification
ii) Coagulation
iii) Electrophoresis.

Solution:

i) Emulsification. An emulsion is a colloidal system consisting of two immiscible liquid phases, one of which is dispersed as globules in another. Examples: Milk (liquid fat dispersed in water), butter (water dispersed in liquid fat).

ii) Coagulation. The colloidal particles carry similar type of charge and due to mutual electrical repulsions they are kept apart. However, they can be precipitated or coagulated by boiling, or by adding an electrolyte or by adding an oppositely charged sol. The phenomenon of precipitation of a colloidal solution by adding electrolyte is called coagulation' and solid that separate out under such conditions is called the coagulum.

iii) Electrophoresis. Migration of colloidal sol particles towards the electrode under the influence of electric current is called electrophoresis or cataphoresis. Negatively charged particles move towards anode and positively charged particles move towards cathode.

12. What do you understand by activity and selectivity of catalysts? Describe some features of catalysis by zeolites.

Solution:

Activity of catalysts. The ability of a catalyst to accelerate the rate of chemical reaction is known as the activity of catalyst. The acceleration of a chemical reaction by a catalyst may be as high as 10^{10} times in particular reaction. For example, H_2 gas and O_2 gas do not react at room temperature. However, in presence of platinum catalyst, the reaction between the two gases becomes explosive and leads to the formation of water. Thus, the presence of platinum activates the formation of water.

Selectivity of Catalysts. The ability of a catalyst to give particular products excluding others, is known as the selectively of the catalysts. For example, normal heptane (C_7H_{16}) selectively gives toluene ($C_6H_5CH_3$) in presence of platinum catalyst. Similarly propylene (CH_3- CH = CH_2) and oxygen give selectively acrolein (CH_2 = CH – CHO) in presence of bismuth molybdate catalyst.

Important features of zeolites:

i) Zeolites are shape selective catalyst.
ii) Shape selective catalysis depends on the pore structure.
iii) The pores size in zeolites generally varies between 260 pm to 740 pm.
iv) Depending on the size of the reactant and product molecules compared to the size of the pores of the zeolite, reactions proceed in a specific manner.

13.. How do size of particles of adsorbent, pressure of gas and prevailing temperature influence the extent of adsorption of a gas on a solid?

Solution:

i) Specific area of the adsorbent. Specific area of an adsorbent is the surface area available for adsorption per gram of the adsorbent. The greater the specific area of the solid, the grater would be its adsorbing capacity. That is why porous or finely divided forms of adsorbents adsorb larger quantities of adsorbate.

ii) Pressure. In general the adsorption of a gas over solid surface increases with increase of Pressure.

iii)Temperature. In general the adsorption of a gas over solid surface decreases with increase of temperature.

14. (a) In which of the following does adsorption take place and why?

i) Silica gel placed in the atmosphere saturated with water.

ii) Anhydrous $CaCl_2$ placed in the atmosphere saturated with water.

(b) How does BF_3 act as a catalyst in industrial process?

(c) Give an example of shape-selective catalysis.

Solution:

(a) i) Adsorption takes place in silica gel as water vapour is retained only on the surface

of it.

ii) Adsorption does not take place in anhydrous $Cacl_2$ because the water vapours are Uniformly distributed throughout the body of the solid.

(b) BF_3 forms an intermediate complex due to its electron deficient nature.

(c) Zeolities are shape-selective catalysts.

15. What are micelles? How do they differ from ordinary colloidal particles? Give two examples of micelles forming substances.

(a) State Hardy-Schulze rule.

Solution:

(b) Micelles are substances which behave as strong electrolytes at low concentrations but exhibit colloidal properties at higher concentrations due to the formation of aggregate particles. Ordinary colloidal particles exists in the dimensions comparable to those of colloidal particles and are called macromolecules whereas micelles obtain the colloidal size by aggregation and sometimes called associated colloids.

(c) The coagulation behaviour of various electrolytes was studied in detail by Hardy and Schulze. They found that

i) The ions carrying charge opposite to that of sol particles are effective in causing the coagulation of the sol.

ii) Coagulating power of an electrolyte is directly proportional to the fourth power of the valency of the ions causing coagulation.

