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MCHE-015

M. SC. (CHEMISTRY)

(MSCCHEM)

Term-End Examination

December, 2025

**MCHE-015 : ADVANCED KINETICS AND
ELECTROCHEMISTRY**

Time : 2 Hours

Maximum Marks : 50

***Note :** Question No. 1 is compulsory. Attempt any **four** questions from Question Nos. 2 to 7.*

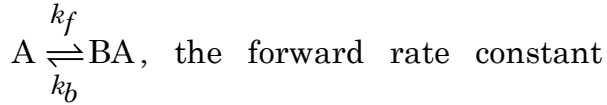
1. Answer any *five* questions from the following : 2×5=10
- (a) What is steady-state approximation and what is its importance ?

- (b) Write the mechanism of the hydrogen-chlorine reaction.
 - (c) Differentiate between inner-sphere and outer-sphere electron transfer reactions.
 - (d) What is meant by energy disposal in a chemical reaction ?
 - (e) What does the Tafel plot represent ?
 - (f) What is a fuel cell ?
 - (g) Write any *two* factors that affect crystal growth during electrodeposition.
2. (a) (i) List the factors that affect the rate of solid-state reactions. 2
- (ii) Explain the kinetic features of photochemical reactions and how they differ from thermal reactions. 3

- (b) (i) Differentiate between controlled potential and controlled current coulometry. 2
- (ii) State the main postulates of Marcus' theory. 3
3. (a) (i) Differentiate between parallel and consecutive reactions. 2
- (ii) Define collision cross-section and reaction cross-section. How are they related to reaction rate? 3
- (b) (i) What is an oscillatory reaction? Give *one* example. 2
- (ii) The quantum yield for the decomposition of HI is found to be 2.5. If 0.1 mole of HI is decomposed by light of wavelength 400 nm, calculate the number of photons absorbed. 3

4. (a) What is the Sabatier principle ? How does it apply to electrocatalysis ? 3
- (b) Compare supercapacitors and lithium ion batteries in terms of the energy storage and performance. 3
- (c) An enzyme reaction shows a maximum velocity $V_{\max} = 5 \times 10^{-4} \text{ mol dm}^{-3} \text{ S}^{-1}$ and has $K_m = 2 \times 10^{-3} \text{ M}$. Calculate the rate when substrate concentration is $1 \times 10^{-3} \text{ m}$. 4
5. (a) What is the working principle of corrosion cells ? 2
- (b) Write the mechanism of the Belousov-Zhabotinsky (BZ) reaction and explain its oscillatory behaviour. 4

(c) For a reversible first-order reaction



$k_f = 2.0 \times 10^{-3} \text{ S}^{-1}$ and backward rate

constant $k_b = 1.0 \times 10^{-3} \text{ S}^{-1}$. Calculate

the equilibrium constant and

the fraction of A converted to B after

600 s. 4

6. (a) Derive the Butler-Volmer equation and

explain the significance of each term

involved. 5

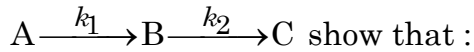
(b) Describe the electrochemical theory of

corrosion and explain how corrosion

inhibitors prevent corrosion. 5

Or

For a consecutive reaction,



$$[B] = \frac{k_1 [A]_0}{k_2 - k_1} (e^{-k_1 t} - e^{-k_2 t})$$

where $[A]_0$ is the initial concentration of the reactant A.

7. (a) Describe the mechanism of Underpotential Deposition (UPD). How does surface diffusion affect crystal growth during electrodeposition ? 5
- (b) What are the kinetic features of the photochemical reaction between hydrogen and chlorine ? Explain the role of chain initiation and chain termination steps. 5

[7]

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Or

What is the Michaelis-Menten mechanism for enzyme reaction ?

Derive the rate equation for the same and give its limitations. 5

x x x x x