Five-Year Integrated M. Sc. Examination 2021-2022

Semester: VII

Paper: PH-4-7-5

Subject: Physics (Spectroscopy-II)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin

Answer *Question No. 1* and *any three* from the rest

1. Answer any four questions: 4x2.5 = 10

(a) Calculate the Larmor frequency associated with the spin of an electron at an external magnetic field of 0.34 T. Given, $g_s = 2$, Bohr magneton $\mu_B = 9.27 \times 10^{-24}$ J T^{-1}, $h = 6.62 \times 10^{-34}$ J s.

(b) Free proton resonates with a NMR frequency of 42.6 MHz in an externally applied magnetic field of 10,000 Gauss. What field is necessary to resonate with same NMR frequency in bare fluorine? Given, $g_H = 5.585$, $g_F = 5.255$.

(c) What are the advantages of MRI over CT scan or traditional X-rays in clinical imaging?

(d) Briefly explain Auger process.

(e) Briefly discuss the difference between normal Zeeman effect, Paschen-Back effect and anomalous Zeeman effect.

2. (a) Starting from the interaction of a nucleus of spin I (no specific value) in presence of an external magnetic field B_z, calculate the separation between neighbouring spin energy levels. Also, calculate the Larmor frequency associated with the nucleus.

(b) In proton NMR of methanol, how many peaks are obtained? What is the ratio of the peaks? Explain.

5+5 = 10

3. (a) Describe, in details, a theory explaining the anomalous Zeeman effect. Illustrate with diagrams the Zeeman splitting of sodium D_1 and D_2 lines.

(b) Draw the experimental set-up to observe anomalous Zeeman effect.

7+3 = 10

4. (a) Explain spin-orbit interaction and fine structure of hydrogen atom with energy level diagram.
(b) Explain the ortho and para states of He atom.

5+5 = 10

5. Explain Lamb-Retherford experiment to determine the energy gap between $2s_{1/2}$ and $2p_{3/2}$ states of hydrogen atom. Draw a schematic diagram to explain the experimental set-up.

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