

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2022
(Regular/Improvement/Supplementary)

PHYSICS
FPHY4C12 - ATOMIC AND MOLECULAR SPECTROSCOPY

Time: 3 Hours

Maximum Weightage: 30

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Distinguish between normal Zeeman effect and anomalous Zeeman effect.
2. Why anti Stokes lines are less intense than Stokes lines.
3. Write a short note on Franck Condon principle.
4. Explain stimulated Raman scattering with the help of a diagram.
5. Deduce the condition for NMR.
6. Outline the principle of ESR.
7. Explain singlet and triplet states with example.
8. Briefly explain recoil-less emission and absorption of gamma rays.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Describe with necessary theory how structure of diatomic and triatomic molecules can be determined by combining Raman and IR spectroscopy.
10. (a) Discuss in detail rotational spectra of a diatomic molecule, considering it as a non rigid rotator.

(b) How will you account the isotope effect in the above spectrum?
11. Obtain Bloch equations in NMR spectroscopy. Explain its significance in defining susceptibilities.
12. Explain the principle and working of Mossbauer spectroscopy.

(2 × 5 = 10 weightage)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage

13. Rotational and centrifugal distortion constant of HCl molecule are 10.593 cm^{-1} and $5.3 \times 10^{-4} \text{ cm}^{-1}$ respectively. Estimate the vibrational frequency and force constant of the molecule.

(P.T.O.)

14. Describe the energy level diagram and the allowed transitions for an electron coupled to a nucleus of spin $I = 1$ (Neglect I.B interactions).
15. The fundamental and first overtone of CO occurs at 2143.3 cm^{-1} and 4260 cm^{-1} . Calculate the dissociation energy.
16. Compute the interaction energies for **pd** electrons in **LS** coupling.
17. If the bond length of H_2 is 0.07417 nm , what would be the positions of the first 3 rotational Raman lines in the spectrum? What is the effect of nuclear spin on the spectrum? ${}^1\text{H} = 1.673 \times 10^{-27} \text{ kg}$.
18. The electron configuration of phosphorus is $1s^2 2s^2 2p^6 3s^2 3p^3$. Obtain its ground state term.
19. Explain fortrat parabolae and find band head and band origin.

(4 × 3 = 12 weightage)