22P405 (Pages: 2) Name: .....

Reg.No: .....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2024

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19P PHY4 C12 - ATOMIC AND MOLECULAR SPECTROSCOPY

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. Explain the concept of space quantisation.
2. What is Born Oppenheimer approximation? Based on this approximation, what are the salient features of rotation vibration spectra of diatomic vibrating rotor?
3. The rotational Raman spectrum of CH_3Cl molecule shows an alternation in intensity. Why?
4. What are the basic requirements for observing inverse Raman scattering?
5. What information is generated from the vibrational analysis of electronic spectra ?
6. What is the principle of NMR spectroscopy?
7. Comment on the intensity of spectral lines in the hyperfine structure of the ESR spectrum of an unpaired electron coupled with two equivalent nuclei of spin 1/2.
8. How do recoilless emission and absorption are achieved in Mossbauer spectrometer?

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. What is Stark effect? Explain the weak field Stark effect in hydrogen atom.
10. With the help of a schematic diagram, describe the construction, working and advantages of FTIR spectroscopy.
11. What is Deslandre's table? Explain progressions and sequences in electronic spectroscopy of molecules.
12. Deduce Bloch equation and its steady state solutions.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. Derive the expression for Lande's g factor

14. Two consecutive lines of the rotational spectrum of HCl molecule are observed at 211.86 cm $(^{-1})$ and 233.046 cm $(^{-1})$. Calculate the values of rotational constant B, distortion constant D and rotational quantum number J of these transitions. μ of HCl =1.6261x 10^{-27}kg and the force constant of the bond= 517.8Nm^{-1}.

15. Derive expression for the frequencies of the Stark components of the $(J = 1 \rightarrow J = 2)$ transitions of a linear molecule.

16. The Raman line associated with a vibrational mode which is both Raman and infrared active is found at 4600 AA, when excited by light of wavelength 4358 AA. Calculate the wavelength of the corresponding infrared band.

17. The band origin of a transition in (CO_2) is observed at 19378 (cm^{-1}), while the rotational fine structure indicates that the rotational constants in the excited and ground states are $(B_2) = 1.7527\ (cm^{-1})$ and $(B_1) = 1.6326\ (cm^{-1})$. Evaluate the position of band head and wavelength.

18. A free electron is placed in a magnetic field of 3.6 T. Calculate the resonance frequency of $g = 2.0023;\ (\mu_B = 9.274 \times 10^{-24} JT^{-1})$.

19. Calculate the recoil velocity and energy of a free Mossbauer nucleus $(^{119}Sn)$when emitting a gamma ray of frequency (5.76×10^{18}) Hz. What is the doppler shift for an outside observer?

(4 × 3 = 12 Weightage)

****