Reg. No. : .....

Code No. : 7809 **Sub. Code : WPHE 31**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2024

Third Semester

Physics

Elective V — SPECTROSCOPY

(For those who joined in July 2023 onwards)

Time : Three hours Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

Choose the correct answer :

1. The rotational spectra of a homonuclear diatomic molecule:

   (a) Is visible in the microwave region

   (b) Is visible in the infrared region

   (c) Is absent due to the lack of a permanent dipole moment

   (d) Appears as a continuous spectrum

2. The rotational spectra of diatomic molecules provide information about:

(a) The bond length of the molecule

(b) The mass of the molecule

(c) The electronic structure of the molecule

(d) The temperature of the gas

3. The rotational spectrum of a diatomic molecule typically appears in the:

(a) Ultraviolet region

(b) Visible region

(c) Infrared region

(d) Microwave region

4. A diatomic vibrating rotator model takes into account:

(a) Rotational transitions only

(b) Vibrational transitions only

(c) Both rotational and vibrational transitions

(d) Only electronic transitions

5. In the diatomic vibrating rotator model, the vibrational energy levels are given by the expression

(a) $E_v = h\upsilon_0\left(v + \frac{1}{2}\right)$

(b) $E_v = h\upsilon_0 v$

(c) $E_v = J(J+1)\frac{h^2}{8\pi^2 I}$

(d) $E_v = \frac{hc}{\lambda}$

6. The rotational energy levels in the diatomic vibrating rotator model are given by

(a) $E_v = h\upsilon_0\left(v + \frac{1}{2}\right)$

(b) $E_v = h\upsilon_0 v$

(c) $E_v = J(J+1)\frac{h^2}{8\pi^2 I}$

(d) $E_v = \frac{hc}{\lambda}$

7. For a linear molecule, the spacing between adjacent lines in the rotational Raman spectrum is:

(a) Constant and equal to 4B

(b) Constant and equal to 2B

(c) Variable and depends on J

(d) Randomly distributed

8. The rotational Raman spectra can be observed for molecules that:

(a) Have a permanent dipole moment

(b) Are homonuclear or heteronuclear with anisotropic polarizability

(c) Are only heteronuclear

(d) Are only homonuclear

9. The rotational constant B of a diatomic molecule can be determined from the Raman spectrum by:

(a) Measuring the difference between successive peaks in the spectrum

(b) Identifying the position of the central peak

(c) Calculating the energy difference between vibrational modes

(d) Identifying the electronic transitions

10. In the chemical industry, NMR spectroscopy can be used for monitoring reactions by:

(a) Measuring energy absorption

(b) Identifying the disappearance of reactants and the formation of products

(c) Estimating the temperature change during reactions

(d) Measuring viscosity changes

11. The Larmor frequency in NMR depends on:

(a) The type of solvent used

(b) The external magnetic field strength and the type of nucleus

(c) The temperature of the sample

(d) The molecular weight of the compound

12. The splitting of NMR peaks due to spin-spin coupling provides information about:

(a) The number of protons on neighboring atoms

(b) The energy levels of electrons

(c) The polarity of the solvent

(d) The molecular weight of the compound

13. The working principle of a double beam UV spectrophotometer is based on:

(a) Beer-Lambert's law

(b) Einstein's photoelectric effect

(c) Newton's law of cooling

(d) Heisenberg's uncertainty principle

14. The detectors used in a double beam UV spectrophotometer are typically:

(a) Thermocouples

(b) Photodiodes or photomultiplier tubes

(c) Scintillation counters

(d) Light-emitting diodes (LEDs)

15. In a double beam UV spectrophotometer, monochromators are used to:

(a) Focus the light beam

(b) Split the light into sample and reference beams

(c) Select specific wavelengths of light

(d) Measure the absorbance of the sample

PART B — (5 × 4 = 20 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

16. (a) Give the theory of diatomic molecule as non-rigid rotator.

Or

(b) Explain the intensity of spectral lines.

17. (a) The frequency of OH stretching vibration in CH_3OH is 3300 cm^{-1}, Estimate the frequency of OD stretching vibrating in CH_3OD.

Or

(b) Explain the effect of anharmonicity on the vibrational spectra of diatomic molecules.

18. (a) Explain the quantum theory of Raman effect.

Or

(b) If the bond length of H_2 is 0.07417 nm, What would be the positions of the first three rotational Raman lines in the spectrum? What is the effect of nuclear spin on the spectrum? H = 1.673×10^{-27} Kg.

19. (a) Define chemical shift. Distinguish between δ and τ chemical shifts.

Or

(b) Explain the principle of ESR.

20. (a) Mention some simple applications of UV spectroscopy.

Or

(b) What do you understand solar in organic compounds?

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

21. (a) Give the theory of rotational spectra of diatomic molecules.

Or

(b) With a neat diagram explain the microwave Spectrometer.

22. (a) Explain the theory of Fourier transform IR Spectroscopy.

Or

(b) Give the theory of diatomic vibrating rotator in IR Spectroscopy.

23. (a) Explain the surface Enhanced Raman Spectroscopy.

Or

(b) With a neat block diagram explain the Raman Spectrometer.

24. (a) With a neat block diagram explain the ESR Spectrometer.

Or

(b) Explain the following:

(i) Proton NMR spectrum of 1-Nitropropane

(ii) Proton spectrum of methyl Ethyl ketone.

25. (a) Discuss in detail color in organic compounds.

Or

(b) With block diagram explain the double beam UV Spectrophotometer.
