

P. Pages : 2

Time : Three Hours

**GUG/W/24/15962**

Max. Marks : 80

1. a) Identify point groups of the following. 8

- |                             |                            |
|-----------------------------|----------------------------|
| i) HCL                      | ii) $\text{BF}_3$          |
| iii) $\text{CHCl}_3$        | iv) Chair                  |
| v) A cone                   | vi) Ferrocene (staggered)  |
| vii) $\text{B}_2\text{H}_6$ | viii) $\text{H}_2\text{O}$ |

b) Derive character table for  $\text{NH}_3$  molecule on the basis of corollaries of Great orthogonality theorem. 8

**OR**

a) Name the symmetry elements and symmetry operations in  $\text{CH}_4$  molecules? 4

b) What is meant by 'group'? Give various properties of group. 4

c) Identify the point groups of : 4

- |                                |                          |
|--------------------------------|--------------------------|
| i) $\text{CH}_2 = \text{CH}_2$ | ii) $\text{SF}_4$        |
| iii) $\text{BF}_3$             | iv) $\text{H}_2\text{O}$ |

d) Construct character table for  $\text{C}_2\text{V}$  point Group 4

2. a) Define "isomer shift" in Mossbauer spectroscopy Give its applications. 8

b) In relation to mass spectrometry explain- 8

- i) Mac-Lafferty Rearrangement
- ii) Fragmentations in Alcohols

**OR**

a) Deduce the structure of molecules based on the following data:- 4

Molecular formula :-  $\text{C}_9\text{H}_{10}\text{O}_2$ 

M/s (m/z) : 150, 108, 91, 77, 65, 51 and 43

b) What is doppler shift? Explain its applications in Mossbauer spectroscopy. 4

c) Explain any two application of mass spectrometry. 4

d) How is Mossbauer used to determine the structure of  $\text{Fe}_3(\text{CO})_{12}$ ? Explain. 4

3. a) What is Stark effect? Explain first order and second order Stark effect in different molecules. 8
- b) Discuss the following. 8
- i) Intensity of ESR lines.
- ii) Line width of signal
- OR**
- a) Explain applications of ESR spectroscopy. 4
- b) What is the effect of isotopic substitution on rotation spectrum of a molecule. 4
- c) What is hyperfine splitting? Predict the number of peaks of ESR spectra of 1,4-benzoquinone radical. What would be the relative intensities of these peaks? 4
- d) The moment of inertia of CO molecule is  $1.4 \times 10^{-46} \text{ kg m}^2$ . Calculate the energy in eV and the angular velocity in the lowest energy level of CO molecule. 4
4. a) Explain the nature of different lines formed during Raman effect. 8
- b) What are PQR bands? Explain why Q branch is absent in IR spectra but present in Raman spectra. 8
- OR**
- a) Explain the term 'normal modes of vibrations'. Derive expression for normal modes in linear and non-linear molecular. 4
- b) Explain classical theory for Raman Scattering. 4
- c) Derive expression for the energy levels in vibrational – rotational spectroscopy. Give selection rules and predict the appearance of spectra. 4
- d) Explain construction and working of Raman spectrometer. 4
5. Attempt **any eight**. 8x2 =16
- a) Define 'sub group' and 'order of group'.
- b) Highlight the importance of character table for  $C_{2v}$  point symmetry.
- c) Give principle of mass spectroscopy
- d) Explain magnetic hyperfine interaction
- e) How ESR used to study free radicals?
- f) Explain rigid and non-rigid rotor in microwave.
- g) Explain Rayleigh scattering.
- h) Why water and ethanol are not suitable solvents for ESR studies? Which solvents are most appropriate?
- i) Explain normal modes of vibration
- j) A sample was excited by 4358 Å line of Hg-lamp. If Raman shift is  $460 \text{ cm}^{-1}$  calculate wavelength of Stokes and anti-Stokes lines.

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