

PSG COLLEGE OF ARTS & SCIENCE  
(AUTONOMOUS)

MSc DEGREE EXAMINATION DECEMBER 2023  
(Third Semester)

Branch – CHEMISTRY

MOLECULAR SPECTROSCOPIC METHODS AND ITS APPLICATIONS

Time: Three Hours

Maximum: 50 Marks

SECTION-A (5 Marks)

Answer ALL questions

ALL questions carry EQUAL marks

(5 x 1 = 5)

- When transition between states of the same multiplicity occurs without emitting light is called
 

(i) Fluorescence	(ii) Internal conversion (IC)
(iii) Quenching	(iv) Intersystem crossing (ISC)
- The correct order of decreasing stretching frequencies of the bonds in IR spectroscopy. O-H, S-H, C-H and N-H
 

(i) C-H > O-H > N-H > S-H	(ii) O-H > N-H > C-H > S-H
(iii) S-H > O-H > N-H > C-H	(iv) O-H > C-H > N-H > S-H
- How many signal(s) would you expect from cyclooctatetraene in its <sup>1</sup>H-NMR spectrum?
 

(i) Two signals centered at 5.68 ppm	(ii) One signal (singlet) at 5.68 ppm
(iii) Two signals at 1.2 ppm and 5.68 ppm	(iv) Two signals at 1.2 ppm
- In the proton decoupled <sup>13</sup>C NMR spectrum of 7-norbornanone, the number of signals obtained is
 

(i) 7	(ii) 3
(iii) 4	(iv) 5
- Number of hyperfine lines have been observed in the ESR spectrum of benzene radical anion are
 

(i) 5	(ii) 6
(iii) 7	(iv) 8

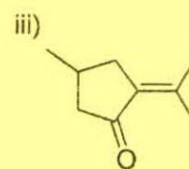
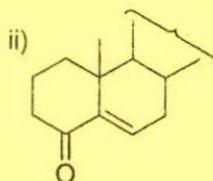
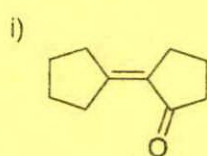
SECTION - B (15 Marks)

Answer ALL Questions

ALL Questions Carry EQUAL Marks

(5 x 3 = 15)

6. (a) The  $\lambda_{\max}$  values of the following compounds are 242 nm, 254 nm and 259 nm in ethanol. Which is for which?



(OR)

- (b) How *o*-nitroaniline can be distinguished from *p*-nitroaniline from UV spectroscopy?
7. (a) How many fundamental vibrational frequencies can be observed in the IR absorption spectrum of water?  
(OR)
- (b) Why vibrations involving polar bonds are weak Raman scatterers?
8. (a) Explain why <sup>1</sup>H-NMR spectrum of CH<sub>3</sub>OH in CCl<sub>4</sub> shows two singlets but in (CD<sub>3</sub>)<sub>2</sub>SO it shows a doublet and a quartet.  
(OR)
- (b) How can you distinguish between the following pair by <sup>1</sup>H-NMR?  
CH<sub>3</sub>-CH<sub>2</sub>-C≡C-H and CH<sub>3</sub>-C≡C-CH<sub>3</sub>
9. (a) Intensities of methyl, methylene and methane carbons differ in <sup>13</sup>C-NMR. Explain.  
(OR)
- (b) What are the advantages of 2D NMR over the 1D NMR spectra?

Cont...



- 10 (a) How many lines are expected in the ESR spectrum of radical anion derived from *p*-xylene and *p*-benzosemiquinone?  
(OR)
- (b) When the Mossbauer effect will occur?

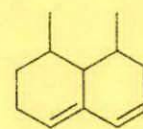
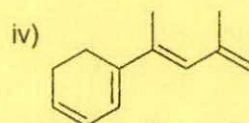
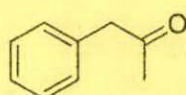
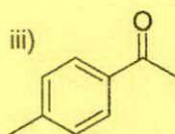
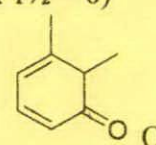
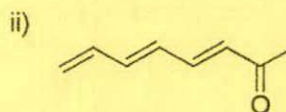
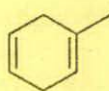
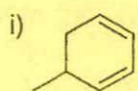
**SECTION -C (30 Marks)**

Answer ALL questions

ALL questions carry EQUAL Marks (5 x 6 = 30)

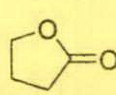
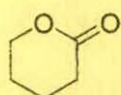
- 11 (a) Distinguish the following pair isomers by UV-VIS spectroscopic technique.

(4x 1½ = 6)



(OR)

- (b) i) Illustrate charge transfer transitions with suitable example. (3)
- ii) The complex  $[\text{Ti}(\text{H}_2\text{O})_6]^+$  absorbs green and yellow light from the white light and appears purple. Why? (3)
- 12 (a) i) How IR spectroscopy can be used to distinguish between the following compounds? (3)



- ii) How is the O-H absorption peak shifted by replacing H by D? (1)
- iii) Distinguish the effect of dilution by carbon tetra chloride on IR absorption of O-H stretching of ethanol. (2)

(OR)

- (b) i) Differentiate IR and Raman Spectroscopy. (4)
- ii) Show fundamental modes of vibration of  $\text{CO}_2$  and predict which modes will be infrared active and which will be Raman active? (2)

- 13 (a) What are the factors influencing chemical shift? Explain them briefly.  
(OR)
- (b) i) Explain nuclear overhauser effect of double resonance technique. (3)
- ii) Write short note on relaxation process. (3)

- 14 (a) Write notes of the following. (3+3)
- i) Factors affecting vicinal coupling in  $^{13}\text{C}$  NMR
- ii) Off resonance technique in  $^{13}\text{C}$  NMR  
(OR)
- (b) Determine the structure the complexes of  $\text{WF}_6$  and  $\text{BOF}_4$  using  $^{13}\text{C}$  NMR spectroscopy.

- 15 (a) i) Derive structural information from the complex ion  $[(\text{NH}_3)_5\text{Co}-\text{O}-\text{O}-\text{Co}(\text{NH}_3)_5]^{5+}$ . (2)
- ii) Explain zero field splitting with one example. (4)
- (OR)
- (b) Explain the applications of Mossbauer spectroscopy to inorganic compounds.