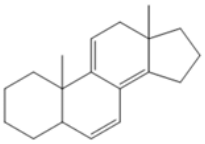
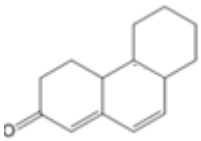
STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2023-24)

B.Sc. DEGREE EXAMINATION, APRIL 2026
BRANCH IV - CHEMISTRY
SIXTH SEMESTER

COURSE : MAJOR-CORE
PAPER : SPECTROSCOPY
SUBJECT CODE : 23CH/MC/SP64
TIME : 3 HOURS **MAX. MARKS :100**

Q. No.	SECTION A **Answer all the following.**	CO	KL
	Choose the correct answer. (15 x 1 = 15 marks)		
1.	The selection rule for rotational transitions is _____. a) $\Delta J = \pm 1$ c) $\Delta J = 0$ b) $\Delta J = \pm 2$ d) $\Delta J = +2$	1	1
2.	Which of the following nuclei is NMR active? a) ^{12}C b) ^{1}H c) ^{16}O d) ^{32}S	1	1
3.	The frequency of vibration of a bond is a function of _____. a) force constant of the bond b) bond order c) force constant and mass of the atom d) masses of the atom involved in bonding	1	1
4.	The number of signals observed in ^{13}C NMR decoupled spectrum of acetaldehyde is _____. a) 1 b) 2 c) 3 d) 5	1	1
5.	Which of the following frequency range is known as the fingerprint region in infrared spectroscopy? a) 400-1400 cm^{-1} c) 900-600 cm^{-1} b) 1400-900 cm^{-1} d) 600-250 cm^{-1}	1	1
6.	Which of the following statement is correct? a) Wavelength is directly proportional to wavenumber b) Wavenumber is directly proportional to energy c) Wavelength is directly proportional to frequency d) Wavelength is directly proportional to energy	1	1
7.	Which of the following is not an auxochrome? a) -OH b) -SH c) -OR d) O_2	1	1
8.	Which of the following leads to decreased intensity of absorption? a) hypochromic c) hypsochromic b) hyperchromic d) bathochromic	1	1

9.	Which of the following is used to bombard the sample for mass spectrometry? a) Alpha particles c) Electrons b) Neutrons d) Protons	1	1
10.	The number of vibrational modes for the ethanal is _____. a) 25 b) 15 c) 5 d) 35	1	1
11.	The IR region most widely used for qualitative analysis is _____. a) Near IR b) Mid IR c) Far IR d) all of the above	1	1
12.	Symmetrical stretching is not observed in a) CO_2 b) H_2O c) ROH d) ROR	1	1
13.	The approximate value of methyl proton in NMR is ___. a) 1.3 b) 1.9 c) 0.9 d) 2.5	1	1
14.	The possible number of signals in proton NMR of the following structure is _____. Cl_2CHCH_2Cl a) 1 b) 2 c) 3 d) 4	1	1
15.	Which of the following solvents is not used in NMR? a) D_2O b) $CHCl_3$ c) CCl_4 d) $CDCl_3$	1	1
Q. No.	**SECTION B** **Answer all the following.**	**CO**	**KL**
	Fill in the blanks. (5 x 1 = 5 marks)		
16.	Carbon dioxide has _____ types of vibrational modes.	2	2
17.	The reduced mass of a diatomic molecule is given by the formula _____.	2	2
18.	The _____ rule predicts the fragmentation patterns of hydrocarbons based on the stability of carbocations.	2	2
19.	The zero point energy in vibrational spectroscopy is _____.	2	2
20.	The shielding effect in NMR leads to a _____ in chemical shift.	2	2
	Match the following. (5 x 1 = 5 marks)		
21.	Hyperchromic shift — Most intense peak	2	2
22.	Tetramethyl silane — Raman spectroscopy	2	2
23.	Base peak — Reference compound	2	2
24.	Integration of NMR signal — Increased intensity	2	2
25.	Inelastic scattering — Number of protons	2	2
	Answer in a line or two. (5 x 1 = 5 marks)		
26.	Differentiate between auxochrome and chromophore.	2	2
27.	Define the Beer-Lambert's law.	2	2
28.	What is chemical shift?	2	2
29.	What is fermi resonance?	2	2
30.	Distinguish between hypsochromic and bathochromic shift.	2	2

Q. No.	SECTION C **Answer any SIX of the following. (6 x 5 = 30 marks)**	CO	KL
31.	Illustrate the instrumentation of NMR spectroscopy with a suitable block diagram.	3	3
32.	Compare Rayleigh and Raman scattering with a suitable diagram.	3	3
33.	Explain the fragmentation pattern for i) $CH_3CH_2CH_2CH_2CH_2OH$ ii) $CH_3CH_2CH_2COOH$	3	3
34.	Derive an expression for the energy of a diatomic rigid rotor.	3	3
35.	From the rotational microwave spectrum of $^{1}H^{35}Cl$, we find that B = 10.59342 cm^{-1}. Given that the masses of ^{1}H and ^{35}Cl are 1.0078 and 34.9689 amu, respectively, determine the bond length of the $^{1}H^{35}Cl$ molecule.	3	3
36.	a) Discuss the types of electronic transitions. (3) b) State nitrogen rule with an example. (2)	3	3
37.	Describe the various fundamental modes of vibrations using a suitable example.	3	3
Q. No.	**SECTION D** **Answer any FOUR of the following. (4 x 5 = 20 marks)**	**CO**	**KL**
38.	Explain the a) McLafferty rearrangement for 2-pentanone and b) Retro Diel's Alder fragmentation for cyclohexene.	4	4
39.	State Franck-Condon principle and explain its role in electronic transitions.	4	4
40.	Calculate the moment of inertia of a rigid diatomic rotor with bond distance equal to 130 pm and the reduced mass equal to 2×10^{-47} kg?	4	4
41.	Define spin-spin coupling. Explain the types of spin-spin couplings in NMR spectroscopy.	4	4
42.	Calculate absorption maximum for the following compounds using Woodward Fieser Rules.  	4	4
Q. No.	**SECTION E** **Answer the following. (2 x 10 = 20 marks)**	**CO**	**KL**
43.	Describe the theory and instrumentation of mass spectrometry. **(OR)** a) List out the factors affecting chemical shift in NMR spectroscopy. (6) b) Outline the differences between IR and Raman spectroscopy. (4)	5	5

44.	An organic compound of molecular formula C_8H_8O shows the following spectral data. Predict the structure of the compound. IR: 3020, 1720, 1600, 1575 cm^{-1} NMR: 7.2 (s, 5H) ppm, 1.25 ppm (s, 3H) Mass: m/e 120, 105 and 43. **(OR)** a) Illustrate with a neat block diagram the components of a double-beam spectrophotometer and explain the function of each component in obtaining an accurate UV-Vis spectrum. (8) b) State the principle of mutual exclusion. (2)	5	5

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