

GROUP THEORY AND MOLECULAR SPECTROSCOPY

Time: Three Hours

Maximum: 75 Marks

SECTION-A (10 Marks)

Answer ALL questions

ALL questions carry EQUAL marks

(10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	Name the type of group that has a multiplication table that is commutative. i) Abelian group ii) Non-Abelian group iii) Cyclic group iv) Dihedral group	K1	CO1
	2	Infer the point group of a molecule with C ₂ axis and σ_v plane. i) C _{2v} ii) C _{2h} iii) D _{2h} iv) C _{3v}	K2	CO1
2	3	Select the correct statement about the great orthogonality theorem. i) It states that the characters of different irreducible representations are orthogonal ii) It states that the characters of different irreducible representations are not orthogonal iii) It states that the characters of same irreducible representations are orthogonal iv) It states that the characters of same irreducible representations are not orthogonal	K1	CO2
	4	Relate the symmetry of the molecule to its vibrational spectrum. i) The symmetry of the molecule determines the vibrational spectrum ii) The vibrational spectrum determines the symmetry of the molecule iii) The symmetry of the molecule and vibrational spectrum are unrelated iv) The symmetry of the molecule and vibrational spectrum are equivalent	K2	CO2
3	5	State the principle of Raman spectroscopy. i) Inelastic scattering of light ii) Elastic scattering of light iii) Absorption of light iv) Emission of light	K1	CO3
	6	Relate the molecular structure to its IR spectrum. i) The molecular structure determines the IR spectrum ii) The IR spectrum determines the molecular structure iii) The molecular structure and IR spectrum are unrelated iv) The molecular structure and IR spectrum are equivalent	K2	CO3
4	7	Tell the effect of conjugation on absorption spectrum. i) Shift to shorter wavelength ii) Shift to longer wavelength iii) Increase in intensity iv) Decrease in intensity	K1	CO4
	8	Relate the UV-Visible spectrum to the molecular structure. i) The UV-Visible spectrum provides information about the molecular structure ii) The molecular structure provides information about the UV-Visible spectrum iii) The UV-Visible spectrum is independent of the molecular structure iv) The molecular structure is independent of the UV-Visible spectrum	K2	CO4
5	9	Name the type of coupling in NMR spectroscopy. i) Geminal coupling ii) Vicinal coupling iii) Long-range coupling iv) All of the above	K1	CO5
	10	Classify the following types of coupling: geminal, vicinal, cis, trans. i) Geminal: 2J, vicinal: 3J, cis: 3J, trans: 3J ii) Geminal: 3J, vicinal: 2J, cis: 3J, trans: 3J iii) Geminal: 2J, vicinal: 3J, cis: 2J, trans: 3J iv) Geminal: 3J, vicinal: 2J, cis: 2J, trans: 3J	K2	CO5

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SECTION - B (35 Marks)

Answer **ALL** questions
ALL questions carry **EQUAL** Marks (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	Plan a strategy to determine the point group of a molecule using symmetry operations.	K2	CO1
		(OR)		
	11.b.	Model the matrix representation for the identity operation.		
2	12.a.	Apply the great orthogonality theorem to derive the character table for H ₂ O molecule.	K3	CO2
		(OR)		
	12.b.	Build a character table for POCl ₃ molecule using Mullikan representations.		
3	13.a.	Dissert the factors that affect the vibrational frequency of a molecule.	K4	CO3
		(OR)		
	13.b.	Classify the following molecules based on their Raman spectra: X ₂ Y (C _{2v}), XY ₃ (C _{3v})		
4	14.a.	Evaluate the effect of conjugation on the intensity of absorption bands.	K5	CO4
		(OR)		
	14.b.	Assess the importance of solvent effects in UV-Visible spectroscopy.		
5	15.a.	Construct a diagram to illustrate the anisotropic effect in ¹ H NMR spectroscopy.	K6	CO5
		(OR)		
	15.b.	Build a table to summarize the factors influencing the chemical shift in ¹³ C NMR spectroscopy.		

SECTION - C (30 Marks)

Answer **ANY THREE** questions
ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Apply the concept of symmetry operations to determine the point group of a molecule with the following symmetry elements: E, C ₂ , σ _v , σ _v '.	K2	CO1
2	17	Plan a strategy to determine the structure of a molecule using IR and Raman spectroscopy.	K3	CO2
3	18	Assume that you are given an unknown compound, and you want to identify it using IR spectroscopy. Explain how you would proceed.	K4	CO3
4	19	Determine the λ _{max} value for a diene using Woodward-Fieser rules. i)  ii) 	K5	CO4
5	20	Develop a strategy to convert a non-first order ¹ H NMR spectrum to a first-order spectrum.	K6	CO6

Z-Z-Z

END