SURFACE CHEMISTRY

1. Which of the following is wrong :

(A) Enthalpy (numerical value) of physisorption is greater than that of chemisorption

(B) Physisorption is not very specific but chomisorption is highly specific

(C) Chemisorption takes place at relatively high temperatures

(D) In physisorption generally multi–molecular layers are formed on the adsorbent

2. Which of the following gases, will be adsorbed maximum on a solid surface :

(A) CO_2 (B) O_2 (C) N_2 (D) H_2

3. Which of the following is a mismatch :

(A) Lyophilic colloids – reversible sols

(B) Associated collides – micelles

(C) Tyndall effect – scattering of light by colloidal particle

(D) Electrophoresis – movement of dispersion medium under the influence of electric field

4. Which of the following ions will be most effective in coaogulating the As_2S_3 sol :

(A) Fe^{3+} (B) Ba^{2+} (C) Cl^- (D) PO_4^{3-}

5. When freshly precipated $Fe(OH)_3$ is shaken with aqeous solution of $FeCl_3$, a colloidal solution is formed. This process is known as :

(A) Emulsification (B) Coagulation (C) Petpization (D) Electro–osmosis

6. **STATEMENT-1 :** A gas with higher critical temperature is absorbed more than a gas with lower critical temperature on the same absorbent.

STATEMENT-2 : Higher critical temperature implies that the gas is more easily liquifiable.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

7. 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 gm of adsorbent :

(A) 0.4 (B) 0.6 (C) 0.8 (D) 0.1

Paragraph for Question Nos. 8 to 13

The Colloidal particles are electrically charged as is indictated by their migration toward cathode or anode under the applied electric field. In a particular colloidal system, all particles carry either positive charge or negative charge.

The electric charge on colloidal particles originate in several ways. According to preferential adsorption theory, the freshly obtained precipitate particles adsorb ions from the dispersion medium, which are common to their lattice and acquire the charge of adsorbed ions. For example, freshly obtained $Fe(OH)_3$ precipitated is dispersed, by a little $FeCl_3$, into colloidal solution owing to the adsorptions of Fe^{3+} ions in preference. Thus sol particles will be positively charged.

In some cases the colloidal particles are aggregates of cations or anions having ampiphilic character. When the ions possess hydrophobic part (hydrocarbon end) as well as hydrophilic part (polar end group), they undergo association in aqueous solution to form particles having colloidal size. The formation of such particles, called micelles plays a very important role in the solubilization of water insoluble substances, (hydrocarbon, oils, fats, grease etc.). In micelles, the polar end groups are directed towards water and the hydrocarbon ends into the centre.

The charge on sol particles of proteins depends on the pH. At low pH, the basic group of protein molecule is ionized (protonated) and at higher pH (alkaline medium), the acidic group in ionized. At Isoelectric pH, characteristic to the protein, both basic and acidic groups are equally ionized.

The stability of colloidal solution is attributed largely to the electric charge of the dispersed particles. This charge causes them to be coagulated or precipitated. On addition of small amount of electrolytes, the ions carrying opposite charge are adsorbed by sol particles resulting in the neutralization of their charge.When the sol particles either with no charge or reduced charge, come closer due to Browman movement, they coalesce to form bigger particles resulting in their separation from the dispersion medium. This is what is called coagulation or precipitation of the colloidal solution. The coagulating power of the effective ion, which depend on its charge, is expressed in terms of its coagulating value, defined as its minimum concentration (m mol/L) needed to precipitate a given sol.

8. A gelatin sol at pH less then the isoelectric value is subjected to an electric field. The sol particles migrate toward

(A) Anode (B) Cathode

(C) Both anode and cathode (D) Neither anode nor cathode

9. Which of the following ions would have the minimum coagulating value for sol obtained on peptizing $Sn(OH)_4$ by little NaOH solution.

