# LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

**M.Sc.** DEGREE EXAMINATION – **PHYSICS**

THIRD SEMESTER – **APRIL 2016**

**PH 3815 – SPECTROSCOPY**

Date: 27-04-2016 Dept. No. Max. : 100 Marks

Time: 09:00-12:00

## PART A

**Answer ALL questions:** **(10×2=20 marks)**

1. How are molecules classified on the basis of moment of inertia? Give one example each.
2. The rotational constant of NO is 1.7021 $cm^{-1}$. Calculate the moment of inertia of the molecule.
3. How many normal modes of vibrations are possible for
   (a) $H_2O$ (b) $NO_2$ (c) $C_2H_4$ (d) $C_6H_6$
4. Explain in brief the rule of mutual exclusion.
5. Explain Born – Oppenheimer approximation.
6. Electron Spin Resonance is observed for atomic hydrogen with an instrument operating at 9.5 GHz. If the g value for the electron in the hydrogen is 2.0026, what is the magnetic field applied? Bohr magneton = $9.274 \times 10^{-24}$ $JT^{-1}$
7. State the advantages of TMS when recording NMR spectra.
8. What is meant by spin- spin relaxation time?
9. Explain the principles of RAIRS.
10. Mention few applications of XRF.

## PART B

**Answer any FOUR questions:** **(4×7.5=30 marks)**

11. (a) Explain the factors that determine the intensity of a spectral line. Obtain an expression for J at which maximum population occurs. (4.5)

    (b) The rotational spectrum of BrF shows a series of equivalent spectral lives spaced 0.71433 $cm^{-1}$ apart. Find which transition give raise to the most intense spectral line at 300 K. (3)

12. (a) Outline briefly each section of an IR spectrometer.

    (b) Calculate the frequency of NO molecule whose force constants is 1609 $Nm^{-1}$.

13. (a) Explain the polarizability ellipsoid. On the basis of polarizability, outline the vibrational Raman effect of $CO_2$

    (b) The first rotational Raman line of $H_2$ appears at 346 $cm^{-1}$ from the exciting line. Calculate the bond length of $H_2$ molecule.

14. Explain the importance of Franck – Condon principle in the study of intensity of molecular spectrum.
15. Explain the chemical shift in NMR spectroscopy.
16. Outline the principle of Electron Energy Loss Spectroscopy and mention the applications.

## PART C

**Answer any FOUR questions:** **(4×12.5=50 marks)**

17. Explain with theory the spectrum of a linear diatomic molecule of rigid type. Outline the correction for non – rigid rotor.
18. Explain the theory of pure rotational Raman spectra of
    (i) Linear molecule (ii) Symmetric top molecule
19. Explain the principle of ESR. Draw a neat diagram and explain the functioning of ESR Spectrometer.
20. (a) Explain the principle of Mossbauer Spectroscopy. With neat diagram explain the Mossbauer spectrometer.
    (b) An excited $^{57}Fe^{*}$ nucleus, recoiling at $10^{2}$ $ms^{-1}$ emits γ - radiation with frequency $3.5 \times 10^{18}$ Hz. Calculate the Doppler shift of the γ - ray frequency.
21. (a) Outline the salient features of nuclear magnetic resonance spectroscopy in the structure determination of compounds.
    (b) A particular NMR instrument is operating at 400 MHz, calculate the magnetic field required to bring $^{1}H$ to resonate at this frequency. Given
    $$\beta_N = 5.051 \times 10^{-27} \text{ J/T}, \qquad g_{H^1} = 5.585.$$
22. Outline the techniques involved in Auger Electron Spectroscopy.

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