

GSQ/M-21**1749****ATOMIC AND MOLECULAR-SPECTROSCOPY**

Paper–XII

Time Allowed : 3 Hours]

[Maximum Marks : 40

Note : Attempt **five** questions in all, selecting **one** question from each Unit.
Question No. 1 is compulsory.

Compulsory Question

1. Give brief answers of the following :
 - (i) A hydrogen atom is in 4p state. To what state or states can it go by radiating a photon in an allowed transition? 1
 - (ii) Why are the I.R. spectra of homonuclear molecular not observed? 1
 - (iii) An atom possesses two valence electrons having antiparallel spins. What is the maximum value of Lande's g-factor for the LS coupled states? 1
 - (iv) Define the Hyperfine splitting of the spectral lines of an atom. 1
 - (v) Is it possible to observe a rotational Raman spectrum by using a radiation in visible region? 2
 - (vi) For principle quantum number $n = 4$, draw all possible orbits (using Sommerfeld Theory). 2

UNIT-I

2. (i) What is Space Quantization ? Show that the quantum conditions due to it, lead to a relationship between the azimuthal quantum number and the magnetic quantum number. 6
- (ii) If Rydberg constant of an atom of finite Nuclear mass is αR_∞ , where R_∞ is the Rydberg constant corresponding to an infinite Nuclear mass is $\frac{(1-\alpha)}{\alpha}$. 2

3. (i) Write down short-comings of Bohr's model. 2
(ii) Derive condition for allowed elliptical Orbits : 6
 $\frac{k}{n} = \frac{b}{a}$, where symbols have their usual meanings.

UNIT-II

4. (i) Discuss the characteristic features of penetrating and non-penetrating Orbits. How do they bring in the concept of Quantum Defect ? 6
(ii) Find intensity ratio for doublet lines of Principal series of Sodium. 2
5. (i) A spinning electron behaves like a magnetic top and undergoes Larmor's precession around the magnetic field direction. Due to this, each energy state in an atom having a Single valence electron splits into a Doublet. Derive an expression for the magnitude of this doublet separation. Illustrate by giving one example. 6
(ii) Find ground state term of Al. 2

UNIT-III

6. (i) Write total number of Spectral terms of two equivalent (f^2) electrons. 2
(ii) If ground state of Cl atom is $2P_{3/2}$, then show that its magnetic moment is $\frac{2}{3}\sqrt{15}$ Bohr magneton. 2
(iii) If Cesium has a Nuclear spin of $\frac{7}{2}$, draw the hyperfine spectrum of the D lines of the Cesium atom. $\left[6^2P_{\frac{3}{2}} \rightarrow 6^2S_{\frac{1}{2}} \text{ and } 6^2P_{\frac{1}{2}} \rightarrow 6^2S_{\frac{1}{2}} \right]$. 4
7. (i) Calculate Γ factors for LS coupling in two valence electron atoms and show interaction energy schematically for pd configuration. 6
(ii) Write total number of terms for two non-equivalent (f,f) electrons. 2

UNIT-IV

8. (i) Why Anomalous Zeeman effect is called Anomalous? Derive an expression for Lande's g-factor. 6
- (ii) The exciting line in an experiment is 4040\AA and the Stoke line is observed at 4220\AA . Find the wavelength of Antistoke line in \AA . 2
9. (i) Discuss the vibrational spectra of a diatomic molecule treating it as a harmonic oscillator as well as an anharmonic oscillator and compare them. 6
- (ii) A sample is placed in a magnetic field of flux 0.3T . Find the separation between the Zeeman components of wavelength 400 nanometer
[given $\frac{e}{m} = 1.7 \times 10^{11} \text{ C log}^{-1}$]. 2