

Five-Year Integrated M.Sc. Examinations 2023

Semester-VII

Course: PH-4-7-5 (2016)

(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 from the following:

- What type of materials show ESR? Give some examples. Write down some important applications of ESR.
- Show the diagrams for Larmor precessions of the magnetic moments and angular momenta associated with the spin of an electron (both spin up and down states) in the presence of an external magnetic field along Z-axis.
- Why neutron possesses a spin magnetic moment despite of being a neutral particle? Write down the empirical classifications of spin quantum numbers of different nuclei.
- What do you mean by para and ortho states of He atom? Explain with diagram.
- Briefly explain the presence of D-lines in the emission spectra of Na atoms with diagram (qualitatively).
- Write a note on Augur spectroscopy.

4 x 2.5 = 10

- 2.
- Starting from the interaction of an electron of spin $\frac{1}{2}$ in presence of an external magnetic field B_z , calculate the separation between neighbouring spin energy levels.
 - Using a diagram, show the energy levels produced as a result of the interaction with increasing value of B_z .
 - Calculate the Larmor frequency associated with spin of an electron at an external magnetic field of 0.34 T. Given, Bohr magneton = $9.27 \times 10^{-24} \text{ J T}^{-1}$, $h = 6.62 \times 10^{-34} \text{ J s}$.
 - What do you mean by ESR signal? Explain.

3+2+2+3 = 10

- 3.
- Explain the basic principle of an experimental set up for detecting NMR signal.
 - Explain the concept of chemical shift in NMR spectroscopy.
 - 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, $g_H = 5.585$ and $g_F = 5.255$.

3+4+3 = 10

- 4.
- Show by energy level diagram, how many lines are predicted by Dirac theory of L-S coupling in the H_α line of the Balmer series of H-atom spectra.
 - What is Lamb shift?
 - Describe Lamb-Retherford experiment.

3+2+5 = 10

- 5.
- What do you mean by normal multiplets in He spectra? Explain by diagram.
 - Explain normal and anomalous Zeeman effect.

2+(4+4) = 10