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
Paper ID : [72614]

Time : 3 Hrs.   Max. Marks : 100

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

Q1 a) What do you mean by magnetic dipole moment? What are various atomic quantum numbers? List the set of quantum numbers possible for n = 3.   (12)

    b) What is Lamb Shift? Explain spectroscopic notations for L-S and J-J couplings.   (8)

Q2 a) In hydrogen atom spectrum, obtain energies of atomic orbitals. Deduce total electronic angular momentum from the orbital and electron spin angular momenta.   (10)

    b) Calculate the first three lines in the absorption spectrum arising from transitions from the 3 s level of the hydrogen atom. What is the ionization energy of this level?   (10)

Q3 a) Discuss intensity rules in case of Zeeman effect. Explain Zeeman Effect for two electron systems.   (10)

    b) Calculate the Lande's g-factor for sp configuration in jj coupling. Also show that g = 3/2 for levels with S = L, except for levels with J = 0.   (10)

Q4 a) Compute the possible terms and energy levels for a configuration with three optically active electrons $^2p^3p^4d$.   (12)

    b) Evaluate the Lande g-factor for the $^3P_1$ level in the $^2P^3S$ configuration of the ^6C atom and use the result to predict the splitting of the level when the atom is in an external field of 0.1Tesla.   (8)

Q5 a) Illustrate with the help of diagram the splitting of ^2D levels of sodium when (i) a weak magnetic field and (ii) a strong magnetic field, is applied.   (12)

    b) Define Born-Oppenheimer Approximation. Discuss in detail the dissociation and pre-dissociation energies.   (8)

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) Calculate the magnetic field needed to satisfy the resonance condition for unshielded proton in a 100 MHz radio frequency field, (g_{proton} = 5.585, Magnetic moment, $\beta_N = 5.05082 \times 10^{-27}$ JT^{-1} and h = 6.6262×10^{-34}Js).   (8)

Q9   Answer briefly :

a) When in a molecule the vibrations are said to be Raman active? Explain.

b) What frequency of light would be needed to make an electron in a hydrogen atom jump from n = l to n = 3?

c) In nλ = 2Πr, n is an integer. Why?

d) Write a note on intensity of rotational spectral lines.

e) Write the selection rules for alkali like spectra and discuss isotopic substitution.

f) Explain zero-point energy.

g) State Franck-Condon principle.

h) Write origins of microwave and infra-Red spectroscopies.   (8×2.5=20)