



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**UNIVERSITY VILLAGE, PLOT 91 CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESS WAY, JABI -**  
**ABUJA.**

**FACULTY OF SCIENCES**  
**DEPARTMENT OF PURE AND APPLIED SCIENCE**  
**SEPTEMBER, 2020\_1 EXAMINATION**

**COURSE CODE:** CHM 402  
**COURSE TITLE:** Theory of Molecular Spectroscopy  
**COURSE UNIT:** 2 Units  
**TIME:** 2 Hours  
**INSTRUCTION:** Answer question one and any three questions.

### **QUESTION ONE**

1a. Discuss briefly the principle of Raman spectroscopy. 5mks

1b. What are the names given to the three types of lines in a Raman spectrum? Account for the relative intensities of these lines.

6 mks

1c. What is the function of Doppler effect in Mössbauer spectroscopy? 3 mks

1d. The following data were obtained for solutions of compound X at a wavelength of 650nm in a 1 cm cell:

Conc. (mol dm <sup>-3</sup> )	Absorbance
1 x 10 <sup>5</sup>	0.312
2 x 10 <sup>5</sup>	0.589
3 x 10 <sup>5</sup>	0.913
4 x 10 <sup>5</sup>	1.179
5 x 10 <sup>5</sup>	1.498

- (i) Make a Beer-Lambert's plot of the data 6 mks
- (ii) From the plot or using Beer-Lambert's relationship, determine the molarity of X solution whose absorbance is 0.170 at 650 nm.

5 mks

### QUESTION TWO

- 2a. Discuss the Born-Oppenheimer approximation in solving the Schrödinger equation. 7½ mks
- 2b. Discuss briefly any three (3) of the five categories of microwave active molecules. 7½ mks

### QUESTION THREE

- 3a. Describe the modes of vibration in a polyatomic molecule. 5 mks
- 3b. With the aid of appropriate diagrams, show the difference between stretching and bending (deformation) vibrations of Methylene ( $-\text{CH}_2$ ). 6 mks
- 3c. State two features of the gas-phase IR spectra of molecules. 4 mks

### QUESTION FOUR

- 4a. Explain briefly the preparation of solid samples in IR spectroscopy. 8 mks
- 4b. Analysis of the vibrational-rotational spectrum of the  $\text{H}^{35}\text{Cl}$  molecule shows that its fundamental vibration frequency  $\nu_0$  is  $2988\text{ cm}^{-1}$ . Calculate the force constant of the H-Cl bond. Given that the speed of light,  $C = 2.998 \times 10^8\text{ ms}^{-1}$  7 mks

### QUESTION FIVE

- 5a. State FOUR advantages inherent in the use of Raman spectroscopy. 6 mks
- 5b. With the aid of a schematic diagram, state the basic components of a Raman spectrometer. 6 mks
- 5c. Distinguish between elastic and inelastic scattering in Raman spectroscopy. 3 mks