

**LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034****M.Sc. DEGREE EXAMINATION – PHYSICS****THIRD SEMESTER – APRIL 2023****PPH 3502 – SPECTROSCOPY**

Date: 04-05-2023

Dept. No. 

Max. : 100 Marks

Time: 09:00 AM - 12:00 NOON

**PART A**

<b>Q. No</b>	<b>Answer all questions</b>	<b>(10 x 2 = 20 Marks)</b>
1	How are molecules classified on the basis of moment of inertia? Give one example for each.	
2	The rotational constant of NO is $1.7021 \text{ cm}^{-1}$ . Calculate the moment of inertia of the molecule.	
3	In $\text{H}_2$ molecule the separation between adjacent rotational Raman lines is $4B$ whereas in $\text{O}_2$ it is $8B$ . Why?	
4	Why Stokes lines are more intense than anti Stokes lines?	
5	What is Fortrat diagram?	
6	Calculate the ESR frequency of a free electron in a magnetic field of 1.25 T. Given that $g = 2.0023$ , $\mu_B = 9.274 \times 10^{-24} \text{ JT}^{-1}$ .	
7	An excited $^{57}\text{Fe}^*$ nucleus, recoiling at $2.3 \times 10^2 \text{ m/s}$ emits $\gamma$ -radiation with frequency $3.2 \times 10^{18} \text{ Hz}$ . Calculate the Doppler shift in $\gamma$ -ray frequency.	
8	Define relaxation time in NMR.	
9	What is the working principle of AFM?	
10	Write two applications of TEM.	

**PART – B**

<b>Answer any four questions</b>		<b>(4 x 7.5 = 30 Marks)</b>
11	(a) Discuss the effect of isotopic substitution on the rotational spectrum. (4.5 marks) (b) The rotational constant of $\text{H}^{35}\text{Cl}$ is $10.5909 \text{ cm}^{-1}$ . What is the value of $B$ for $\text{H}^{37}\text{Cl}$ ? ( $\text{H} = 1.673 \times 10^{-27} \text{ kg}$ , $^{35}\text{Cl} = 58.06 \times 10^{-27} \text{ kg}$ , $^{37}\text{Cl} = 61.38 \times 10^{-27} \text{ kg}$ ) (3 marks)	
12	(a) Outline briefly each section of an IR spectrometer. (4.5 marks) (b) The first rotational Raman line of $\text{H}_2$ appears at $346 \text{ cm}^{-1}$ from the exciting line. Calculate the bond length of $\text{H}_2$ molecule. (3 marks)	
13	State Franck-Condon Principle and explain its use in understanding the variation in the intensity of vibrational electronic spectra.	
14	Discuss the interaction of nuclear spin with magnetic field and deduce an expression for	

the energy associated with the transitions.

15 Explain the chemical shift in NMR spectroscopy.

16 Outline the principle of Auger electron spectroscopy.

**PART – C**

**Answer any four questions**

**(4 x 12.5 = 50 Marks)**

17 With necessary theory explain the spectrum of a linear diatomic molecule of rigid rotator type. Outline the correction for non – rigid rotator type.

18 (a) Explain the vibration spectrum of a diatomic molecule. Deduce the effect of anharmonicity.  
(b) The three consecutive lines in the rotational spectrum of HBr are 84.544, 101.355 and 118.112  $\text{cm}^{-1}$ . Find the values of rotational constant and moment of inertia of the molecule.

19 Explain the theory of pure rotational Raman spectra of (i) Linear molecule and (ii) Symmetric top molecule.

20 Give a detailed note on dissociation energy and predissociation.

21 Explain the impact of Doppler effect and uncertainty principle in Mossbauer spectroscopy. With a diagram, explain the working of Mossbauer spectrometer.

22 Explain the principle and instrumentation of photoelectron spectroscopy. Illustrate the interpretation of the spectrum.

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