(i) Printed Pages: 3 Roll No. .....

(ii) Questions : 9 Sub. Code : 3723

Exam. Code : 0475

M.Sc. Physics 4th Semester

(2054)

ATOMIC AND MOLECULAR PHYSICS

Paper : PHY-8042

Time Allowed : Three Hours] **[Maximum Marks : 60**

Note :—Attempt **FIVE** questions in all, including Q. No. 9 (Unit-V) which is compulsory and selecting **ONE** question each from Units I-IV.

UNIT—I

1. (a) Calculate the possible orientations of the total angular momentum ($\vec{J}$) corresponding to j = 3/2 with respect to a magnetic field along the z-axis.

   (b) What is Larmor Precession ? Find the expression for Larmor Precession frequency. Explain its importance. 2×6=12

2. Write down the electronic configuration for ground state and first excited state of Sodium (Z = 11) and obtain the spectral terms arising from the valance electron. Also draw these energy levels and indicate the allowed transition, mention the transition rules. Clearly denote the D_1 and D_2 line of sodium spectra. 12

UNIT—II

3. With the help of a clean diagram illustrate the splitting of D_1 and D_2 lines of sodium spectra in the presence of :

   (i) Weak Magnetic field

   (ii) Strong Magnetic field. 12

4. (a) What is the natural breadth of a spectral line ? Discuss various line broadening mechanisms.

   (b) Explain the meaning of amplification of the intensity of light. Show mathematically that population inversion is necessary for the amplification of light intensity (lasing action). 2×6=12

UNIT—III

5. What are the differences between atomic spectra and molecular spectra ? What is their origin ? Discuss various types of molecular spectra in detail. 12

6. Obtain an expression for the rotational energy levels of a diatomic molecule. Draw energy level diagram for different rotational states. What is the effect of non-rigidity and isotopes on these energy levels ? 12

UNIT—IV

7. (a) Explain the technique of UV-Visible Spectroscopy (UV-VIS) and its applications in analysis of samples. Discuss the instrumentation used in a UV-VIS spectrophotometer.

   (b) Discuss the principles behind Fourier Transform Spectroscopy (FTS) and how it differs from conventional spectroscopy techniques. 2×6=12

8. Describe the technique of Electron Spin Resonance (ESR) spectroscopy and its applications in studying materials with unpaired electrons. Discuss the instrumentation used in ESR spectroscopy and how it detects the presence of unpaired electrons. 12

UNIT—V

9. All questions are compulsory. Each question carries 2 marks.

(i) What do you mean by Lamb Shift ?

(ii) Show that an atom having filled subshell has $^1S_0$ ground state.

(iii) State and explain Moseley's law in X-rays.

(iv) What is the Frank-Condon principle, and how does it explain the behaviour of molecules during electronic transitions ?

(v) Define Spatial and temporal coherency.

(vi) Describe the Stark effect. 6×2=12