Reg. No. : ..... (Pages : 2) **8262**

Name : .....

III Semester M.Sc. Degree Examination, November 2006
Branch – II : PHYSICS
PH 232 : Atomic and Molecular Physics

Time: 3 Hours Max. Marks: 75

PART – A

Answer **any five** questions. **Each** question carries **3** marks.

1. a) Distinguish between anomalous Zeeman effect and Paschen-Back effect.
   b) Explain the concept of bonding and antibonding orbitals by combining two 1s orbitals.
   c) Differentiate between rotation and improper rotation. Explain improper rotation with an example.
   d) Explain why a molecule with a centre of symmetry cannot have a dipole moment.
   e) Why are antistokes lines much less intense than the stokes lines in a Raman spectrum ?
   f) Explain Franck - Condon principle. What is its importance ?
   g) Explain screening constant. What are the different contributions to screening constant of molecules ?
   h) Discuss the origin of isomer shift or chemical shift in Mössbauer spectroscopy.

(5×3=15 Marks)

PART – B

Answer **all** questions. **Each** question carries **15** marks.

2. a) Discuss the molecular orbital treatment of hydrogen molecule and explain the covalent bonding in hydrogen molecule.

   OR

   b) Explain the first order stark effect of a symmetric top molecule. Discuss its importance in microwave spectroscopy.

3. a) Give the theory of rotational spectra of non-rigid diatomic molecules and show that the separation between adjacent lines decreases with increasing J value.

   OR

P.T.O.

b) i) Discuss the quantum theory of Raman effect. 6

ii) Obtain the energy levels of rotational Raman spectra. 7

iii) Why is Raman spectroscopy important in the study of homonuclear diatomic molecules ? 2

4. a) i) Explain the band origin and band head in the rotational fine structure of electronic vibration spectra. 7

ii) Discuss the method of determining the internuclear distance of the electronic states from the rotational fine structure of electronic vibration spectra. 8

OR

b) Discuss the basic principle of NMR spectroscopy. Draw the block diagram of a NMR spectrometer, describe its various components and explain how the NMR spectrum is recorded ? **(3×15=45 Marks)**

PART – C

Answer **any three** questions. **Each** question carries **5** marks.

5. The term symbol for a particular atomic state is quoted as $^4D_{5/2}$. What are the values of L, S and J for this state ? Determine the minimum number of electrons which could give rise to this. Suggest a possible electronic configuration.

6. How many normal modes of vibration are possible for (a) OCS (linear) and (b) SO_2 (bent) molecules ?

7. A Raman line is observed at 4768.5 Å when acetylene is irradiated by 4358.3 Å radiation. Calculate the vibrational frequency that causes this shift.

8. Draw the energy level diagram and mark the allowed transitions for an electron coupled to a nucleus of spin I = 1. What are their energies ? Neglect the interaction between the magnetic field and the nuclear spin.

9. The HCl molecule has a B value of 10.593 cm^{-1} and a centrifugal distortion constant D of 5.3×10^{-4} cm^{-1}. Estimate the vibrational frequency and force constant of the molecule.

10. ^{57}Fe Mössbauer nucleus has a spin of $^1/_2$ for the ground state and $^3/_2$ for the first excited state. Determine the splitting of the energy levels due to nuclear Zeeman interaction. Also, determine the number of allowed transitions. **(3×5=15 Marks)**
