

Five-Year Integrated M.Sc. Examination 2024

Semester-VII

Course: PH-4-7-5

(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:
 - (a) If an unpaired electron gives ESR line at 30 GHz, when the magnetic field is 1.24 T, find the electron g-factor. Given, Bohr magneton = $9.27 \times 10^{-24} \text{ J T}^{-1}$, $h = 6.62 \times 10^{-34} \text{ J s}$.
 - (b) What should be the magnetic field strength to observe the NMR signal of protons in benzene at 120 MHz? Given, $g_n = 5.585$, $\beta_n = 5.05 \times 10^{-27} \text{ J T}^{-1}$.
 - (c) What is the chemical shift in Hz of an NMR peak at 6.0 ppm, if the spectra are recorded at a frequency of 60 MHz?
 - (d) What are the advantages of using TMS as a standard reference while studying the proton NMR of an unknown sample?
 - (e) Write a brief note on photoelectron spectroscopy.
 - (f) Briefly discuss the concept of the width of a spectral line due to electronic transition. Write down the factors responsible for this parameter.

2 x 2.5 = 10
2.
 - (a) Explain the basic principle of an experimental set up for detecting ESR signal.
 - (b) Explain hyperfine structure in the ESR spectra of methyl radical. Determine the number of peaks and their relative intensities showing the 'family tree' of couplings which produce the peaks.

5+5 = 10
3.
 - (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
4.
 - (a) Explain the fine structure in H-atom spectra (first line of Balmer series) with diagram based on Dirac theory.
 - (b) Explain He atom spectra (ortho and para states).

5+5 = 10
5.
 - (a) What is Lamb shift?
 - (b) Describe Lamb-Retherford experiment.

2+8 = 10