KAMARAJ COLLEGE (Autonomous)

Accredited with A+ Grade by NAAC

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI – 628 003

(6 Pages) **Reg. No: ……**

Question Code No : 25003304 **Course Code : 24PEPH31**

PG Degree - End Semester Examinations, November 2025

Third Semester

M.Sc. PHYSICS

Spectroscopy

(For those who joined in July 2024 onwards)

Time : 3 Hours **Maximum : 75 Marks**

PART – A (10 × 1 = 10 Marks)

Answer ALL Questions

Choose the correct answer:

1. The condition for the molecule to be microwave active
   (a) Permanent dipole moment
   (b) Constant dipole moment
   (c) Change in polarizability
   (d) All
2. The selection rule for symmetric top molecules are

(a) $\Delta J = \pm 1$ and K =0 (b) $\Delta J = 1$ and K =0

(c) $\Delta J = \pm 2$ and K =0 (d) $\Delta J = \pm 1,2$ and K =0

3. Overtones are mainly observed in

(a) Far IR (b) Middle IR

(c) Near IR (d) Not in IR region

4. The transitions that occur in IR

(a) Rotational (b) Electronic

(c) Rotational and vibrational (d) Vibrational

5. Lambert law is related to_____ of the absorbing material.

(a) Concentration (b) Thickness

(c) Path length (d) Intensity of incident light

6. The possible transition for water molecule in UV region are

(a) σ-σ^* (b) n-σ^*

(c) π-π^* (d) n-π^*

7. The Raman spectrum said to consist of stokes line when change in frequency is

(a) Positive (b) Negative

(c) Zero (d) Infinite

8. If a molecule has a centre of symmetry then Raman active vibrations are

(a) IR active (b) IR inactive

(c) Microwave active (d) Microwave inactive

9. Identify the NMR inactive nuclei

(a) ^{12}C (b) ^{16}O

(c) ^{32}S (d) All

10. Materials that do not show electron spin resonance are

(a) Free radicals (b) Paramagnetic

(c) Transition metals (d) Diamagnetic

PART – B (5 X 5 = 25 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 250 words.

11. (a) Outline the effect of isotopic substitution on the rotational spectra of molecules.

(OR)

(b) Microwave causes molecules to rotate more energetically. A molecule absorbs microwave photon of wavelength 20cm. Calculate the energy difference between the two rotational levels in joule.

12. (a) Make use of the selection rule to determine the fundamental absorption, the first overtone and second overtone of an anharmonic oscillator.

(OR)

(b) With a neat sketch explain the principle and working of FTIR spectrometer.

13. (a) State and explain Lambert-Beer law.

(OR)

(b) Discuss the applications of UV spectroscopy.

14. (a) Compare classical and quantum theories of the Raman effect.

(OR)

(b) Distinguish between spherical top and asymmetric top molecules in Raman spectroscopy.

15. (a) Differentiate between direct dipole-dipole interaction and Fermi contact interaction.

(OR)

(b) Analyze the basic requirements of a NMR spectrometer.

PART – C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).
Answer should not exceed 600 words.

16. (a) Using the Schrodinger equation, determine the rotational energy and rotational constant of a rigid diatomic molecule.

(OR)

(b) Calculate the bond length and moment of inertia of the molecule OCS.

17. (a) Analyze the vibrational energy levels and the allowed transitions between them for a diatomic molecule undergoing simple harmonic motion.

(OR)

(b) Describe the working principle of a double beam IR spectrophotometer and illustrate it with a neat schematic diagram.

18. (a) Illustrate the principle and working of a double-beam UV spectrophotometer using a neat diagram.

(OR)

(b) Give an account of solvent choice and its effects in UV spectroscopy.

19. (a) Discuss the structures of polar and non-polar molecules through IR and Raman spectroscopy.

(OR)

(b) Determine the Raman frequencies of Stokes and anti-Stokes lines in vibrational Raman spectra.

20. (a) Evaluate the magnetic moment of electrons and nuclei under the influence of a magnetic field.

(OR)

(b) Analyse the medical applications of ESR.