



‘সমানো মন্ত্র: সমিতি: সমানী’

## UNIVERSITY OF NORTH BENGAL

B.Sc. Honours Part-III Examination, 2022

## CHEMISTRY

## PAPER-IX

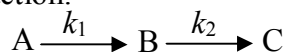
Time Allotted: 4 Hours

Full Marks: 65

*The figures in the margin indicate full marks.  
All symbols are of usual significance.*

Answer Question No. 1 and any *five* from the rest

1. Answer any *five*: 3×5 = 15
- CCl<sub>4</sub> does not show rotational and IR spectra but gives Raman spectra. Why?
  - What will happen to the energy of a particle in one-dimensional box if the walls of the box are suddenly removed?
  - “KCl has a face-centred cubic lattice. However, it appears from X-ray data to be simple cubic”. — Explain.
  - What is the difference between a photosensitizer and a catalyst?
  - For some chemical reactions, the concept of order is not applicable. Justify.
  - Evaluate the commutator  $(x, d/dx)$  operator on an arbitrary function  $\psi(x)$ .
  - Write down the structural formula of ATP and indicate the base, sugar and phosphate unit.
2. (a) Distinguish between differential rate law and integrated rate law. 2+2+3+1+2
- (b) Discuss one method for the determination of rate constant for a second-order reaction.
- (c) For the reaction:



Derive the following expressions:

$$[A] = [A_0] \exp(-k_1 t)$$

$$[B] = [A_0] \left( \frac{k_1}{k_2 - k_1} \right) \{ \exp(-k_1 t) - \exp(-k_2 t) \}$$

$$[C] = [A_0] \left[ 1 - \frac{1}{k_2 - k_1} \{ k_2 \exp(-k_1 t) - k_1 \exp(-k_2 t) \} \right]$$

Draw a graph showing the typical variation of concentrations of A, B and C with time.

- (d) Explain the term ‘reaction coordinate’.

3. (a) What is a linear operator? Show that if  $\hat{\alpha}$  is an operator which squares the function, cannot be a linear operator. 1+2+3+2+2  
 (b) What is meant by orthonormal wave functions?  
 (c) The quantized energy associated with the motion of a particle is given by  $E = n^2 (h^2 / 8ml^2)$ . Explain with the help of this relation the quantum effect produced by (i) free particle and (ii) a particle of large mass.
4. (a) The rotational transitions of HF fall into the IR region after only a few transitions in the microwave region. Why? 2+(2+1)+1+2+2  
 (b) What is 'Raman scattering'? What is the essential condition (gross selection rule) for a molecule to be Raman active?  
 (c) What is Born-Oppenheimer approximation?  
 (d) 'CO<sub>2</sub> does not give IR spectra'. Is the statement true? Give reasons.  
 (e) "Vibrational transitions of a diatomic molecule are normally accompanied by rotational transitions". — Explain.
5. (a) What is co-enzyme? State its functions. 2+1+2+2+3  
 (b) What is emulsion? Explain the role of emulsifier in the preparation of emulsion.  
 (c) What do you understand by auto-catalysis? Explain with suitable examples.  
 (d) What is meant by Gold number? Give its significance.
6. (a) Explain how BET equation can be used for the determination of surface area of finely divided solids. 2+2+3+3  
 (b) Why is ATP called the universal energy transfer agent?  
 (c) Write short notes on the following (any *two*):  
 (i) Primary kinetic salt effect  
 (ii) Structure of DNA  
 (iii) Lambert-Beer Law  
 (iv) Collision theory for chemical kinetics.
7. (a) Describe the general appearance of rotational spectrum of a rigid diatomic molecule. 3+1+1  $\frac{1}{2}$   
 +1  $\frac{1}{2}$  +3  
 (b) What are the selection rules for an anharmonic oscillator? Explain what you understand by (i) overtone transitions and (ii) hot bands.  
 (c) What is the explanation of Raman effect from quantum view point?
8. (a) Derive the expression for the Boltzmann distribution law, clearly mentioning the underlying assumptions [Assume  $B = kT^{-1}$ ] 3+2+2+3  
 (b) What is Compton shift? How was Planck's quantum concept used to explain this?  
 (c) Derive Michaelis-Menten equation. Give its significance.

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