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Reg. No.....

Name.....

M.Sc. DEGREE (C.S.S.) EXAMINATION, MAY 2018

Fourth Semester

Faculty of Science

Branch II–Physics–A–Pure Physics

PH4C11—ATOMIC AND MOLECULAR PHYSICS

[Common for all]

(2012 Admission onwards)

Time : Three Hours Maximum Weight : 30

Part A

Answer any **six** *questions.*
Each question carries weight 1.

1. Explain Hund's rule with an example.
2. Write down the spin-orbit interaction energy for a hydrogenic atom.
3. Briefly explain about the width of spectral lines.
4. Spherical top molecule do not show rotational spectrum. Why ?
5. Write down the selection rules for vibrational rotational transitions of a symmetric top molecule ?
6. What is Born-Oppenheimer approximation ?
7. What is inverse Raman effect ?
8. State and explain Franck-Condon principle.
9. Obtain the resonance condition in NMR spectroscopy ?
10. Briefly explain recoilless emission and absorption of gamma rays.

(6 × 1 = 6)

Part B

Answer any **four** *questions.*
Each question carries weight 2.

11. Consider a hydrogen atom in the $^{D}_{3/2}$ state. (i) Find the possible values of Iz. (ii) What are the different orientations of the J-vector in space.

Turn over

12. Rotational and centrifugal distortion constants of Hcl molecule are 10.593 cm^{-1} and 5.3 × 10^{-4} cm^{-1} respectively. Estimate the vibrational frequency and force constant of the molecule.

13. The fundamental and first overtone transition of $^{14}N\,^{16}O$ are centred at 1876.06 cm^{-1} and 3724.20 cm^{-1} respectively. Evaluate the equilibrium vibration frequency, the anharmonicity constant, zero point energy and the force constant of the molecule.

14. The first three rotational Raman lines of a linear triatomic molecular are at 4.86, 8.14 and 11.36 cm^{-1} from the exciting Raman lines. Estimate the rotational constant B and the moment of inertia of the molecule.

15. The value of Je and *xe* for the ground and excited states of C_2 molecule are 1641.4 cm^{-1}, 7.11 × 10^{-3} and 1788.2 cm^{-1}, 9.19 × 10^{-3} respectively. If its J00 is at 19.378 cm–1, calculate the energy difference of the two electronic states.

16. A free electron gives resonance at a frequency of 9.5 GHz when the magnetic field strength is 0.34T. At what frequency the resonance occures if the magnetic field is 1.3T ?

(4 × 2 = 8)

Part C

Answer **all** *questions.*
Each question carries weight 4.

17. (a) Discuss in detail Ls and jj coupling schemes in many electron atoms. Give examples.

Or

(b) (i) Give the theory of Paschen-Back effect.

(ii) Explain Stark effect on one electron system.

18. (a) What is a non-rigid rotators. Obtain an expression for the rotational energy levels of a diatomic molecule, taking it as a non-rigid rotator.

Or

(b) Explain in detail the theory of a diatomic vibrating rotators.

19. (a) State the rule of mutual exclusion. Explain structure determination using IR and Raman spectroscopy.

Or

(b) Discuss the theory of rotational fine structure of the electronic-vibrational spectra of a diatomic molecule.

20. (a) Explain in detail (i) Relaxation process in NMR (ii) Theory of chemical shift with an example.

Or

(b) Give the theory of ESR. What are the factors responsible for the hyperfine structure in ESR spectra. Explain the applications of ESR spectroscopy.

(4 × 4 = 16)