SET A

M.Sc. PHYSICS
SECOND SEMESTER
LASER & SPECTROSCOPY
MSP – 205
[USE OMR FOR OBJECTIVE PART]

Duration: 1:30 hrs. **Full Marks: 35**

Objective

Time: 15 mins. **Marks: 10**

Choose the correct answer from the following: ***1×10=10***

1. The distance between any point pn the surface of the polarizability ellipsoid and the electrical centre of the molecule is
   a. $1/\sqrt{\alpha_i}$ b. $\sqrt{\alpha_i}$
   c. $\frac{1}{2}\alpha_i$ d. α_i

2. The separation between any two successive rotational Raman stokes lines of $^{12}C^{16}O_2$ molecule is
   a. 4B b. 8B
   c. 6B d. 12B

3. The number of common vibration spectral lines in Raman spectra and IR spectra of CO_2 molecule is
   a. Three b. Two
   c. Zero d. One

4. If the energy of transition from the rotational level J=1 to J=2 is $8cm^{-1}$. Then the energy of transition from the rotational level J=3 to J=4 is
   a. 24 cm^{-1} b. 20 cm^{-1}
   c. 12 cm^{-1} d. 16 cm^{-1}

5. The selection rule applied to rotational Raman spectroscopy is
   a. $\Delta J = 0, \pm 2$ b. $\Delta J = +1$
   c. $\Delta J = +2$ d. $\Delta J = -1$

6. The nucleus having spin (I) value 5/2 is
   a. ^{35}Cl b. ^{17}O
   c. ^{15}N d. ^{18}O

7. The compound which have the maximum value of chemical shift is
   a. CH_4 b. CH_3Cl
   c. CH_3F d. CH_3I

8. The nucleus which does not exhibit NMR spectra is
   a. ^{35}Cl b. ^{31}P
   c. ^{11}B d. ^{18}O

9. The ESR spectrum of free radical containing nuclei with non zero nuclear spin is obtained when

a. $\Delta = \pm 1\ \Delta = 0$ b. $\Delta = 0\ \Delta = 0$

c. $\Delta = \pm 1\ \Delta \neq \pm 1$ d. $\Delta = 0\ \Delta = \pm 1$

10. The selection rule for the transitions among the Mössbauer energy levels is

a. $\Delta = 0$ b. $\Delta = 0, \pm 1$

c. $\Delta = +1$ d. $\Delta = -1$

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Descriptive

Time : 1 hr. 15 mins. Marks:25

[Answer question no.1 & any two (2) from the rest]

1. a. On the basis of quantum theory, deduce the expression of frequencies of Stokes and Anti Stokes Raman lines. 3+2=5

   b. State the failure of classical theory of Raman effect and explain the success of quantum theory in this regard.

2. a. Show that in an external magnetic field, the separation of the energies of the two spin states of a proton increases linearly with the strength of the magnetic field. Write the condition of proton resonance in NMR spectroscopy. Explain why protons in different chemical groups in the same molecule resonate at different value of the magnetic field. 3+2+2+3=10

   b. At what value of the magnetic field will a free proton (g_p=5.5857) resonate in a 60 MHz NMR spectrometer?

3. a. Explain the principle of Mössbauer spectroscopy. Show that in order to have resonance absorption, the line width must be equal or greater than the loss of gamma ray energy due to recoil. Why the source and the sample are put in a crystal in Mössbauer spectrometer? 4+2+1+3=10

   b. Calculate the recoil energy of an iron nucleus (^{57}Fe) when it emit gamma ray photon of 14.4 keV. (1 amu= 931 MeV)

4. a. State the condition of resonance in ESR spectroscopy. Why ESR is obtained in microwave region of electromagnetic spectrum? Explain why ESR spectrum is taken in derivative mode. Draw the ESR spectrum of methyl (CH_3) radical. Mention the relative height of the spectral lines. 2+1+1+2+1+3=10

   b. Calculate the ratio of spin magnetic moment of electron and proton. (Given: g_e=2.0023 and g_p=5.5857)

5. a. What do you mean by stimulated emission of radiation? 2+4+1+3=10

b. Discuss the laser action and state the condition of it. Mention the properties of laser radiation.

c. Showing the transition of laser radiation, describe the laser action in Helium-Neon (He-Ne) laser.

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