MASTER OF SCIENCE EXAMINATION, 2017 (EVENING).
(3rd Year, 1st Semester)

Subject: PHYSICS
Paper: **Atomic & Molecular Physics**
PHY / TG / 115
(Ref. No. *EX/M.SC./PHY/E/III/115/29/2017*)

Time: Two Hours
Full Marks: 40

GROUP - A (Atomic Physics)

Answer any ONE question

1. (a) Show that the average of the square of the distance between two non-interacting quantum particles is statistically lesser for symmetric wave-functions than antisymmetric ones.

   (b) Construct all the possible full (space part along with spin part) wavefunctions involving two spin-half particles.

   (c) For a Helium atom, show analytically that triplet states are lower in energy than the singlet state.

   Marks: 6 + 4 + 10 = 20

2. (a) A hydrogen atom is placed in a uniform magnetic field $\vec{B} = B\hat{z}$. Show that the part of the Hamiltonian that consists of (i) internal spin-orbit coupling and (ii) coupling of the orbital and spin momenta with $\vec{B}$, commutes with J_z (which is the z-component of the total angular momentum).

   (b) Calculate the matrix elements of this part of the Hamiltonian in a suitably chosen basis.

   (c) Find the corrections to energy to first order in perturbation theory and show the strong-field and weak-field limits.

   Marks: 4 + 6 + 10 = 20

M.Sc. (Physics) 3rd Year 1st Semester (*Evening*) Examination, 2017

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Group – **B** (20 marks) Use separate Answer-script

Answer question no. **3** and *any one* from the rest

3. Answer *any* two: 2×3

(a) Write down the main differences in Raman and IR spectra? What is *Morse* function?

(b) Discuss briefly the role of *centrifugal distortion constant D*.

(c) What is the polarizability ellipsoid?

4. (a) Obtain an expression for rotational quantum number J of the most intense transition. (b) Derive the term value expression for *prolate* symmetric top molecule. (c) Discuss the role of Franck–Condon principle in connection with intensity of vibrational electronic spectral lines with necessary diagrams. (d) What are the differences between Rayleigh and Raman scattering? (e) The exciting line in an experiment is 546 *nm* and the Stokes line is at 552 *nm*. Find the wavelength of the anti-Stokes line. 3+4+3+2+2

5. (a) Explain the difference between equilibrium internuclear distance r_e and internuclear distance r_0. (b) In the rotational fine structure of electronic vibration spectra, in certain molecules the band head appears on the violet side of the spectrum and in some molecules it appears on the red side of the spectrum – Explain. (c) Derive an expression for Raman shift of a rotating molecule following the classical theory. (d) What are Fortrat parabolæ? (e) The rotational constant for $H^{35}Cl$ is observed to be at 10.5909 cm^{-1}. What are the values of B for $H^{37}Cl$ and for $^2D^{35}Cl$? 2+3½+3½+2+3