Total No. of printed pages = 6

63/2 (SEM-3) PHY 302(0)

2021

PHYSICS

(Theory Paper)

Paper Code : PHY-302 (Old)

(Atomic And Molecular Physics)

Full Marks – 80

Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer from the following : $1 \times 5 = 5$

   (i) In Zeeman effect, a spectral line upon the application of magnetic field, splits into more than three components because of

   (a) energy levels split into $2J+1$

   (b) in magnetic field $\Delta m_j = 0, \pm 1$ no longer hold

   (c) variation of Lande g factor from one level to another

   (d) None of the above

[Turn over

(ii) Which of the following is not true for Laser ?

(a) extremely intense light

(b) highly monochromatic

(c) coherent

(d) divergent

(iii) Which of the following pairs of the molecules exhibit rotational spectrum

(a) $CC1_4$ & HF

(b) $CC1_4$ & O_2

(c) HCN & HF

(d) HCN & $CC1_4$

(iv) According to intensity rule, the transition will be most intense, for

(a) $\Delta L = \pm 1, \Delta J = \pm 1$

(b) $\Delta L = +1, \Delta J = 0$

(c) $\Delta L = -1, \Delta J = -1$

(d) $\Delta L = -1, \Delta J = 0$

(v) In Paschen Back effect, the separation between component lines are _____ than the separation between multiplet fine structure components.

(a) smaller

(b) greater

(c) equal

(d) None of the above

2. Answer the following questions : 2×5=10

(i) Discuss about hyperfine structure of spectral lines.

(ii) Why diatomic molecules having a permanent electric dipole moment exhibit rotational spectrum ?

(iii) In a two level system, why it is not possible to have Laser action ?

(iv) Find the degeneracy of diatomic rotator whose rotational energy level is $\frac{h^2}{4\pi^2 I}$

(v) In what way the absorption spectra of diatomic molecules differ from the emission spectra ?

3. Answer any *five* of the following questions : 5×5=25

(i) What is Stark effect? Find the first order change in energy levels of hydrogen atom due to an external dielectric field. 1+4=5

(ii) Explain the working principle of NMR.

(iii) Write short notes on Frank Condon principle.

(iv) What do you mean by population inversion in Laser? Deduce the threshold condition for Laser oscillation. 1+4=5

(v) What do you mean by half intensity breath of spectral lines? Show that the Doppler broadening is proportional to the square root of absolute temperature. 1+4=5

(vi) Explain the physical significance of Pauli's exclusion principle. Discuss the periodic table in the light of Pauli's exclusion principle. 2+3=5

4. Answer any *four* of the following questions : 10×4=40

(i) Distinguish between normal and anomalous Zeeman effect. Derive expression for the magnetic interaction energy (Zeeman energy splitting) for a single valence electron atom given as $\Delta E = gM_j\mu_g B$, where the symbols have usual meanings. In a normal Zeeman experiment the Calcium 4226 Å line splits into 3 lines separated by 0.25 Å in a magnetic field of 3T. Determine e/m for the electron from those data. 2+5+3=10

(ii) Show that the absorption spectrum of a rigid rotator is expected to consist of a series of equidistant lines. Describe a suitable experimental arrangement for the study of pure rotational spectrum of a diatomic molecule. The far infrared spectrum of H^1Br^{79} consists of a series of lines spaced 17 cm^{-1} apart. Find the internuclear distance of H^1Br^{79}. (Given $h = 6.63\times10^{-34}$Js) 5+2+3=10

(iii) Explain what is Raman effect. Discuss the Quantum theory of Raman effect and describe the rotational structure of the Raman spectrum of a diatomic molecule. 2+4+4=10

(iv) What are the characteristics of a Laser beam ? Explain the working principle of He-Ne Laser. Mention the advantages of a gas Laser over a solid state Laser. 2+5+3=10

(v) Mention salient features of molecular electronic spectra. Discuss rotational fine structure of electronic vibrational transition What is Fortrat diagram ? 2+6+2=10