Second Semester M.Sc. Physics Examination, January 2016

Spectroscopy

Time: 3 Hours Max. Marks: 80

***Instructions**: Answer all questions.*

1. (a) Explain the normal Zeeman effect and obtain an expression for the transition between the D_1, D_2 lines of sodium. Also deduce the expression for Lande's g_j factor. 10

   (b) Explain the natural width of the spectral line. 5

   OR

2. (a) Describe the Stark effect in weak and strong field. 10

   (b) Explain the nuclear spin and obtain an expression for nuclear magneton. 5

3. (a) Mention the principles involved in NMR spectroscopy and explain with neat diagrams the basic requirements in NMR spectrometer. 10

   (b) Mention the applications of NMR in medicine. 5

   OR

4. (a) Explain the rotational spectra of rigid rotator and non- rigid rotator of diatomic molecules. 10

   (b) Write a note on microwave spectroscopy. 5

5. (a) Explain the theory of diatomic vibrating rotator. 10

   (b) Explain the working of FTIR spectrometer. 5

   OR

6. (a) Explain the quantum theory of Raman effect. Also explain the intensity of Raman lines. 10

   (b) Explain the selection rules used in the IR spectroscopy. 5

7. (a) Describe the spectrofluorimeter and mention its applications. 10

   (b) Write the qualitative applications of gas liquid chromatography. 5

   OR

8. (a) Explain the stellar evolution and write a note on cosmic rays. 10

   (b) Write the applications of mass spectroscopy. 5

9. Answer **any four** of the following. 4X5=20

(a) Using the isotopes ${}_1H^1$ and ${}_1H^2$, estimate the change of wavelength.

(b) A sample of a certain element is placed in a magnetic field of flux density 0.3 tesla. How far apart is the Zeeman component of a spectral line of wavelength 4500 Å? Given: e/m = 1.76 X10^{11} C/kg, c = 3 X 10^8 m/s.

(c) For a given organic compound two kinds of protons exhibit signals at 50 and 200 Hz using a 60 MHz p.m.r spectrometer. What will be their relative position using 90 MHz spectrometer? And convert the position of signal at 50 Hz into δ *and* τ units.

(d) The rotational spectrum of HCl shows a series of lines separated by 20.6/cm. Find the moment of inertia and inter-nuclear distance.

(e) Using wavelength of 4000 Å, the first Stokes' line appears at a spacing of 350/cm from the Rayleigh line. Calculate the frequency of the first anti-Stokes line in wave number.

(f) The fundamental frequency of a molecule is 8.67 X 10^{13}/s. calculate the corresponding Raman lines of the molecule when irradiated with 435.8 nm wavelength.

(g) Calculate the energy in joules per quantum calories per mole and electron volts of photons of wavelength 3000 Å.

(h) Write a note on cosmic ray spectrum.