M.Sc. CHEMISTRY
THIRD SEMESTER
PHYSICAL CHEMISTRY III
MSC – 303
[USE OMR SHEET FOR OBJECTIVE PART]

SET

B

Duration : 3 hrs.

Full Marks : 70

(**Objective**)

Time: 30 min.

Marks: 20

Choose the correct answer from the following: **1X20=20**

1. The Gibbs-Duhem equation is given by

    a. $\sum n_i \, d\mu_i = 0$

    b. $\sum \mu_i \, dn_i + \sum n_i \, d\mu_i = 0$

    c. $\sum \mu_i \, dn_i = 0$

    d. $\sum \mu_i \, dn_i - \sum n_i \, d\mu_i = 0$

2. The potential in Debye-Huckel theory is proportional to
    a. $1/\kappa r$
    b. $\exp[-\kappa r]/r$
    c. $\exp[-\kappa r]$
    d. κr

3. The ground-state complex is formed in
    a. Static quenching
    b. Dynamic quenching
    c. Collisional quenching
    d. Both a and b

4. The variation of potential of the electrical double layer with distance into the solution is linear for which of the following model?
    a. Helmholtz-Perrin model
    b. Guoy-Chapmann's model
    c. Stern model
    d. Devanathan model

5. In the Born model, the work done in discharging is given by
    a. $W = z_i e_0$
    b. $W = \frac{1}{4\pi\varepsilon_0}\left\{\frac{(z_i e)^2}{2R}\right\}$
    c. $W = -\frac{1}{4\pi\varepsilon_0}\left\{\frac{(z_i e)^2}{2R}\right\}$
    d. $W = 0$

6. The catalyst used in photocatalysis is
    a. Au
    b. Raney Ni
    c. TiO_2
    d. Al_2O_3

7. Spin inversion of electrons do not take place in which the following process?
    a. Inter System Crossing
    b. Phosphorescence
    c. Both a and b
    d. None of the above

8. The excitation of a molecule without spin inversion gives rise to the
    a. Singlet excited state
    b. Triplet excited state
    c. Both the above
    d. None of the above

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9. The surface morphology of a solid catalyst can be characterized by
   a. XRD study
   b. TGA study
   c. SEM study
   d. NMR study

10. The chemical formula of zeolite is _____
    a. $FeSO_4.7H_2O$
    b. $Al_2(SO_4)_3.18 H_2O$
    c. $Na_2O.Al_2O_3.xSiO_2.yH_2O$
    d. Na_2Al_2O

11. Which is not an examples of unimolecular surface reactions
    a. Decomposition of N_2O on gold
    b. Decomposition of NH_3 on molybdenum
    c. Decomposition of HI on Platinum
    d. The reaction between H_2 and O_2 on platinum

12. The equation that accounts for the difference between Λ_m and Λ_m^0 is
    a. Debye-Huckel Limiting Law
    b. Debye-Huckel-Bjerrum equation
    c. Diffusion-Einstein
    d. Debye-Huckel-Onsager equation

13. Solutions of three electrolytes have the same ionic strength and different dielectric constants as 4, 25 and 81. The corresponding magnitude of Debye Huckel screening lengths of three solutions are
    a. 4, 25 and 81
    b. 2, 5 and 9
    c. 1/2, 1/5 and 1/9
    d. 1, 1 and 1

14. Which of the following statements are correct about solid catalyst?
    a. Catalyst does not change ΔH of reaction
    b. Catalyst is required in large quantities to catalyse reactions.
    c. Catalytic activity of a solid catalyst does not depend upon the strength of chemisorption
    d. None of the above

15. Which one is incorrect from the followings?
    a. Exciplex are polar species
    b. Excimer are non polar species
    c. Both a and b
    d. Excimer are polar species

16. Which of the following is also known as diffuse charge model
    a. Helmholtz-Perrin model
    b. Guoy-Chapmann's model
    c. Stern model
    d. Devanathan model