16. Describe the following types of colloids, giving an example for each:

i) Multimolecular colloids. When a large number of atoms or smaller molecules of a substance aggregate together to form species having size(with diameters less than 1 nm) in the colloidal range are called multimolecular collloidals,e.g., a gold sol, sulphur sol.

ii) Macromolecular colloids. When the size of the macromolecules may be in the colloidal range such systems are called macromolecular colloids, e.g., starch, cellulose, proteins, enzymes.

17. Write about the following:

Solution:

i) Shape- Selective catalysis. The catalytic reaction that depends upon the pore structure of the catalyst and the size of the reactant and product molecules is called shape-selective catalysis. For example, zeolites.

ii) Dialysis. Removal of solution impurities from sols by a semi permeable membrane is known as dialysis. For example, ferric hydroxide sol.

18. Which will be adsorbed more readily on the surface of charcoal and why: NH_3 or Co_2?

Solution:

NH_3 has higher critical temperature than CO_2 and therefore, it is more easily liquefiable.

Hence, NH_3 has greater intermolecular forces of attraction and will be adsorbed more readily.

19. How do the size of particles of adsorbent, pressure of gas and prevailing temperature influence the extent of adsorption.

Solution:

i) Smaller the size of the particles of adsorbent, greater is the surface area and hence greater is the adsorption.

ii) At constant temperature, adsorption first increases with increase of pressure and then attains equilibrium at high pressure and becomes constant.

iii) In physical adsorption, it decreases, it decreases with increase of temperature but in chemisorption, it first increases becomes maximum and then decreases.

20. What is observed when sodium chloride is added to a colloidal solution of ferric hydroxide?

Solution:

When sodium chloride is added to ferric hydroxide sol, the sol. gets coagulated. This is because the Cl^- ions from NaCl neutralize the +ve charge on $Fe(OH)_3$ sol.

21. Complete the following:

i) The liquid-liquid colloidal dispersions are called…….

ii) The enthalpy of chemisorption is…… than the enthalpy of physisorption.

iii) The scattering of light by colloidal dispersion is called……

iv) The zig-zag motion of colloidal particles is called……

Solution:

i) Emulsions ii) more iii) Tyndall effect iv) Brownian movement.

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

Solution:

A reddish brown colloidal solution of $Fe(OH)_3$ is obtained. This process is called Peptization. The Fe^{3+} ions from $FeCl_3$ are adsorbed on the surface of the precipitate and form positively charged colloidal solution.

$FeCl_3 \rightarrow Fe_3^{+} + 3Cl^-$

$Fe(OH)_3 + Fe_3^{+} \rightarrow [Fe(OH)_3\ Fe_3^{+} + 3Cl^-$

23. 50mL of standard gold sol. Needs 0.05 mg of gelatin for its protection from coagulation. Calculate gold number of gelatin.

Solution:

50ml of gold sols. Require gelatin for protection from coagulation = 0.05 mg

10 ml of gold sol. Will require gelatin for protection from coagulation = 0.005 mg

Gold number of gelatin= 0.005.

24. 100 mlof a colloidal solution is completely precipitated by addition of 5 ml of 1 M NaCl .Calculate the coagulation value of NaCl.

Solution:

Coagulation value is the millimoles of an electrolyte that must be added to 1 L of a colloidal solution for complete coagulation

5 ml of 1 M NaCl= $\frac{1}{1000} X\, 5 = 0.005\, pt 5 mmoles$

100 mL of a colloidal solution require NaCl for complete coagulation = 5 m moles

1 L of colloidal solution require NaCl for complete coagulation = 50 m moles

Coagulation value of NaCl = 50.

25. What is the difference between a sol? And a gel?

Solution:

In a sol. Dispersion medium is liquid and dispersed phase is solid. On the other hand, in a gel, dispersion medium is solid and dispersed phase is liquid.

