NATIONAL OPEN UNIVERSITY OF NIGERIA
UNIVERSITY VILLAGE, PLOT 91 CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESS WAY,
JABI - ABUJA.
FACULTY OF SCIENCES
DEPARTMENT OF CHEMISTRY
2024_2 EXAMINATION

COURSE CODE: CHM 307
COURSE TITLE: Atomic and Molecular Structure and Symmetry
COURSE UNIT: 3
TIME: 3 HOURS
INSTRUCTION: Answer question one and any other three questions.

QUESTION ONE

(1a) State de Broglie's theory on matter. (3 marks)

(1b) What is an operator? State the rules for operators? (8 marks)

(1c) Write the Schrodinger wave equation for particle in one-dimensional box. (4 marks)

(1d) What is hybridization? (4 marks)

(1e) State clearly why atomic radii decrease across a period and increase down a group. (6 marks)

QUESTION TWO

(2a) Sketch and label the potential energy diagram of the hydrogen molecule (5 marks)

(2b) Describe the theory of resonance in chemistry. (4 marks)

(2c) Highlight three applications of the Walsh diagram (6 marks)

QUESTION THREE

(3a) What is the internal energy of a molecule? Hence based on your definition, write an equation to show the various components of the internal energy (5 marks)

(3b) HCl shows a very intense absorption at 2886 cm^{-1}, a weak absorption at 5668 cm^{-1}, and a weaker absorption at 8347 cm^{-1}, calculate the force constant. (mass of H= 1.6727 amu, mass of chlorine =35.435 amu) (5 marks)

(3c) Draw a well-labelled diagram of the molecular orbital of ethane. (5 marks)

QUESTION FOUR

(4a) What describes the total angular momentum of an electron? (use equation where appropriate). (4 marks)

(4bi) What are the letters designated to L= 1,2,3,4,5, and 6? (3 marks)

(4bii) Why does a closed shell have zero angular momentum? (2 marks)

(4ci) Write out the equation for the amount of energy associated with absorption using simplest harmonic transitions. (3 marks)

(4cii) Draw the resonance structures for ozone. (3 marks)

QUESTION FIVE

(5a) List the different types of symmetry operations applicable in group theory. (5 marks)

(5b) Perform improper rotation operation on methane. (5 marks)

(5c) Highlight three application of group theory. (5 marks)

QUESTION SIX

(6ai) What is the heat capacity of 83 g of mercury (specific heat of mercury = 0.14J/g/^{o}C). (2 marks)

(6aii) Draw the diagram showing the relationship between polar and Cartesian coordinates. (2 marks)

(6b) What is dipole moment of a molecule (Use equation where necessary). (5 marks)

(6c) Classify molecules into four using their rotational behavior. (6 marks)