17. Thermal stability of a solid catalyst can be characterized by
    a. TGA
    b. FTIR
    c. DSC
    d. XRD

18. The thermally activated delayed fluorescence was first observed in
    a. Eosin
    b. Pyrene
    c. Anthracene
    d. None of the above

19. What are the chemicals needed to produce the glow?
    a. Nitrogen and Monosodium Glutamate
    b. Cyanide and Fluorescent Brightener
    c. Benzentricarboxylic acid and tris ester
    d. Luciferin and Luciferase

20. Photodynamic therapy:
    a. Involves use of a photosensitiser given by intravenous injection or orally
    b. Is an oxygen-dependent reaction
    c. Requires exposure to UVA
    d. May cause skin cancer

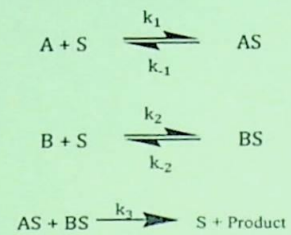-- --- --

$$\boxed{\textbf{Descriptive}}$$

Time : 2 hrs. 30 mins.   Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. a. Write two differences between excimer and exciplex quenching.   2+5+3
                                                                             =10
    b. The following mechanism has been proposed for a surface reaction,

$$A + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} AS$$

$$B + S \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} BS$$

$$AS + BS \xrightarrow{k_3} S + Product$$

Where, S is the vacant site on the surface. Using steady state approximation for the intermediate, show that the rate of the reaction is,

$$r = \frac{K' P_A P_B}{(K_1 P_A + K_2 P_B + 1)^2}$$

Where, the symbols have their usual meanings. Discuss the rate when both the reactants are weakly adsorbed.

   c. What is excess charge density? Give the expressions for the contributions of ionic cloud (Ψ_{cloud}) and the central ion (Ψ_{ion}) to the total potential (Ψ_r) at a particular distance (r) from the reference ion in strong electrolyte.

2. a. Write the general formula of Zeolite. Give two examples of important   2+2+1+
       zeolites.   3+2=10

    b. Explain the applications of Zeolites.

    c. What are effects of zeolites in hard water?

    d. What is the major role of using a phase-transfer catalysts? Write the main limitations of phase transfer catalysts.

    e. Write a short note on clay.

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3. a. Describe one technique for determination of surface area of a catalyst. **3+2+5 =10**

   b. What are the spectroscopic techniques mainly used to characterize a catalyst. Explain.

   c. Give the Debye Huckel Bjerrum equation. Calculate the mean ionic activity coefficient ($\gamma_\pm$) of NaCl at a molality of 0.01 in aqueous solution at 25° C.

4. a. What is chemiluminescence? Discuss use of chemiluminescence in forensics and glow-sticks. Give detailed reactions involve in each process. **2+6+2 =10**

   b. Write two success of Guoy-Chapmann's model.

5. a. What is fluorescence resonance energy transfer? Explain it. **3+3+4 =10**

   b. Define the terms Forster critical energy transfer distance and efficiency of energy transfer.

   c. Discuss the Helmholtz-Perrin model of electrical double layer.

6. a. Write Stern-Volmer equation for each of collisional and static quenching. Define each term used in these equations. **3+3+4 =10**

   b. Explain thermally activated delayed fluorescence using proper diagram.

   c. What do you mean by photosensitization? Explain the mechanism of photosensitization of ground state oxygen by porphyrin sensitizer.

7. a. Discuss the photocatalysis of ozone and photo-Fenton system. **4+4+2 =10**

   b. Explain Einstein's quantum theory of radiation and derive the expression for the ratio of Einstein's coefficients.

   c. Discuss the asymmetry effect in the conductance of strong electrolytes.

8. a. Derive the Lippmann equation. **7+3=10**

   b. Differentiate between polarizable and non-polarizable electrodes.

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