(A) Cl^- (B) SO_4^{2-} (C) K^+ (D) Ba^{2+}

10. How would you obtain a sol of AgI, the particles of which migrate toward cathode under the electric field ?

(A) By adding little excess of KI to $AgNO_3$ solution

(B) By adding little excess of $AgNO_3$ to KI solution

(C) By mixing equal volumes of 0.010 M $AgNO_3$ and 0.010 M KI

(D) None of these

11. When 9.0 ml of arsenius sulphide sol and 1.0 ml of 1.0×10^{-4} M $BaCl_2$ are mixed, turbidity due to precipitation just appears after 2 hours. The effective ion and its coagulating value are respectively

(A) Cl^-, 10 m mol/L (B) Cl^-, 20 m mol/L (C) Ba^{2+}, 10 m mol/L (D) Ba^{2+} , 20 m mol/L

12. 100 ml each of two sols of AgI, one obtained by adding $AgNO_3$ to slight excess of KI and another obtained by adding KI to slight excess of $AgNO_3$, are mixed together. Then

(A) The two sols will stabilize each other

(B) The sol particles will acquire more electric charge

(C) The sols will coagulate each other mutually

(D) A true solution will be obtained

13. Under the influence of an electric field, the particles in a sol migrate towards cathode. The coagulation of the same sol is studied using NaCl, Na_2SO_4 and Na_3PO_4 solutions. Their coagulating values will be in the order

(A) $NaCl > Na_2SO_4 > Na_3PO_4$ (B) $Na_2SO_4 > Na_3PO_4 > NaCl$

(C) $Na_3PO_4 > Na_2SO_4 > NaCl$ (D) $Na_2SO_4 > NaCl > Na_3PO_4$

14. Surfactant molecules can cluster together as micelles, which are colloid sized cluster of molecules. Micelles form only above critical micelle concentration (CMC) and above certain temperature called Kraft temperature. ΔH of micelle formation can be positive or negative. Which is false about micelle formation?

(A) ΔS of micelle formation is positive

(B) the hydrophobic part lie towards interior of micelle

(C) the hydrophilic part lie towards surface of micelle

(D) ΔS of micelle formation is negative

15. Which of the following statements is **correct** with respect to colloidal state and surface phenomenon.

(A) Gold sol can be coagulated by SO_4^{2-} ion.

(B) Sb_2S_3 sol can be coagulated by adding $Fe(OH)_3$ sol.

(C) Adsorption processes are entropy driven process always.

(D) At very high pressures, adsorption increases with pressure.

16. When blood containing "Haemoglobin" as the colloidal partial is subjected to electro osmosis. The dispersion medium moves towards the anode. Hence, the incorrect statement will be

(A) $Fe(OH)_3$ solution on mixing with haemoglobin in blood can cause coagulation

(B) As_2S_3 solution can cause coagulation in blood on mixing.

(C) In electrophoresis of blood, movement of colloidal particle will be towards cathode.

(D) NaCl on mixing in blood can cause coagulation.

17. What happens when lyophillic sol is added to a lyophobic sol?

(A) A film of lyophillic sol is formed over lyophobic sol and lyophobic sol is stabilized.

(B) Lyophobic sol gets coagulated.

(C) Lyophillic sol gets coagulated.

(D) Lyophillic sol gets protected by the lyophobic sol.

18. Identify the statements which is **incorrect** w.r.t. surface phenomenon.

(A) A sol, prepared by adding excess $AgNO_3$ solution in KI solution when subjected to electro-phoresis will show coagulation near cathode.

(B) The conductivity of a soap solution decreases steeply at CMC.

(C) Tyndall effect will be more prominent in gold solution as compared to rubber solution.

(D) Extent of physisorption increases with increase in temperature initial and then decreases with temperature.

19. If $Fe(OH)_3$ sol is subjected to electrophoresis then which of the following statement regarding coagulation will be correct.

(A) No coagulation will occur at any electrode.

