E–760

M. Sc. (Third Semester)
EXAMINATION, Dec.-Jan., 2020-21

CHEMISTRY

Paper Third

(Catalysis, Solid State and Surface Chemistry)

Time : Three Hours]   [*Maximum Marks : 80*

[*Minimum Pass Marks : 16*

Note : Attempt all Sections as directed.

Section—A   1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. A surfactant with a very large Hydrophile-Lipophile Balance (HLB) value (e.g. 40) is expected to function as a :

    (a)   Anti-foaming agent

    (b)   Water in oil (w/o) emulsifier

    (c)   Oil in water (o/w) emulsifier

    (d)   Solubility enhancer

P. T. O.

2. Among the following surfactant molecules, the surfactant that forms micelles in aqueous solution at the lower CMC at ambient condition is :

   (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) $CH_3(CH_2)_{11}N + (CH_3)_3Br^-$

3. Which of the following statement(s) is/are correct for Gibbs Adsorption Isotherm ?

   (a)   It is an equation used to relate the change in concentration of a component in contact with a surface with a change in surface tension.

   (b)   It is used to estimate the surface excess concentration for surfactants (non-ionic and ionic surfactants).

   (c)   Gibbs adsorption equation corresponds to relatively solute solution, highly hydrated organic compounds and amphipathic species.

   (d)   All the statements are correct.

4. The Young-Laplace equation when applied to a spherically-shaped liquid drop indicates :

   (a)   The pressure inside the drop is the same as the pressure outside the drop.

   (b)   The pressure inside the drop is larger than the pressure outside the drop.

   (c)   The pressure inside the drop is smaller than the pressure outside the drop.

   (d)   The pressure inside the drop does not have a constant value.

5. The CMC of CTAB at 27 C is 1 mm (alpha = 1). The free energy of Micellization will be (R = 8.314 J) :

   (a) 27.0 kJ

   (b) – 34.46 kJ

   (c) – 27.0 kJ

   (d) 34.46 kJ

6. Which of the following statements about a plot of V^0 vs. [S] for an enzyme that follows Michaelis-Menten kinetics is false ?

   (a) K_m is the [S] at which $V^0 = 1/2\ V_{max}$.

   (b) The shape of the curve is a hyperbola.

   (c) The y-axis is a rate term with units of $\mu m/min$.

   (d) As [S] increases, the initial velocity of reaction, V^0, also increases. i.e. At very high [S] the velocity curve becomes a horizontal line that intersects the y-axis at K_m.

7. In competitive inhibition, an inhibitor :

   (a) binds at several different sites on an enzyme.

   (b) binds reversibly at the active site.

   (c) binds only to the ES complex.

   (d) lowers the characteristic V_{max} of the enzyme.

8. According to the Lewis' theory, a base _____.

   (a) is a proton acceptor

   (b) is a proton donor

   (c) makes available a share in a pair of electrons

   (d) produces OH^- ions in aqueous solution

9. Fluorosulfuric acid (HSO_3F) is one of the strongest Brønsted acids known, with H_0 (Hammett's Acidity Function) value is :

   (a)   – 15.1

   (b)   – 14.0

   (c)   15.1

   (d)   14.1

10. Which of the following is Alpha Nucleophiles ?

    (a)   Hydrazine

    (b)   Hypochlorite ion

    (c)   Hydroperoxide anion

    (d)   All of the above

11. Cations are present in the interstitial sites in _____.

    (a)   Frenkel defect

    (b)   Schottky defect

    (c)   Vacancy defect

    (d)   Metal deficiency defect

12. Which kind of defects are introduced by doping ?

    (a)   Dislocation defect

    (b)   Schottky defect

    (c)   Frenkel defect

    (d)   Electronic defect

13. Fermi energy level for intrinsic semiconductors lies :

    (a)   At middle of the band gap

    (b)   Close to conduction band

    (c)   Close to valence band

    (d)   None of the above

14. The most commonly used semiconductor is _____.

    (a) Germanium

    (b) Carbon

    (c) Sulfur

    (d) Silicon

15. What is the effect of at very high temperature on P-type semiconductors ?

    (a) Concentration of electrons and holes is almost equal due to ionization of donor ions and it turns into intrinsic semiconductor.

