CHAPTER

10 Surface Chemistry

1. Which of the following statements about colloids is false?

(a) When excess of electrolyte is added to colloidal solution, colloidal particle will be precipitated.

(b) Freezing point of colloidal solution is lower than true solution at same concentration of a solute.

(c) When silver nitrate solution is added to potassium iodide solution, a negatively charged colloidal solution is formed.

(d) Colloidal particles can pass through ordinary filter paper.

(Online 2018)

2. 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 constant and $n > 1$)

(a) log k (b) n (c) $2k$ (d) $\frac{1}{n}$

(Online 2018)

3. Which one of the following is not a property of physical adsorption?

(a) Unilayer adsorption occurs.
(b) Greater the surface area, more the adsorption.
(c) Lower the temperature, more the adsorption.
(d) Higher the pressure, more the adsorption.

(Online 2018)

4. The Tyndall effect is observed only when following conditions are satisfied

(A) the diameter of the dispersed particle 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 the dispersion medium differ greatly in magnitude.

(a) (A) and (C) (b) (B) and (C)
(c) (A) and (D) (d) (B) and (D) *(2017)*

5. Among the following, correct statement is

(a) Hardy Schulze law states that bigger the size of the ions, the greater is its coagulating power
(b) sols of metal sulphides are lyophilic
(c) one would expect charcoal to adsorb chlorine more than hydrogen sulphide
(d) Brownian movement is more pronounced for smaller particles than for bigger particles.

(Online 2017)

6. 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 ($\frac{x}{m}$ is the mass of the gas adsorbed per gram of adsorbent)

(a) adsorption is proportional to the pressure
(b) adsorption is proportional to the square root of pressure
(c) adsorption is proportional to the square of pressure
(d) adsorption is independent of pressure.

(Online 2017)

7. 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.)

(a) Both k and $1/n$ appear in the slope term.
(b) $1/n$ appears as the intercept.
(c) Only $1/n$ appears as the slope.
(d) log ($1/n$) appears as the intercept. *(2016)*

8. A particular adsorption process has the following characteristics : (i) It arises due to van der Waals forces and (ii) it is reversible. Identify the correct statement that describes the above adsorption process.

(a) Adsorption is monolayer.
(b) Adsorption increases with increase in temperature.
(c) Enthalpy of adsorption is greater than 100 kJ mol^{-1}.
(d) Energy of activation is low. *(Online 2016)*

9. 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?

(a) Gelatin (b) Starch
(c) Oleate (d) Gum Arabic

(Online 2016)

10. The following statements relate to the adsorption of gases on a solid surface. Identify the incorrect statement among them.

(a) Enthalpy of adsorption is negative.
(b) Entropy of adsorption is negative.
(c) On adsorption, the residual forces on the surface are increased.
(d) On adsorption decrease in surface energy appears as heat.

(Online 2015)

11. Under ambient conditions, which among the following surfactants will form micelles in aqueous solution at lowest molar concentration?

(a) J O_8-J $O_{7\cdot 6:}^{0}$V-J $O_{8\cdot 8}$I ~

(b) $CH_3(CH_2)_{13}OSO_3^-Na^+$

(c) $CH_3(CH_2)_8COO^-Na^+$

(d) J O_8-J $O_{7\cdot 66}^{0}$V-J $O_{8\cdot 8}$I ~ *(Online 2015)*

12. The coagulating power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphide sol increases in the order :

(a) $Al^{3+} < Na^+ < Ba^{2+}$ (b) $Al^{3+} < Ba^{2+} < Na^+$

(c) $Na^+ < Ba^{2+} < Al^{3+}$ (d) $Ba^{2+} < Na^+ < Al^{3+}$

(2013)

13. According to Freundlich adsorption isotherm, which of the following is correct?

(a) $\frac{x}{m} \propto p^1$ (b) $\frac{x}{m} \propto p^{1/n}$

(c) $\frac{x}{m} \propto p^0$

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

(2012)

14. Which of the following statements is incorrect regarding physisorption?

(a) It occurs because of van der Waals forces.

(b) More easily liquefiable gases are adsorbed readily.

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

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

(2009)

15. 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

(a) $B < D < A < C$ (b) $D < A < C < B$

(c) $C < B < D < A$ (d) $A < C < B < D$

(2008)

16. In Langmuir's model of adsorption of a gas on a solid surface

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

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

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

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

(2006)

17. 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?

