22/10/25

TM253471G

Reg. No :.....

Name :.....

MASTER'S DEGREE (C.S.S) EXAMINATION, NOVEMBER 2025

2024 ADMISSIONS REGULAR

SEMESTER III - CORE COURSE

PH3C11TM20 - Atomic and Molecular Physics

Time : 3 Hours **Maximum Weight : 30**

Part A

I. Answer any Eight questions. Each question carries 1 weight **(8x1=8)**

1. Distinguish between equivalent and non equivalent electrons.
2. Explain different spectral lines of Sodium atom.
3. Find the separation between the quantum states $P_{3/2}$ and $P_{1/2}$
4. Give a brief account of classification of molecules based on moment of inertia.
5. Hot bands are less intense. Justify.
6. Describe Raman effect with the help of an energy level diagram.
7. Explain Bohr- Oppenheim approximation.
8. Describe the physical significance of gyromagnetic ratio and write the expression for it.
9. With necessary explanation, illustrate the ESR spectrum of Hydrogen atom.
10. Explain quadrupole effects in Mossbauer spectroscopy.

Part B

II. Answer any Six questions. Each question carries 2 weight **(6x2=12)**

11. Explain different types of quantum numbers associated with vector atom model.
12. Draw the normal Zeeman pattern of Sodium D1 and D2 line.
13. The rotational constant for HCl molecule is given by $10.593cm^{-1}$ and its centrifugal distortion constant is $0.00053cm^{-1}$. Calculate the first two rotational levels. Also calculate the force constant for HCl.
14. The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at $1876.06cm^{-1}$ and $3724.20cm^{-1}$ respectively. Evaluate the equilibrium vibration frequency, the anharmonicity constant and force constant of the molecule.
15. Outline the advantages of CARS over spontaneous Raman scattering.
16. Explain Franc-Condon principle.
17. With necessary theory, explain Magnetic Resonance imaging.
18. Calculate the recoil velocity and energy of the free Mossbauer nucleus Sn^{119} when emitting a γ-ray of frequency $6.78 \times 10^{18} Hz$. What is the Doppler shift of the γ-ray frequency to an outside observer?

Part C

III. Answer any Two questions. Each question carries 5 weight **(2x5=10)**

19. Explain linear Stark effect in Hydrogen atom
20. Discuss the vibrational spectrum of an anharmonic oscillator and compare it with that of a harmonic oscillator.
21. Explain Rotational Raman spectra for polyatomic molecules.
22. Derive Bloch equations and arrive at the steady state solution.