SECTION – D (SURFACE CHEMISTRY)

1. What is meant by Autocatalysis and induced catalysis?

2. Answer the following:
i) Why silica gel is used as dehumidizer?
ii) What is the significance of a gold number?
iii) Ferric hydroxide sol coagulates on addition of aqueous solution of sodium sulphate.
iv) Why gelatin is generally added to ice creams?

3. Explain as to what happens when:
i) Persistent dialysis of a colloidal sol is carried out.
ii) A beam of light is passed through colloidal sol.
iii) A dilute solution of $FeCl_3$ is added to freshly prepared $Fe(OH)_3$ sol.
iv) Gelatin is added to gold sol.

4. How do size of particles adsorbent, pressure of gas and prevailing temperature influence the extent of absorption of a gas on a solid?

5. Explain the following in brief.
i) Sun looks red at the time of sun set.
ii) Physisorption is multimolecular white chemisorption is monomolecular.

6. i) Suggest methods for preparing silver iodide sol. Which is positively charged and the one which is negatively charged.
ii) What do you understand by isoelectric point of a colloid?

7. i) What is the cause of Brownian movement?
ii) Compare the coagulating power of $K_2C_2O_4$ with that of KBr. Their respective coagulating values are 0.238 and 138.

8. What do you understand by the terms i) CMC ii) Kraft's temperature iii) Mc Bain micelle.

9. Explain as to why SnO_2 forms a positively charged sol. In solutions with $P^H < 7$ and negatively charged sol in solutions with $P^H > 7$.

10. i) How does enzyme catalyzed reaction varies with temperature and also with pH of medium.
ii) 1 L vessel contains a gas at 300 K.When 9 g of charcoal was put into it the pressure of the gas decreases by 40% of the original pressure which is 700m bar. Calculate the volume of the gas at 1 bar and 273.15 K adsorbed per gram of charcoal. Density of charcoal sample is 1.5 g cm^{-3}.

11. 1 g of charcoal adsorbs 100ml of 0.5 M CH_3COOH to form a monolayer, and thereby the molarity of CH_2 COOH reduces to 0.49. Calculate the surface area of the charcoal adsorbed by each molecule of acetic acid. Surface area of charcoal=3.01 x 10^2 m^2 lg.

12. 20% of surface sites are occupied by N_2 molecules. The density of surface sites is 6.023 x 10^{14} cm^{-2} and total surface area is 1000 cm^2. The catalyst is heated to 300 K while N_2 is completely desorbed into a pressure of 0.001 atm and volume 2.46 cm^3. Find the active sites occupied by each N_2 molecule.

13. The volume of nitrogen gas V_m(measured at 1 atm and 273.15 K required to cover a sample of silica gel with a monomolecular layer is 129 cm^3 g^{-1} of gel. Calculate the surface area per gram of the gel if each nitrogen molecule occupies 16.2 x 10^{-20} m^2.

14. In an adsorption experiment, a graph between log(x/m) versus log p was found to be linear with a slope of 45^0. The intercept on the log(x/m) axis was found to be 0.3010. Calculate the amount of the gas adsorbed per gram of charcoal under the pressure of 0.6 bar.

15. Give one example each of water in oil and oil in water emulsions.
16 How does adsorption of a gas on a solid surface vary with temperature?
17 What happens when sodium chloride is added to ferric hydroxide solution? Explain.
18 Name two important processes in which heterogeneous catalysts are employed.
19. Write Freundlich adsorption isotherm.
20. Name the lyophobic sols.
21. Give two examples of enzyme catalyzed reactions.
22. Explain what happens when:
a) Beam of light is passed through colloidal solution of As_2S_3
b) Sodium chloride is added to ferric hydroxide sol?
c) An electric current is passed through colloidal solution.

23. What are lyophobic sols? Describe the preparation of colloidal solution of ferric chloride by peptization.
24. Write Brownian movement in relation to a colloidal solution. Write two applications of adsorption.
25. What are Lyophilic and lyophobic sols? Compare the two terms in terms of stability and reversibility.
26. How will you differentiate between?
i) sols and emulsions
ii) physical adsorption and chemical adsorption
iii) Lyophobic and Lyophilic sols?
27. Describe a chemical method each for the preparation of sols of sulphur and platinum in water.

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