Roll No. ☐☐☐☐☐☐☐☐☐☐☐☐☐ Total No. of Pages : 02

Total No. of Questions : 09

M.Sc.(Physics) (2015 to 2017)   (Sem.–3)
ATOMIC & MOLECULAR PHYSICS
Subject Code : MPH-301
M.Code : 72614

Time : 3 Hrs.   **Max. Marks : 100**

INSTRUCTIONS TO CANDIDATES :
  1.   **Attempt FIVE questions in all including the compulsory question no.9**

Q1 (a) Deduce and explain spectrum of hydrogen atom from principles of atomic spectroscopy but limited to relative correction to kinetic energy.   (12)

   (b) Calculate to three significant figures, the wavelength of the first member of each of the series in the spectrum of atomic hydrogen with the quantum numbers n'' = 90 and 166. In which region of the electromagnetic spectrum do these transitions appear?   (6,2)

Q2 (a) Discuss in brief the vector model for one and two valence electron atoms.   (10)

   (b) Explain spectroscopic notations for L-S and J-J couplings. Also explain interaction energy in L-S and J-J coupling for two electron systems.   (4,6)

Q3 (a) Discuss Russel-Saunders coupling approximation for non-equivalent electrons.   (10)

   (b) Give a schematic representation of the interaction energy for pd configuration in L-S coupling.   (10)

Q4 (a) Discuss intensity rules in case of Zeeman effect. Explain Zeeman effect for two electron systems.   (4,6)

   (b) Predict the splitting of $^3P_1$ level when the atom is in an external magnetic field of 2T.
                                                                (10)

Q5 (a) Explain linear Stark effect? How does Stark effect play important part in the theories of molecule formation from atoms of the broadening of spectral lines and of dielectric constants?   (3,7)

   (b) Define Born-Oppenheimer Approximation? Discuss in detail the dissociation and pre-dissociation energies.   (4,6)

Q6 (a) Obtain an expression for the rotational energy of a diatomic molecule considering rigid rotator model. (12)

   (b) What do you mean by molecular polarizability? What does induced electric dipole moment set up in a molecule, mean? (8)

Q7 (a) Explain the quantum and classical theories of Raman effect. Deduce rotational Raman spectrum for linear diatomic molecule. (12)

   (b) Can Raman spectra be obtained from a mixture of materials? Explain. (8)

Q8 (a) Discuss in brief, any three features of ESR spectra. Write in reasonable size, about two basic branches of NMR spectroscopy. (12)

   (b) What is the difference in fractional population of C^{13} spins between the upper and lower states in a magnetic field of 2T at 298K? (g_{carbon} = 1.404) (8)

Q9 (a) Define the terms Magnetic dipole moment, Bohr Magneton, Raman anti-Stokes' and Stokes' lines and Lande's interval rule.

   (b) Consider a p-electron in a one electron system. Calculate values of I, s, j and possible angle between I and s. (Ask for trigonometric tables).

   (c) List the set of quantum numbers possible for n = 3.

   (d) State Hund's rule. Using this rule name the term, lowest in energy for ground configurations of both C and O.

   (e) Why is it impossible for $^2D_{3/2}$ state to exist?

   (f) Calculate the fine structure splitting of 4d and 5f of Be IV.

   (g) Write origins of microwave and infra-Red spectroscopies.

   (h) What is spectral line broadening? Give at least two remedies two reduce line broadenings. ($8\times2.5 = 20$)

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.