

2016

M.Sc.

2nd Semester Examination

CHEMISTRY

PAPER—CEM-201

Full Marks : 40

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(Physical)

Answer *four* questions,
taking *one* question from each group.

Group—A

Answer any *one* of the following.

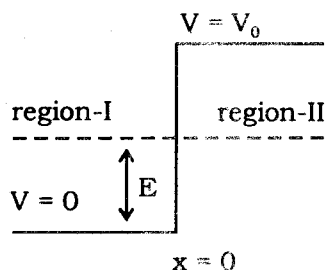
1. Show that in the n^{th} eigen state of the Harmonic Oscillator, the average Kinetic energy, $\langle T \rangle$ is equal to the average potential energy, $\langle V \rangle$. 5+5

(Turn Over)

2. (a) Consider a particle of mass m_e moving in the positive x-direction under the potential field defined by

$$V = 0 \quad \text{for } x < 0$$

$$V = V_0 \quad \text{for } x > 0$$



Find the transmission probability of the particle from region-I to region-II.

- (b) Draw the schematic potential energy diagram of the following :
- Umbrella inversion of ammonia
 - α -particle decay from radioactive nucleus.

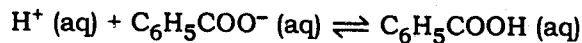
6+(2+2)

Group—B

Answer any one of the following.

3. (a) Derive the equation for Lineweaver-Burk plot for enzyme catalysis reaction. State the consequences of this plot.

- (b) Calculate the relaxation time for the reaction



for a temperature jump experiment to a final temperature of 298K. The solution was initially prepared by adding 0.015 moles of benzoic acid to water such that a liter of total solution was made. Assume that both the forward and reverse reactions are first order in each of the reactants and the forward and backward rate constants are $k_1 = 3.5 \times 10^{10} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ and $k_{-1} = 2.2 \times 10^6 \text{ s}^{-1}$ respectively. (5+2)+3

4. (a) Define oscillatory reaction with a suitable example.
 (b) What is the principle of relaxation method to study the kinetics of fast reaction ?
 (c) Write down the basic criteria to occur a redox reaction through inner sphere mechanism.
 (d) What is non-complementary electron transfer reaction ?
 3+2+3+2

Group—C

Answer any *one* of the following.

5. (a) Intensities of stokes and anti stokes lines are different in vibrational Raman spectra — why ?

- (b) What do you mean by the term "CARS"? How is it advantageous over the conventional Raman spectroscopy?
- (c) N_2O molecule shows the following peaks in IR and Raman spectra. Assign the peaks and predict the structure of N_2O therefrom.

$\bar{\nu}$ (cm^{-1})	IR	Raman
580	m (temp. dependent)	m
589	s	v.w.
1167	m	v.s.
1285	v.s.	v.s.
2223	v.s.	s

(s = strong, v.s. = very strong, m = medium, w = weak, v.w. = very weak)

- (d) Why are the maxima of vibrational energy levels (except the zeroth one) reside on the edges of the potential energy curves?
 $2+(1+2)+3+2$
6. (a) Symmetric stretching mode of vibration is Raman active for CO_2 while its bending mode and asymmetric vibrational modes are not — explain why.

- (b) Schematically show the different modes of vibration for H_2O . Assign the peaks which are IR active and/or Raman active separately.
- (c) What are progressions and sequences in electronic spectroscopy ?
- (d) Phenolic compounds are more basic in their ground states — explain the reason. 3+2+2+3

Group—D

Answer any *one* of the following.

7. Consider a Harmonic Oscillator in the superposition state,

$$\psi(x, 0) = \frac{1}{\sqrt{2}} [\psi_0(x) + \psi_1(x)]$$

- (i) Find $\psi(x, t)$
- (ii) Show that in the state $\psi(x, t)$

$$\langle x \rangle = \sqrt{\frac{\hbar}{2m\omega}} \cos(\omega t)$$

where symbols have their usual significances.

2+8

8. (a) How does rate of a fast reaction is measured using plug flow technique ?
- (b) The presence of $4.8 \times 10^{-6} \text{ mol dm}^{-3}$ of a competitive inhibitor decreases the initial rate of $1.11 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$ by a factor of 3.7. Calculate K_1 , the equilibrium constant for the binding reaction between the enzyme and the inhibitor. Given
- turnover number = $4.0 \times 10^7 \text{ s}^{-1}$
 $[E]_0 = 0.016 \times 10^{-6} \text{ mol dm}^{-3}$
 $K_m = 25 \times 10^{-3} \text{ mol dm}^{-3}$
 $[S]_0 = 4.32 \times 10^{-6} \text{ mol dm}^{-3}$
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