



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
SEMESTER EXAMINATION 2021_2

COURSE CODE: CHM402

COURSE TITLE: Theory of Molecular Spectroscopy

TIME: 2 Hours

INSTRUCTION: Answer question one and any three questions.

QUESTION ONE

- 1(a)(i) What is Mossbauer effect and its applications (3 marks)
- (ii) Explain the steps involved in absorption and emission of spectrum. How do they contribute to produce spectrum (4 marks)
- (iii) State the selection rule for rotational spectroscopy (1 mark)
- (b)(i) State what is expected if a molecule interact with micro wave (2 marks)
- (ii) What is the requirement for molecules to undergoes transition after absorption of microwave (2 marks)
- (iii) What is the effect of rotation of a molecule on its dipole moment (2 marks)
- (c)(i) Highlight the five categories of micro wave active molecules (5 marks)
- (ii) State the bases for categorization of micro wave active molecules as listed in b(i) above (2 marks)
- (iii) What is a radiospectroscope (1 mark)
- (iv) How can you improve the sensitivity of a radiospectroscope ? Hence define Stark and Zeeman effect (3 marks)

QUESTION TWO

- 2(a)(i) Explain the involvement of two spectroscopic techniques that can be used to measure the vibrational energy of a molecule (4 marks)

- (ii) State the number of normal modes (and the types) common for polyatomic and linear molecules (4 marks)
- (iii) Calculate the number of normal modes of vibration possible for carbon (IV) oxide (CO_2). Also states the number each vibration takes (3 marks)
- (iv) State the number of normal modes of vibration possible (for at least one named example for each) symmetry and asymmetrical molecules (4 marks)

QUESTION THREE

- 3a(i) State the four types of electronic transitions that are possible (2 marks)
- (ii) Based on selection rule, what are allowed and forbidden transitions and under what condition can forbidden transition occur (3 marks)
- (b) In not more than two sentences for each, explain the following,
- (i) Chromophore (2 marks)
- (ii) Auxochrome (2 marks)
- (iii) Bathochromic shift (1 mark)
- (iv) Hypsochromic shift (1 mark)
- (v) Hyperchromic shift (1 mark)
- (vi) Hypochromic shift (1 mark)
- (c)(i) State the four basic components of UV visible spectrophotometer (2 marks)
- (ii) What are the classes of organic compounds that can be analysed with UV visible spectrophotometer (1 mark)

QUESTION FOUR

- 4(a)(i) Why is the potential energy curve of a harmonic oscillator fails for real molecule and hence what is the model that account for real molecules? (3 marks)
- (ii) Write the equation for the model (presented above) and also another equation to defined the constant in the model (3 marks)
- (iii) Write an expression for the potential energy of anharmonic function. Define all the term in the equation , including anharmonic constant (4 marks)
- (iv) What is the selection rule for anharmonic oscillator (1 marks)

- (b) What is vibrator rotor? Write equation that describes vibrator rotor (3 marks)
- (ii) How is the selection rule for a rotation vibration function obtained? (1 mark)

QUESTION FIVE

- 5 a(i) What is chemical shift and how can it be measured (4 marks)
- (ii) State inter and intra molecular forces affecting chemical shift (3 marks)
- (iii) What is coupling constant in NMR and what are its usefulness (3 marks)
- (b)(i) Consider a proton signal having n identical adjacent protein. What would be the expected number of peaks. Hence calculate the peak when $n = 3$ (2 marks)
- (ii) State three analytical applications of electron spin resonance spectroscopy (2 marks)
- (iii) Why is nuclear quadrupole resonance spectroscopy call zero field NMR? (1 mark)