(B) Coagulation will occur at cathode

(C) Coagulation will occur at anode

(D) Coagulation will occur at both the electrodes

20. Among the following electrolytes which is the most effective coagulating agent for $Fe(OH)_3$ sol.

(A) Na_2SO_4 (B) KCl (C) $Mg_3(PO_4)_2$ (D) CH_3COONa

21. Which of the following statements is **correct** with respect to Langmuir adsorption theory?

[x $\rightarrow$ represents mass of adsorbed gas**, m** $\rightarrow$ represents mass of adsorbent**]**

(A) Graph of $\frac{x}{m}$ vs P will be linear always. (B) Graph of $\frac{m}{x}$ vs P will be linear always.

(C) Graph of $\frac{m}{x}$ vs $\frac{1}{P}$ will be linear always. (D) Graph of $\frac{x}{m}$ vs $\frac{1}{P}$ will be linear always.

22. When a white chalk stick is dipped in ink then

(A) the coloured pigments in the ink get absorbed in the chalk.

(B) the solvent get adsorbed on the surface

(C) the inside of the chalk will remain as white

(D) both surface as well as inside will have the coloured pigments.

23. An aqueous solution of sodium stearate, $C_{17}H_{35}COONa$, becomes a colloidal sol at the concentration of 1.2×10^{-3} M at 25°C. If at this concentration, 2.4×10^{13} colloidal (micelle) particles are present per mm^3, the number of stearate ions in each colloidal particle is : ($N_A = 6 \times 10^{23}$)

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

24. One gm of charcoal adsorbs CH_3COOH from 100 ml 0.6 M CH_3COOH aqueous solution to form a mono-layer, and thereby the molarity of CH_3COOH reduces to 0.58. Calculate the surface area of the charcoal adsorbed by each molecule of acetic acid. Surface area of charcoal = 3.0×10^2 m^2/gm.

(A) 5 nm^2 (B) 0.5 nm^2 (C) 0.25 nm^2 (D) 2.5 nm^2

25. A colloidal solution of $Mg(OH)_2$ is prepared by adding excess of NaOH in aq. $MgCl_2$ solution. The best coagulating agent for the $Mg(OH)_2$ sol, thus obtained, is :

(A) $FeCl_3$ (B) $CaCl_2$ (C) $FeSO_4$ (D) Na_3PO_4

26. On adding $AgNO_3$ solution into KCl solute, a positively charged colloidal sol is obtained when they are mixed in:

(A) 200 ml of 0.2 M $AgNO_3$ + 200 ml of 0.2 M KCl

(B) 100 ml of 0.1 M $AgNO_3$ + 50 ml of 0.2 M KCl

(C) 100 ml of 0.15 M $AgNO_3$ + 100 ml of 0.1 M KCl

(D) 100 ml of 0.1 M $AgNO_3$ + 100 ml of 0.15 M KCl

27. Which of the following statement is **incorrect**?

(A) The elevation in boiling point of an alcoholic solution of sulphur is more than that of its sol in water, if mass of sulphur present per unit volume of mixture is same in both case.

(B) CMC value of $CH_3(CH_2)_9NH_2Cl$ will be less than that of $CH_3(CH_2)_6COONa$.

(C) Freundlich adsorption theory is followed at all pressures.

(D) $CO_{2(g)}$ can displace adsorbed $O_{2(g)}$ from surface of an adsorbent showing physisorption.

ANSWER AND SOLUTION

1. **(A)**

Sol. from the knowledge of two types of adsorptions.

2. **(A)**

Sol. Easily liquefiable gases like CO_2 are adsorbed to a greater extent than gases like O_2, N_2 and H_2

3. **(D)**

Sol. Electrophoresis means movement of colloidal particles under the influence of electric field.

4. **(A)**

Sol. According Hardy-Schulze rule

5. **(C)**

Sol. Conversion of a freshly prepared ppt. into a colloidal solution by application of a suitable electrolyte is called peptization.

6. **(B)**

Sol. Both assertion ans reason are correct but reason is not correct explanation.

7. **(B)**

Sol. $\log \frac{x}{M} = \log k + \frac{1}{n} \log P$

$\frac{1}{n} = \tan 45°$ $\log k = 0.3010$

$n = 1$ $k = 2$

$\frac{x}{m} = 2 \times (0.3)^1$

$x = 0.6$

8. **(B)**

Sol. At low pH the basic group will be ionized (protonated) so will have positive charge and hence sol particles will move towards cathode.

