TM243328Z

Reg. No :.....

Name :.....

MASTER'S DEGREE (C.S.S) EXAMINATION, NOVEMBER 2024

2020, 2021, 2022 ADMISSIONS SUPPLEMENTARY

SEMESTER III - CORE COURSE PHYSICS

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 the shortcomings of Bohr atom model.
3. Calculate the orbital, spin and total magnetic moments of f electron.
4. Illustrate the relevance of isotopic substitution in a non-cyclic polyatomic molecule.
5. Hot bands are less intense. Justify.
6. Briefly explain the structure of vibrational Raman spectra.
7. With a neat diagram, Explain sequences in vibrational coarse structure.
8. Explain the reason for chemical shift in NMR.
9. Write a note on paramagnetic materials and mention some examples.
10. Explain magnetic hyperfine interaction in Mossbauer spectroscopy.

Part B

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

11. Explain different factors that cause the broadening of spectral line
12. Draw the normal Zeeman pattern of Sodium D1 and D2 line.
13. Three consecutive lines in the rotational spectrum of a diatomic molecule are observed at 84.544, 101.355 and 118.112cm^{-1}. Assign these lines to their appropriate J" → J' transitions and deduce approximate vibrational frequency of the molecule.
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. Explain the principle of CARS and PARS.
16. Explain how can you determine the dissociation energy from the electronic spectrum of molecules.
17. Explain the significance of relaxation process and also explain spin-spin and spin- lattice relaxations.
18. Compute the recoil velocity of a free Mossbauer nucleus of mass $1.67 \times 10^{-25} kg$ when emitting a γ- ray of 0.1nm wavelength. Calculate 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. Derive the interaction energy term in LS coupling. Also find the possible states arising from two equivalent ss electrons .
20. Discuss the spectrum of a diatomic vibrating rotator and hence the effects of break down of Born Oppenheimer approximation on the spectrum.
21. Explain Rotational Raman spectra for polyatomic molecules.

22. With a neat diagram, explain the principle and working of ESR spectrometer