ELIZADE UNIVERSITY, ILARA – MOKIN, NIGERIA
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
FIRST SEMESTER EXAMINATIONS: 2017/2018 ACADEMIC SESSION
COURSE CODE: CHM 205   COURSE TITLE: STRUCTURE AND BONDING

DURATION: 2 HOURS   **HOD's SIGNATURE**

TABLE OF CONSTANTS:
Speed of light c, $2.997 \times 10^8 m/s$
Faraday constant F, 96500 C/mol
Gas constant R, $8.314 JK^{-1}mol^{-1}$
Gas constant R, $8.314 \times 10^{-2} Lbar\ K^{-1}mol^{-1}$
Mass of proton, $1.672 \times 10^{-27}kg$
Mass of electron $9.109 \times 10^{-31}kg$
$1D = 3.34 \times 10^{-30}\ C.m$

Elementary charge e, $1.602 \times 10^{-19}C$
Boltzmann constant k, $1.38 \times 10^{-23} J/K$
Planck's constant h, $6.626 \times 10^{-34} Js$,
Atomic mass unit u, $1.661 \times 10^{-27}kg$
Mass of neutron, $1.6739 \times 10^{-27}kg$
Avogadro's constant Na, $6.022 \times 10^{23}\ mol^{-1}$

INSTRUCTIONS:
   ATTEMPT QUESTION ONE AND ANY OTHER THREE QUESTIONS

   QUESTION ONE IS COMPULSORY [30 marks]

1.   (a) The bond length of a diatomic molecule is 1.63 Å.
      i.   Calculate its dipole moment when the it carries a charge of $+1$ and -1
      ii. What is the magnitude of charge on the molecule when the experimental dipole moment is 2.67 D.
      (b) State the Hund's rule and Pauli Exclusion Principle
      (c) Predict the magnetic properties of B_2, C_2 and N_2
      (d) Arrange these molecules: PH_3, NH_3, SbH_3, AsH_3 AsH_3 in order of decreasing polarity.
      (e) Explain why PF_3 has a dipole moment of 1.03 D and BF_3 has a dipole moment of zero.
      (f) Using the valence bond theory and/ or valence electron shell theory predict the Geometry of the following molecules
          (i) XeF_4 (ii) NH_3 (iii) SF_4, (iv) $BeCl_2$ (v) CH_4 (vi) BF_3
   (Atomic numbers of elements: Xe = 54, Be =4, B =5, Cl, 17, F,=9, H = 1, N = 7, S =16, C =6)

2.   (a) Using molecular orbital theory, predict the existence of Be_2 and Be^{2-} (atomic number of Be = 4)
      (b) Explain why the N – O bond length decreases for the following species in the order $NO_2^- > NO_2 > NO_2^+$ Arrange the species in order of increasing bond strength and bond energy
      (c) State the limitations to Bohr model of the line spectrum.   **[10marks]**

3.   (a) Using the valence bond theory and by schematic illustrations show the orbital occupancy of electrons in the chlorine in ClO_4^- and ClO_3^-. Describe the geometry of these species.
                                                                               [8marks]
      (b) Sketch the Benzene analogue of Boron nitride   **[2marks]**

4. (a) Explain why the uncertainty principle is not important for macroscopic bodies. [2marks]
    (b) Distinguish between   [8marks]
    i.   Electronegativity and electron affinity.
    ii.   Electron affinity and ionization energy
    iii. a polar bond and a polar molecule
    iv.   a line spectrum and a continuous spectrum

5. (a) Which of the following molecules are isoelectronic species?   [2marks]
        $B_2H_4^{2-}$, NH_3BH_3, C_2H_6, BF_4^-, NO, C_2H_4, O_2, NF, CH_4, $S_2O_7^{2-}$, $P_2O_7^{4-}$

    (b) Complete the following reactions stating the conditions if any for the reactions. Give at
        least two uses of the product or a named derivative .
        i. $B_2O_{3(l)}$ + ? $\longrightarrow$ $BN_{(s)}$ + $H_2O_{(g)}$ [2marks]
        ii. $HClO_4$ + P_4O_{10} $\longrightarrow$? + ?   [2marks]
        iii. $H_3PO_{4(l)}$ + $H_4P_2O_{7(l)}$ $\longrightarrow$? + ?   [2marks]
        iv.   ? + NH_4Cl $\longrightarrow$ $(Cl_2PN)_3$ + HCl   [2marks]