



Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
End-Semester (Sem-II) Examination-Spring 2021

Subject: Structure and Spectroscopy
Full Marks: 50

Subject Code(s): CHS 1201
Time Allotted: 3 h

1. Draw the Conformation energy diagram for Energy versus dihedral angle in (a) butane (b) 1,2-dihydroxyethane. (6 marks)
2. Define enantiomeric excess (*ee*) and give one strategy to prepare optically compound starting from racemic mixture. (4 marks)
3. Explain why a chair conformation of cyclohexane is more stable than the boat conformation. Can you suggest one strategy to stabilize a boat conformation of a cyclohexane derivative? (6 marks)
4. Distinguish between an aromatic and homoaromatic molecule and draw structures for each. (4 marks)
5. (a) Explain all the process along with their respective time scales associated with the Jablonski diagram? (4 marks)
(b) Explain the Kasha rule with proper justification? (2 marks)
(c) Why the quantum yield of any fluorophore can not be one? (2 marks)
(d) The quantum yield of a molecule is 0.8 and life time in the excited state is 2 ns. Calculate the rate of the radiative and nonradiative processes. (2 marks)
6. (a) Discuss all the possible vibrational modes of H₂O and CO₂ and which of them will show the vibrational spectrum. (3 marks)
(b) What is the energy difference for the harmonic oscillator and anharmonic oscillator? Define the zero point energy. Discuss the vibrational selection rule for the harmonic and anharmonic oscillator. (4 marks)
(c) Why two state laser is not possible? Discuss the working principle for the three state and four state lasers. (3 marks)
7. (a) Derive the relationship between the absorption, stimulated emission and spontaneous emission? (4 Marks)
(b) Which of the molecules will show the rotational spectrum H₂, HCl, CH₄, CH₃Cl, CH₂Cl₂, H₂O and SF₆. (2 marks)
(c) The first line of the rotational spectrum of CO molecule (*J*=0) shows the spacing of 3.84235 cm⁻¹. Calculate the moment of inertia as well as bond length of the CO molecule. (4 Marks)