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	_____	_____	_____
v	_____	_____	_____
v'	_____	_____	_____

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)