



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**DEPARTMENT OF PURE AND APPLIED SCIENCES**  
**2021\_1 EXAMINATION**

**COURSE CODE:** CHM307

**CREDIT UNIT:** 3

**COURSE TITLE:** Atomic and Molecular Structure and Symmetry

**TIME:** 3 HRS

**INSTRUCTION:** *Answer question 1 and any other 4 questions*

**QUESTION ONE**

- a) With the aid of a well-labeled diagram, draw the energy levels in a  $H_2$  molecule (5 marks)
- b) State five (5) steps you would take in writing resonance structures (5 marks)
- c) Atomic radii increase down a group and decrease across a period. Why? (5 marks)
- d) Highlight two (2) main limitations of Crystal Field Theory (CFT) (4 marks)
- e) Write the Schrodinger wave equation for 3D box (3 marks)

**QUESTION TWO**

- a) Calculate the wavelength of the visible line in the hydrogen spectrum that has the longest wavelength given that Rydberg constant  $R = 1.097 \times 10^5 \text{ cm}^{-1}$ . (6 marks)
- b) Highlight three differences between molecular orbital and valence bond theory (6 marks)

**QUESTION THREE**

Write out the hybrid orbitals and shapes of the following molecules: (12 marks)

- i.  $CH_3Cl$       ii.  $BF_3$       iii.  $PF_5$       iv.  $BeF_2$

**QUESTION FOUR**

With a well-illustrated diagram show the molecular orbital for each of the following molecules:

- (i). Ethane (6 marks)
- (ii). Ethene (6 marks)

**QUESTION FIVE**

- a) List any three (3) types of internal coordinates (6 marks)
- b) Give any six (6) appropriate combinations of atomic orbitals (6 marks)

### QUESTION SIX

- a) Write resonance structures for each of the following compounds: (4 marks)
- (i). Ozone                      (ii). Allyl Cation
- b) State the two (2) conditions for the formation of chemical bond (4 marks)
- c) Itemize four (4) classes of molecules based on rotational behavior (4 marks)