



NATIONAL OPEN UNIVERSITY OF NIGERIA
DEPARTMENT OF PURE AND APPLIED SCIENCES

2020_2 EXAMINATION...

COURSE CODE: CHM 307

CREDIT UNIT: 3

COURSE TITLE: Atomic and Molecular Structure and Symmetry

TIME: 3 HRS

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

- Q1. a) Provide mathematical expression for dimensionless heat capacity (3 marks)
- b) CH_4 and H_2O are sp^3 hybridized, but H_2O has distorted geometry, explain (5 marks)
- c) Predict hybrid orbitals, geometry and number of lone pair in PCl_5 (5 marks)
- d) Give electronic configuration of Calcium. Why is calcium not a transition metal? (5 marks)
- e) What are the two (2) limitations of valence bond theory? (4 marks)
- Q2. a) State Pauli's Exclusion Principle (2 marks)
- b) Mention any three quantum numbers (3 marks)
- c) In concise term, describe valence bond theory (3 marks)
- d) Calculate the total number (N) of microstates for d^2 configuration (4 marks)
- Q3. a) According to Debye and Einstein models, give the graph of dimensionless heat capacity divided by three as a function of temperature (4 marks)
- b) List two types of symmetric tops and one example of each (4 marks)
- c) Briefly explain the term centrifugal distortion (4 marks)
- Q4. a) Determine number of normal mode of vibration for CO_2 as a linear molecule (4 marks)
- b) State Franck-Condon Principle (4 marks)
- c) With the aid of diagram, show why H_2O is a C_2 symmetric element (4 marks)
- Q5. Copy and complete the Table below for the point group formation (12 marks)

	E	C ₂	N
E	_____	_____	_____

C_2	_____	_____	_____
ν	_____	_____	_____
ν'	_____	_____	_____

- Q6. a) List out the symmetry elements in each of the following: (i) BCl_3 (ii) NH_3 (8 marks)
b) Using orbital combination, show that the bond order of O_2 is 2 (4 marks)