

M Sc DEGREE END SEMESTER EXAMINATION - MARCH 2018**SEMESTER 4 : PHYSICS****COURSE : 16P4PHYT13 ; ATOMIC AND MOLECULAR PHYSICS***(For Regular - 2016 admission)*

Time : Three Hours

Max. Marks: 75

Section A**Answer all the following (1 marks each)**

- For two electron system if $l_1 = 2$ and $l_2 = 1$, the value of J according to LS coupling will be
a) 3,2,1 b) 4,3,2,1,0 c) 1,2,3,4 d) 4,3,2
- At ordinary temperatures, molecules lie in their
a) Lowest vibrational level b) Highest vibrational level
c) Can remain in any vibrational state d) Does not show vibration
- Vibrational transitions in a molecule are accompanied with energy change as
a) 10eV b) 0.1eV c) 0.05eV d) 5eV
- In a Raman scattering experiment, light of frequency ν from a laser is scattered by adiaomic molecule having moment of inertia I. The typical Raman shifted frequency depend on:- a. ν and I b) only ν c) only I d) neither on I or ν
- In a spectrometer operating at 1T. the NMR frequency of ^{19}F is 40.06MHz. The Magnetogyroic ratio of ^{19}F is
a) $1.517 \times 10^8 \text{ T}^{-1}\text{s}^{-1}$ b) $2.517 \times 10^{-8} \text{ T}^{-1}\text{s}^{-1}$
c) $2.517 \times 10^8 \text{ T}^{-1}\text{s}^{-1}$ d) $1.517 \times 10^6 \text{ T}^{-1}\text{s}^{-1}$

(1 x 5 = 5)

Section B**Answer any 7 (2 marks each)**

- Show that no two electrons in an atom can have the same quantum state.
- List the reasons for hyperfine structure in atomic spectra.
- Give examples of prolate and oblate symmetric top molecules.
- What will be the change in the rotational constant, if hydrogen is replaced by deuterium in hydrogen molecule?
- Show that the potential energy curve of a harmonically oscillating molecule is parabolic.
- Distinguish between Raman Scattering and Rayleigh scattering.

12. Why anti – stokes lines are less intense than stokes lines?
13. Explain the principle of ESR
14. What are the applications of NMR technique?
15. What is the role of spin – spin coupling in NMR spectroscopy?

(2 x 7 = 14)

Section C

Answer any 4 (5 marks each)

16. Draw the vector diagram for $L S$ coupling in a pd electron system
17. Evaluate Lande's g factor for ${}^2P_{1/2}$ state.
18. Briefly discuss the effect of isotopic substitution on the rotational spectra of molecules.
19. Describe CARS.
20. In H_2 molecule the separation between adjacent rotational Raman lines is $4B$ while in O_2 it is $8B$. Why?
21. Calculate the Doppler velocity corresponding to the natural line width of the gamma ray emission from 14.4 keV excited state of ${}^{57}Fe$ nucleus having half life 9.8×10^{-8} nsec.

(5 x 4 = 20)

Section D

Answer any 3 (12 marks each)

22. Explain the theory of linear stark effect in Hydrogen atom.
23. Explain the Anomalous Zeeman pattern of sodium D lines.
24. Explain the theory of a diatomic vibrating rotator.
25. Explain the Born – Oppenheimer approximation. Hence deduce the theory of a diatomic vibrating rotator.
26. Give quantum theory of Raman Effect. Explain how size, shape and orientation of polarizability ellipsoid changes when CO_2 molecule vibrates.
27. Explain the theory of NMR. Prove that the relaxation time in NMR is inversely proportional to the transition probability.

(12 x 3 = 36)