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Total No. of Pages : 02

Total No. of Questions : 09

M.Sc.(Chemistry) (2015 to 2017) (Sem.-3)

**SPECTROSCOPY – II**

Subject Code : MSCH-302

Paper ID : [72620]

Time : 3 Hrs.

Max. Marks : 100

**INSTRUCTIONS TO CANDIDATES :**

1. Attempt FIVE questions in ALL including the Question No. 1 which is COMPULSORY and selecting ONE EACH from each UNIT.

**Q1 Answer briefly :**

- a) After ionization and fragmentation occur, what does the mass spectrometer do to provide a mass spectrum?
- b) How will you identify a particular signal in PMR arise due to NH or OH proton?
- c) Why greater sensitivity is required to record  $^{13}\text{C}$  NMR spectrum compared to that PMR spectrum?
- d) Why Mossbauer Spectroscopy is well suited for biological applications?
- e) What is NQR? In which region of electromagnetic spectrum, NQR spectra are observed?
- f) What is nuclear quadrupole coupling constant?
- g) Predict different peaks in the mass spectrum of ethyl chloride.
- h) What is a *metastable* ion?
- i) Of the two molecules  $\text{N}_2$  and  $\text{O}_2$ , which will show an ESR spectrum and why?
- j) Predict the ESR spectrum of methyl radical. (2×10=20)

**UNIT-I**

- Q2
- a) Discuss the principle of NMR spectroscopy and explain how this technique is being used in elucidating the structure of the molecules. (10)
  - b) What is chemical shift? In the 300 MHz spectrum of a certain compound there are two triplets separated by 3 ppm. The observed coupling constant is 7 Hz. What is this separation in Hz? In a 500 MHz spectrum, what is the separation between these signals in Hz and in ppm? (5)
  - c) Explain magnetic anisotropy effect in NMR by taking suitable examples. (5)

- Q3 a) What is coupling constant? Describe various types of proton couplings in PMR spectroscopy. (8)
- b) Write short notes on : (12)
- i) Correlation spectroscopy
  - ii) MRI
  - iii) NOE
  - iv) Chemical shift reagents.

### UNIT-II

- Q4 a) Explain the principle of NQR. (8)
- b) Explain how NQR spectroscopy helps in studying hydrogen bonding in crystals? (6)
- c) From the drawing of energy level diagram calculate transition frequencies for a nucleus having  $I = 5/2$  and assuming (a)  $\eta = 0$  (b)  $\eta \neq 0$ . (6)
- Q5 a) Discuss the applications of ESR spectra. (10)
- b) Which valence state of copper *i.e.*  $\text{Cu}^+$  ion or  $\text{Cu}^{+2}$  ion, will show ESR and why? (5)
- c) Outline some of the differences between NMR and NQR. (5)

### UNIT-III

- Q6 a) Explain the principle and applications of Mossbauer Spectroscopy. (15)
- b) Calculate the recoil velocity of free Mossbauer nucleus of mass  $9.4684 \times 10^{-26}$  kg, when emitting a  $\gamma$ -ray of wavelength  $8.57 \times 10^{-11}$  m. What is the Doppler shift of the  $\gamma$ -ray frequency to an outside observer? (5)
- Q7 a) What is isomer shift? Explain with examples. (5)
- b) Outline briefly : (10)
- i) Quadrupole interaction.
  - ii) Magnetic hyperfine interaction in Mossbauer spectroscopy.
- c) Draw the energy level schemes and transitions for a Mossbauer nucleus having  $I_g = 1/2$  and  $I_e = 3/2$ . (5)

### UNIT-IV

- Q8 a) Explain the following by taking suitable examples : (6)
- i) Nitrogen rule.
  - ii) McLafferty rearrangement.
- b) Describe various ionization techniques in mass spectrometry. (8)
- c) Describe the fragmentation pattern of alcohols and esters. (6)
- Q9 a) Explain the appearance of  $m/z$  44 in the mass spectrum of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ . (6)
- b) Give the applications of mass spectrometry. (6)
- c) Account for the major peaks of each of the following compounds. Write equations for their formation : (8)
- i)  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_3$  :  $m/z = 31, 45, 59$ , and  $74$ .
  - ii)  $\text{CH}_3\text{CH}_2\text{COOCH}_3$  :  $m/z$   $57, 59$  and  $88$ .