    (b) Concentration of holes is more and it becomes more positive.

    (c) More electrons are created and it turns into N-type semiconductor.

    (d) It turns more positive as more electrons will break the bonds and more holes are created.

16. In the formation of a macromolecule, what type of reaction would join two subunits together ?

    (a) Hydrophobic reaction

    (b) Hydrolysis reaction

    (c) Dehydration reaction

    (d) Denaturation reaction

17. Which of the following is a thermosetting polymer ?

    (a) Polystyrene

    (b) Polyolefins

    (c) Nylons

    (d) Phenolic resins

18. The number average molecular mass and mass average molecular mass of a polymer are 30,000 and 40,000 respectively. The polydispersity index of the polymer is :

    (a) < 1

    (b) > 1

    (c)   zero

    (d) $- 1.3$

19. The monomer used in the production of Nylon-66 are :

    (a)   Hexamethylene Diamine and Ethylene Glycol

    (b)   Hexamethylene Diamine and Phenylamine

    (c)   Hexamethylene Diamine and Adipic Acid

    (d)   Adipic Acid and Ethylene Glycol

20. In the formation of a macromolecule, what type of bond would join two amino acid subunits ?

    (a)   Ionic bond

    (b)   Phosphodiester bond

    (c)   Hydrogen bond

    (d)   Peptide bond

Section—B   2 each

(Very Short Answer Type Questions)

Note : Attempt all questions. Write answer in 2-3 sentences.

1. Write *two* applications of Acidity Function.
2. What is the difference between Nucleophilicity and Basicity ?
3. Define Critical Micelle Concentration and Counter Ion Binding.
4. Write Kelvin's equation and give its significance.

5. Define Perfect and Imperfect Crystal.

6. What are Intrinsic Semiconductors ?

7. Give *two* examples of Fire Resistant Polymer.

8. What is the theory of Sedimentation method for the determination of molecular weight of polymers ?

Section—C 3 each

(Short Answer Type Questions)

Note : Attempt all questions. Write answer within 75 words.

1. The pH of an aqueous solution of 3-nitrophenol is 4.91. Calculate its pK_{AH}.

2. Explain alpha effect nucleophiles with examples.

3. Write *one* method for the determination of CMC of ionic surfactants.

4. What is surface tension capillary action ?

5. Discuss the formation of colour centres in Alkali Halide Crystals.

6. Differentiate N-type and P-type Semiconductors.

7. What is electrically conducting polymers ? Write *one* application.

8. How one can calculate average dimensions of various chain structure of macromolecules ?
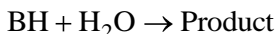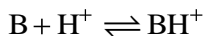
Section—D 5 each

(Long Answer Type Questions)

Note : Attempt all questions.

1. Define Acidity Function for acids and bases. Derive kinetic equation for the following reaction using Hammett's Acidity Function (H_0) :

$$B + H^+ \rightleftharpoons BH^+$$

$$BH + H_2O \rightarrow Product$$

Or

Explain Specific and General Acid-Base catalysis with suitable examples. What is pH-Rate acidity constant profile ?

2. Define Surface excess concentration and minimum surface area per molecule. Derive Gibbs Adsorption Isotherm.

Or

What is the significance of Thermodymanics of Micellization ? Discuss Mass Action and Phase Separation Models for ionic surfactants.

3. Explain how metallic conductors and semiconductors are identified. Discuss Band theory of Semiconductors.

Or

Explain crystal defects and Non-Stoichiometry. Discuss the thermodynamics of Frenkel and Schottky defects.

4. Discuss briefly viscometry and light scattering method for the determination of molecular weight of macromolecules.

Or

What is polymer ? How is it polymer classified ? Discuss the kinetics of polymerization with examples.