6. (a) What is nuclear magnetic resonance? How do you estimate the magnetic field of Sun? (10)

(b) In the rotational Raman spectrum of a heteronuclear molecule, the shift of lines from the exciting line are found to be given by $\Delta\bar{\nu} = \pm(48J+72)\ cm^{-1}$. Find the rotational constant for the molecule and the corresponding moment of inertia. (8)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5899 **H**

Unique Paper Code : 2224002011

Name of the Paper : Atomic and Molecular Physics

Name of the Course : **B.Sc. Hons. – (GE)_NEP_ UGCF-2022**

Semester : IV

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.
5. Use of nori-programmable scientific calculator is allowed.

1. Attempt all parts of the question: (3×6=18)

   (a) Explain the concept of degeneracy of energy levels.

   (b) Calculate the natural width of the spectral line in terms of wavelength if mean life time for the excited state of an atom is 10^{-8} s and the atom emit radiation of wavelength 6000 Å.

   (c) Evaluate the Lande g-factor for the state $^2D_{3/2}$.

   (d) What are bonding and anti-bonding orbitals?

   (e) Write the ground state electronic configuration of N_2.

   (f) Raman effect is an important tool for determining the information regarding the structure of diatomic molecules, explain.

2. (a) Discuss the different modes of relaxation of an excited atomic state. (10)

   (b) Calculate the shift of H_α-line of Hydrogen, if Hydrogen contains mixture of its two isotopes protium and tritium. [Given: mass of electron m_e = 9.1×10^{-28} g, mass of proton $M_p = 1.67 \times 10^{-24}$ g, $= 1.097 \times 10^5$ cm^{-1}]. (8)

3. (a) Explain Stern-Gerlach experiment. Why a non-uniform magnetic field is used in this experiment? (10)

   (b) What is anomalous Zeeman effect? Draw the anomalous Zeeman splitting of the spectral lines corresponding to $2^3S_1 \rightarrow 2^3P_2$ transition. (8)

4. (a) Explain LS and JJ coupling schemes giving the corresponding selection rules. (10)

   (b) Determine the terms symbols for 4p 4d system under LS coupling. (8)

5. (a) What are the different types of molecular spectra? Explain the significance of the vibrational spectrum in the study of molecular structure and bonding. (10)

   (b) The fundamental bond in vibrational spectra of a diatomic molecule is obtained at wave number 1876 cm^{-1}. Determine the force constant of the bond. [Given: reduced mass = 1.63×10^{-27} kg]. (8)