A–089

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MSCPH–507

M.Sc. PHYSICS (MSCPH)

(Spectroscopy)

2nd Semester Examination, 2024 (June)

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

(Long Answer Type Questions) 2×19=38

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. Explain the origin of doublet fine structure in alkali spectra and derive expression for the spin-orbit interaction energy for one valence electron. Also discuss the selection and intensity rules giving suitable examples.

2 Write short notes on any *three* of the following :

(a) Hund's rule

(b) Hyper fine structure

(c) Moseley Law

(d) Isotope effect on vibrational level

3. Derive an expression for interaction energy for an atom in electric field and show that for hydrogen atom the first order stark effect in the ground state is zero.

4. Give the explanation of the rotational fine structure of electronic vibrational transitions of a diatomic molecule. Write the selection rules and explain the various branches obtained therein.

5. Calculate the Lande g-factor for (a) $^3S_1$ and (b) $^3P_1$ levels, and find energy splitting of the two levels if an external magnetic field of 1 Tesla is applied. Use known values of e, m.

Section–B

(Short Answer Type Questions) 4×8=32

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. State Born-Oppenheimer approximation and explain how it is a justified approximation with mathematical derivation.

2. Discuss the vibrational structure of electronic bands.

3. Determine the normal Zeeman effect of the cadmium redline of 6438 A° when the atoms are placed in a magnetic field of 9×10^{-3} T.

4. Describe and explain the fine structure observed in X-ray emission spectrum.

5. Outline the essential features of alkaline earth elements. How are they explained theoretically ?

6. What is Doppler broadening. On what factors Doppler broadening depends on ?

7. The term for a particular atomic state is $^4D_{5/2}$. What are the values of L, S and J ? What is the minimum number of electrons which could give rise to this state ?

8. The separation of lines in the far infrared spectrum of HCI molecules is 20.68 cm^{-1}. Calculate the moment of inertia and internuclear distance of the molecule. Given $h = 6.63 \times 10^{-34}$ J-sec, $c = 3.0 \times 10^{8}$ m/s, $N_A = 6.023 \times 10^{23}$ mol^{-1}.

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