

**CARMEL COLLEGE OF ARTS, SCIENCE & COMMERCE FOR WOMEN,
NUVEM-GOA
SEMESTER END EXAMINATION, JUNE 2022**

Semester: VI OF BSC

Course Title: Atomic & Molecular Physics Course Code: PYC 108

Total marks: 80 Date: 06/06/2022 Duration: 120 minutes Total No of pages: 03

Instructions:

- 1) All questions are compulsory, however internal choice is available.
- 2) Figures to the right indicate maximum marks to the question.
- 3) Symbols have their usual meanings unless otherwise stated.
- 4) Draw neat diagram wherever necessary.
- 5) Use of non-programmable calculator is permitted.
- 6) Some useful universal constants: $h=6.63 \times 10^{-34} \text{ Js}$, $e=1.6 \times 10^{-19} \text{ C}$, $m_e=9.1 \times 10^{-31} \text{ kg}$

Q 1. Answer any Five of the following

(4x4=16)

- a) State Pauli's Exclusion Principle. What conclusions can be drawn from it?
- b) Explain the Auger effect.
- c) State and explain the Hund's Rule of maximum multiplicity.
- d) Explain Principal and Sharp series lines of alkali metal spectra.
- e) Give explanation to absence of absorption line in a X-Ray spectra.
- f) Discuss vibration-rotation spectra in case of diatomic molecule with the help of energy level diagram and show possible transitions that give rise to P and R branch.

Q 2. Answer any Five of the following

(4x4=16)

- a) Explain Bremsstrahlung radiation with respect to continuous X-ray spectra.
- b) Find the values of S, L and J that corresponds to $^2D_{3/2}$, 1S_0 state.
- c) Why it is not possible to have a $2^2P_{5/2}$ state?
- d) Describe magnetic quantum number (m_l) and show that $m_l=0, \pm 1, \pm 2 \dots \dots \pm l$.
- e) Explain space quantization of the orbital angular momentum.
- f) Show that for a diatomic molecule its moment of inertia about an axis perpendicular to the line joining the two atoms and passing through the centre of mass of the system $I = \mu r_o^2$ where μ is the reduced mass of the molecule and r_o is its internuclear distance.

Q3 A)

- x) Find the S, L and J values that correspond to each of the following states: (3)
 ${}^2F_{5/2}, {}^3P_0$.
- y) A beam of electrons enters a uniform magnetic field of induction 1.4 Wb/m². Find the difference between the energy of the electrons whose spins are parallel to the field and the energy of the electrons whose spins are antiparallel to the field. (3)

OR

Q3.A)

- p) Interpret the positions of elements in the periodic table using the Pauli's exclusion principle. (3)
- q) A beam of electrons with energy 3.5×10^{-22} J enters a uniform magnetic field. Calculate the effective magnetic induction experienced by the valence electron in its orbital motion. (3)

- Q3.B)** Write Schrödinger's wave equation for hydrogen atom in spectral polar coordinates. What are the advantages of solving the equation in this coordinate system? (6)

Q4 A)

- x) What is gyromagnetic ratio for the orbital motion and the spin of an electron? (2)
- y) Calculate the Lange-g factor for the state $3^2S_{1/2}$. (3)

OR

Q4 A)

- p) Explain the origin of spectral lines. (3)
- q) Calculate the Lange-g factor for the state $3^2P_{3/2}$. (3)

- Q4 B)** Explain the concept of spin orbit coupling & show that energy of an electron changes by $\pm \frac{e\hbar}{2m} B$. (6)

Q 5 A)

- x) State Hund's Rule. How does this rule explain ferromagnetism in Fe^{26} and Ni^{28} ? (3)
- y) Determine the frequency of vibration for CO molecule, if the force constant is given by 187 N/m and the reduced mass is 1.14×10^{-26} kg. (3)

OR

Q 5 A)

- p) Using LS coupling, draw the vector addition diagrams for a two electron system having $l_1 = 1$, $l_2 = 2$, $s_1 = \frac{1}{2}$ and $s_2 = \frac{1}{2}$. (3)
- q) Determine the frequency of vibration for HCl molecule, if the force constant is given by 480 N/m and the reduced mass is 1.627×10^{-27} kg. (3)

Q 5 B) Give classical explanation to the Normal Zeeman Effect. (6)

Q 6 A)

- x) State and explain the Mosley's Law. (3)
- y) The adjacent lines in the pure rotational spectrum of $\text{Cl}^{35}\text{F}^{19}$ are separated by a frequency of 1.12×10^{10} Hz. What is the interatomic distance in this molecules? (3)

OR

Q 6 A)

- p) State the importance of Mosley's Law. (3)
- q) The adjacent lines in the pure rotational spectrum of $\text{Cl}^{35}\text{B}^{11}$ are separated by a frequency of 0.91×10^{10} Hz. What is the interatomic distance in this molecules? (3)

Q 6 B) Derive an appropriate expression and show that the vibrational energy level are equally spaced. (6)

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