ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL AND CHEMICAL SCIENCES

2016/2017 ACADEMIC SESSION: FIRST SEMESTER EXAMINATIONS

COURSE CODE: CHM 205 COURSE TITLE: STRUCTURE AND BONDING

HOD's SIGNATURE

DURATION: TWO (2) HOURS

INSTRUCTIONS:

- **ATTEMPT ANY THREE QUESTIONS.**
- **BORROWING OF WRITING MATERIALS, ELECTRONIC CALCULATORS OR LENDING OF ANY SORT IS STRICTLY PROHIBITED**

QUESTION ONE

a. The emission spectra of *Aurora Borealis* observed at 391nm is as a result of N_2^+ returning to its ground state. What is the energy gap between the molecular orbitals involved in the transition? (Planck's constant h = 6-626 x 10^{-34} J s, speed of light C = 2.998 x$10^8$$ms^{-1}$

b. Using the valence bond theory predict the structure and bonding in

i. BeF_2
ii. SF_6
iii. BCl_3
iv. $SnCl_4$

(Atomic numbers of elements: Be = 4, B = 5, F =9, S = 16, Cl =17, Sn = 50)

QUESTION TWO

a. Define the following terms

i. Bond length
ii. Isoelectronic species
iii. Bond order
iv. van der Waal's radius

b. Complete the following equations stating the conditions for the reactions where necessary

i. $H_2O + P_4O_{10} \rightarrow$
ii. $H_3PO_4 \rightarrow ? + H_2O$
iii. $HClO_4 + ? \rightarrow Cl_2O_7 + H_3PO_4$

c. Which of the following molecules are isoelectronic species?
$B_2H_4^{2-}$, B_2H_6, $B_2H_4^{2-}$, BH_4^-, NO, C_2H_4, O_2, NF, CH_4

d. Define all the quantum numbers that characterize an electron.

QUESTION THREE

a. Using the Heisenberg uncertainty principle, calculate the uncertainty in the position of
   i. 1.50mg of mosquito moving at a speed of 1.4m/s
   ii. A proton moving at a speed of 5.00×10^4 m/s. (mass of a proton is 1.673×10^{-27}kg)

b. Use the De Broglie relationship to determine the wavelength of the following objects
   i. An 85.0 kg person skiing at 50km.hr
   ii. 10.0g bullet fired at 250m/s
   iii. An ozone (O_3) molecule in the upper atmosphere moving at 550m/s.(atomic mass of oxygen = 16)

c. Using molecular orbital theory arrange the following species in order of decreasing bond strength and length: O_2^{2-}, O_2^+, O_2 and O_2^-

d. Predict if it is possible to form the He_2^+ and He^+ ions

QUESTION FOUR

a. Explain how the existence of line spectra is consistent with Bohr's theory of quantized energies for the electron in hydrogen atom.

b. State the limitations to Bohr model of the line spectrum.

c. Explain why the N – O bond length decreases for the following species in the order $NO_2^- > NO_2 > NO_2^+$

d. The first 3 lines in the spectrum of atomic hydrogen is assigned the following wave number: 82258, 97491, 102822 cm^{-1}. Show that they fit the equation and derive an accurate value for the Rydberg constant for Hydrogen

$$\bar{\upsilon} = R\left[\frac{1}{N_1^2} - \frac{1}{N_2^2}\right], \text{ where } N_2 = 2, 3, 4 \text{ and } N_1 = 1$$

QUESTION FIVE

a. Using molecular orbital theory predict the stability of Li_2 and Be_2

b. Determine the longest wavelength of light that the ground state C_2^+ ion will absorb assuming the ground state energy is 1.602×10^{-18} J.

c. State the Heisenberg uncertainty principle

d. State the Hund's rule and Pauli exclusion principle

e. Define the following
   i. Polar covalent bond
   ii. Non polar covalent bond
   iii. Electronegativity
   iv. Dipole moment