

Reg. No

Name

19P4004

MSc DEGREE END SEMESTER EXAMINATION - MARCH/APRIL 2019

SEMESTER 4 : PHYSICS

COURSE : 16P4PHYT13 : ATOMIC AND MOLECULAR PHYSICS

(For Regular - 2017 Admission and Supplementary - 2016 Admission)

Time : Three Hours

Max. Marks: 75

Section A

Answer all the following (1 marks each)

1. The different values for total orbital quantum number of a two electron system with $l_1 = 3$ and $l_2 = 2$ are
a) 5 b) 5, 1 c) 1,2,3,4,5 d) $\pm 5, \pm 4, \pm 3, \pm 2, \pm 1, 0$
2. In HCl molecule the energy gap between two vibrational levels is 0.36eV. Its Zero point energy will be
a) 0 b) 0.18eV c) 0.36eV d) 0.54eV
3. In infra red band spectrum of diatomic molecules, frequency interval between successive lines on either side of band origin is
a) B/h b) $4B/h$ c) B d) $2B/h$
4. In Raman spectra Q branch is
a) Absent b) Present c) Depends on state of polarization d) None of these
5. Value of nuclear spin I can be
a) Integer only b) half integer only
c) Integer, half integer or zero d) can not have zero value

(1 x 5 = 5)

Section B

Answer any 7 (2 marks each)

6. Obtain the Lande 'g' factor of an d electron
7. What is the effect of nuclear spin on the intensity of atomic spectra?
8. Give examples of prolate and oblate symmetric top molecules.
9. Comment on the rotational spectra of polyatomic linear molecules.
10. The first line in the P branch is numbered as P_1 whereas the first line in the R branch is R_0 . Explain.
11. Why anti - stokes lines are less intense than stokes lines?
12. Distinguish between dissociation energies D_0 and D_e
13. Explain recoilless emission.

14. Sketch and label the Zeeman splitting of energy levels of an unpaired electron in a magnetic field.
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. Evaluate Lande's g factor for 3P_1 state. Use the result to predict the splitting of the energy level when the atom is in an external field of 0.1 T.
17. The ground state of chlorine is $^2P_{3/2}$. Find its magnetic moment. To how many sub states will the ground state split in a weak magnetic field?
18. The fundamental band of CO is centered at 2143cm^{-1} and the first overtone at 4259cm^{-1} . Calculate the equilibrium oscillation frequency and the corresponding anharmonicity constant.
19. What information can be derived from the Raman spectroscopic studies?
20. Explain how size, shape and orientation of polarizability ellipsoid changes when CO_2 molecule vibrates.
21. ESR spectrum of Hydrogen atom slided with 9.3GHz shows two lines at 3570 Gauss and 3044 Gauss. Calculate hyperfine splitting constant.

(5 x 4 = 20)

Section D

Answer any 3 (12 marks each)

- 22.1. Derive the expression for spin orbit interaction energy. Draw the doublet formation in 2P energy state.
- OR
2. Explain the Anomalous Zeeman pattern of sodium D lines.
- 23.1. Explain the Born – Oppenheimer approximation. Hence deduce the theory of a diatomic vibrating rotator.
- OR
2. Describe the microwave spectra of a polyatomic symmetric top non rigid molecule.
- 24.1. Describe pure rotational Raman spectra of linear molecules.
- OR
2. Explain the phenomenon of ESR. Obtain the resonance condition. How does a hyper fine structure arise in ESR?

(12 x 3 = 36)