9. **(D)**

Sol. Minimum coagulating value will be for the ion with maximum charge and since the sol particles are negatively charged, hence positively charged are required for coagulations

10. **(B)**

Sol. We want to prepare sol of AgI having positively charged particles, so a little excess of Ag^+ should be added to KI.

11. **(C)**

Sol. Conc. of $Ba^{2+} = \frac{10^{-4}}{10 \times 10^{-3}}$ M = 10^{-2} M = 10 mmole/L.

12. **(C)**

Sol. The sols will neutralise each other so will coagulate each other.

13. **(A)**

Sol. Greater the charge on negative ions of salt used (since sol is positively charged) smaller will be its coagulating value.

14. (A)

Sol. The formation of micelle only above certain temperature called Kraft temperature suggests positive ΔS of micelle formation which even overcome effect of positive ΔH of micelle formation. Besides kinetic effect also become important at high temperature.

15. (B)

Sol. Sb_2S_3 is the negatively charged sol.

16. (A)

Sol. Dispersion medium moves towards anode
$\Rightarrow$ dispersion medium has –ve charge
$\Rightarrow$ dispersed phase has +ve charge
$\Rightarrow Fe(OH)_3$ cannot cause coagulation

17. (A)

Sol. (A) It is the correct statement.
(B) Lyophobic sol get protected not Lyophilic.
(C) Lyophillic sol don't get coagulated.
(D) Lyophillic sol get protected not lyophobic sol.

18. (D)

Sol. (A) AgI / Ag^+ positively charged solution (excess $AgNO_3$)
(B) Factual information
(C) Tyndall effect is more dominating in lyophobic solution
(D) Extent of physisorption decreases with increase in temperature.

19. (B)

Sol. $Fe(OH)_3$ is positively charged colloidal sol hence coagulation will occur at cathode.

20. (C)

Sol. $Fe(OH)_3 \longrightarrow$ +ve sol
$\therefore$ Most effective coagulation agent = $Mg_3(PO_4)_2$ having greater –ve charge. PO_4^{3-} has – 3 negative charge.

21. (C)

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

$$\frac{m}{x} = \frac{1}{ap} + \frac{a}{b}$$

$\downarrow$

$$y = \frac{1}{a}x + C$$

22. (C)

Sol. Solvent will be absorbed while solute will be adsorbed on surface.

23. (A)

Sol. $1mm^3 = 10^{-9}\ m^3$
$1m^3 \longrightarrow 10^3$ litre
$10^{-4}\ m^3 \longrightarrow 10^{-6}$ litre

number of particle = $\dfrac{1.2\times10^{-9}\times N_A}{2.4\times10^{13}}$

$= \dfrac{1}{2}\times10^{-22}\times6\times10^{23} = 30$

24. (C)

Sol. mm of CH_3COOH adsorbed = 2

number of molecule = $2 \times 10^{-3} \times 6 \times 10^{23} = 12 \times 10^{20}$

area adsorbed by each molecule = $\frac{3\times10^{6}}{12\times10^{20}}$

$= 0.25 \times 10^{-14}$ cm^2

$= 25 \times 10^{-16}$ cm^2 $= 0.25 \times 10^{-14}$ cm^2

$= 0.25$ nm^2

25. (A)

Sol. $MgCl_2 + 2NaOH \longrightarrow Mg(OH)_2 + 2NaCl$

excess Negatively charged sol

26. (C)

Sol.

$AgNO_3$ +	KCl	$\rightarrow$	AgCl	+	KNO_3
100 × 0.15		100×0.1			
15		10	0		0
5		0	10		10

A positively charged will be obtained when $AgNO_3$ is in large quantity.

27. (C)

Sol. (A) because of solution formation number of sulphur particles will be less in water.

(B) CMC α size of hydrophobic portion.

(C) it is applicable for limited range of pressure.

(D) CO_2 is non polar having more molecular mass so will be adsorbed more and replace O_2 (non polar gas with less molecular mass)