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

(b) Sodium sulphate solution causes coagulation in both sols

(c) Mixing of the sols has no effect

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

(2005)

18. The volume of a colloidal particle, V_c as compared to the volume of a solute particle in a true solution V_s could be

(a) ~ 1 (b) ~ 10^{23}

(c) ~ 10^{-3} (d) ~ 10^3 *(2005)*

19. Which one of the following characteristics is not correct for physical adsorption?

(a) Adsorption on solids is reversible

(b) Adsorption increases with increase in temperature

(c) Adsorption is spontaneous

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

(2003)

ANSWER KEY

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

Explanations

1. (b) : Freezing point of colloidal solution is higher than true solution at the same concentration of a solute.

2. (d) : According to Freundlich adsorption isotherms, $\frac{x}{m} = kP^{1/n}$

Taking log on both sides, $\log\frac{x}{m} = \log k + \frac{1}{n}\log p$

A graph between $\log \frac{x}{m}$ *vs* $\log p$ gives a straight line with slope equal to $\frac{1}{n}$.

3. (a) : Physical adsorption forms multimolecular layer.

4. (d)

5. (c, d) : Higher the critical temperature of the gas, more will be its adsorption. As critical temperature of chlorine is more than H_2S, so it is adsorbed more on charcoal surface. Also, Brownian movement is more prominent for smaller particles.

6. (b) : $\log\left(\frac{x}{m}\right) = \frac{1}{2}\log(p) + \log k$

$\frac{x}{m} = kp^{1/2}$

Hence, adsorption is proportional to the square root of pressure.

7. (c) : For the Freundlich adsorption isotherm, equation is

x(s (—) = x(s + — x(s

Now, comparing this equation with $y = mx + c$, slope - . = —;

intercept (c) = $\log k$

8. (d) : In physical adsorption, no activation energy or very low activation energy is required.

9. (a) : Gold number $\propto \frac{1}{\text{Protective power}}$

10. (c) : After adsorption their is decrease in the residual forces due to bond formation. ΔG, ΔH and ΔS, all are negative in the case of adsorption.

11. (a) : Longer hydrophobic chain, $CH_3(CH_2)_{15}\overset{+}{V}(CH_3)_3Br^-$ will form micelles in aqueous solution at lowest molar concentration.

12. (c) : For a negatively charged sol, like As_2S_3, greater the positive charge on cations, greater is the coagulating power.

13. (d) : According to Freundlich adsorption isotherm

$\frac{x}{m} = kp^{1/n}$

$1/n$ can have values between 0 to 1 over different ranges of pressure.

14. (d) : Physical adsorption is an exothermic process (*i.e.*, ΔH = –ve) but its value is quite low because the attraction of gas molecules and solid surface is weak van der Waals forces.

15. (d) : The different protecting colloids differ in their protecting powers. Zsigmondy introduced a term called Gold number to describe the protective power of different colloids. Smaller the value of gold number greater will be protecting power of the protective colloid. Thus

protective power of colloid $\propto \frac{1}{\text{Gold number}}$

16. (c) : Assuming the formation of a monolayer of the adsorbate on the surface of the adsorbent, it was derived by Langmuir that the mass of the gas adsorbed per gram of the adsorbent is related to the equilibrium pressure according to the equation:

$\frac{x}{m} = \frac{aP}{1+bP}$

where x is the mass of the gas adsorbed on m gram of the adsorbent, P is the pressure and a, b are constants.

17. (c) : Opposite charges attract each other. Hence on mixing coagulation of two sols may be take place.

18. (d) : For true solution the diameter range is 1 to 10 Å and for colloidal solution diameter range is 10 to 1000 Å.

$\frac{V_c}{V_s} = \frac{(4/3)\pi r_c^3}{(4/3)\pi r_s^3} = \left(\frac{r_c}{r_s}\right)^3$

Ratio of diameters = $(10/1)^3 = 10^3$

$V_c/V_s \simeq 10^3$

19. (b) : During adsorption, there is always decrease in surface energy which appears as heat. Therefore adsorption always takes place with evolution of heat, *i.e.* it is an exothermic process and since the adsorption process is exothermic, the physical adsorption occurs readily at low temperature and decreases with increasing temperature. (Le Chatelier's principle).