

**CARMEL COLLEGE OF ARTS, SCIENCE & COMMERCE FOR WOMEN,  
NUVEM - GOA.  
SEMESTER END EXAMINATION (REPEAT), AUGUST 2020**

**Semester: VI      PHYSICS (Paper – II)    Atomic and Molecular Physics**

Total Marks: 30      Date: 10/8/2020      Duration: 2 Hours      Total No of pages: 2

---

- Instructions:*
1. All questions are compulsory.
  2. Figures to the right indicate full marks.
  3. Symbols have their usual meaning unless specified.
  4. Use of nonprogrammable calculator is permitted.
  5. Draw neat diagrams wherever necessary.

Constants:  $h = 6.63 \times 10^{-34}$  J-S  
 $c = 3 \times 10^8$  m/s  
 $m = 9.1 \times 10^{-31}$  kg  
 $e = 1.6 \times 10^{-19}$  C  
1 a.m.u. =  $1.67 \times 10^{-27}$  kg  
Avogadro number =  $6.022 \times 10^{23}$

1. Answer any **five** of the following: **5 x 2=10**
- a. What is meant by space quantization. What is the physical significance of orbital quantum number  $m_l$ .
  - b. Find the S, L, and J values that correspond to each of the following states  ${}^2F_{5/2}$ ,  ${}^4D_{5/2}$ .
  - c. Show that a complete shell must necessarily have  $L = 0$  and  $S = 0$ .
  - d. Explain the origin of doublet fine structure of alkali elements.
  - e. What inferences are drawn from the results Stern-Gerlach experiment ? What is the significance of this experiment?
  - f. Considering a diatomic molecule as vibrating spring find the frequency of oscillation
  - g. State Frank-Condon principle and explain the origin of electronic spectra.
  - h. Give the quantum mechanical explanation of Raman effect.

2. Answer any **four** of the following:

**5 x 4 = 20**

- a. What are symmetric and antisymmetric wave functions? Show that the system of electrons must be described by antisymmetric wave functions in order that their behavior is consistent with Pauli's exclusion principle.
- b. Give Schrodinger wave equation for hydrogen atom in spherical polar co-ordinates. What are the advantages of solving this equation in this coordinate system? The azimuthal wave function for the hydrogen atom is  $\Phi(\varphi) = Ae^{im_l\varphi}$  Show that the value of the normalisation constant A is  $1/(\sqrt{2\pi})$  by integrating over all angles from 0 to  $2\pi$ .
- c. Explain Zeeman Effect. Discuss normal Zeeman effect and derive expression for Zeeman splitting.
- d. What is the difference between x-ray characteristic line and adsorption edge. Calculate the K fluorescence yield in the case of an element, if out of 165 K photoelectrons tracks, 153 are accompanied by Auger tracks.
- e. Obtain the expression for Raman frequencies for a molecule undergoing pure roatation. Hence find the Raman shift for  $J=0$ ,  $J=1$ , and  $J=2$  and the spacing between sucessive lines.
- f. Explain the rotational and vibrational spectra of diatomic molecules. Hence derive expressions for p,q,r branches.