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FIFTH SEMESTER

B.Tech. (EP)

SUPPLEMENTARY EXAMINATION

Feb-2019

EP-305 Atomic and Molecular Physics

Time: 3 Hours

Max. Marks: 50

Note: Answer ALL questions.

Assume suitable missing data, if any.

Part A (Atomic Physics)

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Q1. (a) Prove that the number of degenerate eigenfunctions for an one-electron atom corresponding to a particular eigenvalue is n^2 . Show that the total number of electrons in a shell is $2n^2$, where n is the principal quantum number of the shell. (5)

(b) Write the values of quantum numbers l , s and j corresponding to each of the following one-electron terms. Is $^2D_{1/2}$ a possible term?
 $^2S_{1/2}$, $^2P_{1/2}$, $^2P_{3/2}$, $^2D_{3/2}$, $^2D_{5/2}$ (5)

Q2. (a) What were the challenges of Bohr-Sommerfeld theory? Enumerate the possible values of j and m_j for states in which $l=2$ and $s=1/2$. (5)

(b) Distinguish between L-S and j-j couplings schemes in the case of two-valence electron systems. The quantum numbers of two electrons in a two valence electron atom are:

$$n_1=2, l_1=1, s_1=1/2 \text{ and } n_2=3, l_2=0, s_2=1/2$$

Assuming L-S coupling, find possible values of L and hence of J . Assuming j-j coupling, find possible values of J . (5)

Q3. Write short notes on any TWO from the following: (2½×2=5)

- (a) Space quantisation
- (b) Larmor precession
- (c) Parity of eigen functions

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Part B (Molecular Physics)

Q1. Answer any Three of the following (5 × 3 = 15 marks)

- (a) Distinguish between symmetric top (prolate and oblate), spherical top and asymmetric top molecules. To which symmetric top, the benzene (C_6H_6) molecule belong?
- (b) State the Franck-Condon principle. How does it help in understanding the intensity distribution in the vibrational structure of the electronic transition of a diatomic molecule?
- (c) The O-H-radical has a moment of inertia of 1.48×10^{-40} gm.cm². Calculate its internuclear distance. Also calculate for $j=5$, its angular momentum and angular velocity. Determine the energy absorbed in the $J=6 \rightarrow J=3$ transition in cm^{-1} and erg/molecule. (Given $h=6.62 \times 10^{-27}$ erg-sec.).
- (d) Discuss Anharmonic oscillator and calculate the transition frequency of fundamental absorption, first and second overtones.

Q2. Describe any Two of the following (5 × 2 = 10 marks)

- (d) Luminescence and types of luminescence
- (e) Kasha's rule, quantum yield and lifetime
- (f) Predissociation and Dissociation
- (g) Spectrophotometer

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