

M.Sc. CHEMISTRY
FOURTH SEMESTER
CHEMICAL DYNAMICS & ELECTROCHEMISTRY
MSC - 401C

**SET
A**

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

(PART-A: Objective)

Marks: 20

Choose the correct answer from the following:

1X20=20

- The mercury drop has which charge
 - Positive charge
 - Neutral charge
 - Negative charge
 - None of these
- DME act as
 - Anode
 - Cathode
 - Both anode and cathode
 - None of these
- Which current is measured in polarography
 - Diffusion current
 - Kinetic current
 - Limiting current
 - Residual current
- In DPP additional pulse is applied ___ of a drop
 - At beginning
 - In middle
 - Near the end
 - None of these
- The potential wave form is used in CV is
 - Linear
 - Pulse superimposed on staircase
 - Pulse superimposed on linear
 - Triangular
- Which of the following voltammetric techniques enhances the sensitivity through improving the faradaic current?
 - Differential pulse voltammetry
 - Square wave voltammetry
 - Cyclic voltammetry
 - Stripping voltammetry
- In polarography, saturated calomel electrode is used as.....
 - Polarizable electrode
 - Reference electrode
 - Non-polarizable electrode
 - Gas electrode
- Molecular reaction dynamics is the study of
 - The structure of molecules
 - The chemical properties of molecules
 - The spectroscopic properties of molecules
 - The rates and mechanisms of chemical reactions
- Which technique is commonly used to study molecular reaction dynamics?
 - X-ray crystallography
 - Nuclear Magnetic Resonance (NMR) spectroscopy
 - Mass spectrometry
 - Ultrafast laser spectroscopy

10. Which factor(s) influence the rate of a chemical reaction?
- Temperature
 - Concentration of reactants
 - Presence of a catalyst
 - All of the above
11. The concept of reaction rate refers to
- The speed at which products are formed
 - The activation energy of the reaction
 - The equilibrium concentration of reactants and products
 - The speed at which reactants are consumed
12. Molecular reaction dynamics provides insights into
- Reaction mechanisms
 - Energy transfer in reactions
 - Product distributions
 - All of the above
13. Which of the following particles commonly exhibits tunneling behavior?
- Protons
 - Photons
 - Neutrons
 - Electrons
14. Tunneling is a quantum mechanical phenomenon in which a particle passes through a
- Liquid barrier
 - Gas barrier
 - Vacuum barrier
 - Solid barrier
15. The Hammett substituent constant, σ is based on
- The dissociation of Benzoic acid
 - The dissociation of Phenol
 - The hydrolysis of ethyl benzoate
 - In Ester hydrolysis
16. The most common material for the SOFC is
- zirconium oxide
 - TiO₂
 - Cadmium oxide
 - None of the above
17. The relation between the rate constant and viscosity for diffusion controlled reaction is
- Rate constant is directly proportional to viscosity
 - Rate constant is inversely proportional to viscosity
 - Rate constant is half of the viscosity
 - No relation
18. Taft equation is
- $\log (K_X/K_H) = \rho\sigma$
 - $\log (K/K_0) = \rho^* \sigma^* + E_s$
 - $\log (K_X/K_H) = \rho[\sigma + r(\sigma^+ - \sigma)]$
 - $\log (K_{NucX}/K_{H2O}) = \alpha.E_n + \beta.H$
19. The factors which depend on diffusion of reactant are
- Movement of the reactant
 - Size of the reactant
 - Solubility
 - All of the above
20. In a fuel cell, the electrons flow from :
- Anode to cathode through the electrolyte
 - Cathode to anode through the solution
 - Anode to cathode through the external circuit
 - Cathode to anode through the external circuit

(Descriptive)

Time : 2 hrs. 30 mins.

Marks : 50

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

1. a. What do you mean by exchange current density and overpotential? 3+4+2+
b. What are the salient features of the PES of H₃ system? Explain by 1=10
drawing the PES of H₃ system?
c. What is cage effect for reactions in solutions? What are the differences in the rate of a reaction between gas-phase and reactions in solution?

2. a. At 25 °C the exchange current density of a Pt | H₂(g) | H⁺(aq) 3+5+2
electrode is 0.79 mAcm⁻². Calculate the current flowing through a =10
standard electrode of area 5.0 cm² when the overpotential is 5.0 mV.
b. When the electrodes are to be polarizable and nonpolarizable for an electrochemical reaction? Discuss three different types of electrodes with suitable example of each.
c. Write down the Tafel equations. What can you interpret from Tafel plot?

3. a. What is the principle of polarography? 2+3+3+
b. Why mercury is useful as working electrode? 2=10
c. Write three advantages of differential pulse polarography.
d. Write two applications of stripping voltammetry.

4. a. Discuss about chronoamperometry and chronopotentiometry 4+2+4
techniques. =10
b. What do you mean by 2-D and 3-D potential energy surface (PES)?
c. Explain the process of quantum mechanical tunneling with the help of variable potential?

5. a. Explain what is Marcus Theory? What are the two main concepts in 5+4+1
Marcus reaction? =10
b. Using Marcus cross relation, calculate the rate constant at 273 K for the reaction of [Co(en)₃]³⁺ by [Co(bipy)₃]²⁺ also write the reactions involved in it. Given, k₁ = 11.0 dm³mol⁻¹s⁻¹, k₂ = 46.0 dm³mol⁻¹s⁻¹ and K = 4.17
c. What 'f' signifies in Marcus cross relation?

6. a. What do you mean by Fast reactions? 1+2+2+
 b. What do you mean by Flash photolysis and Pulse radiolysis? 2+3=10
 c. What are the factors that affect the rate of a reaction in activated complex theory?
 d. For the reaction $A + B \leftrightarrow C^{\ddagger} \xrightarrow{\text{-----}} P$, Activation energy is 20 KJ/mol at 300. Find the enthalpy change for the formation of activated complex?
 e. What is supercapacitors? Write its applications.
7. a. Derive the equation for double sphere model? 3+2+2+
 b. What are LFERs? 3=10
 c. What is CO₂ poisoning in alkaline full cell? How this effect can be minimized?
 d. Write the working principle and half-cell reactions of Phosphoric acid fuel cell? Mention the working temperature range of this fuel cell.
8. a. Write the Taft equation and explain its applications. 2+2+2+
 b. What are the application of isotopic effect? 2+2=10
 c. How zero point energy is related to isotope effects of reaction rates?
 d. Write a short-note on molten carbonate fuel cell? What are the application area of this cell?
 e. Estimate the diffusion controlled rate constant for the combination of molecules A and B in water at 50 °C. The coefficient of viscosity of water at this temperature is 2 cP.

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