**UNIVERSITY EXAMINATIONS 2014/2015 ACADEMIC YEAR**

**$2^{nd}$ YEAR EXAMINATION FOR THE DEGREE OF BSC GENERAL, INDUSTRIAL AND B.ED SC**

**COURSE CODE/TITLE: SCH 200: ATOMIC STRUCTURE AND BONDING**

**END OF SEMESTER: I** **DURATION: 3 HOURS**

**DAY/TIME: THURSDAY 8.00 TO 11.00AM** **DATE: 18.12.2014 (NL4)**

**CONSTANT:**

**Speed of light =3.0 $\times 10^8$ m.sec, Planck's constant = 6.62 X $10^{-34}$ Js; mass of electron = 9.1091 X $10^{-31}$ kg; $N_A$ = 6.022 x $10^{23}$ $mol^{-1}$; Rydberg constant = 2.18 X $10^{-18}$J; charge of electron (e) = 1.60210 × $10^{-19}$ C; permittivity of vacuum ($\mathcal{E}_0$) = 8.854185 × $10^{-12}$ kg $M^{-3}$; nm = 1.0 x$10^{-9}$ M, π = 3.14, J = kg $m^2s^{-2}$, 1pm = $10^{-12}$m**

**SECTION A (40MKS): ANSWER ALL QUESTIONS**

**QUESTION ONE (30MKS)**

a) State short notes on the terms below and briefly state their significance

i. Zeeman effect **(2marks)**

ii. Azimuthal quantum number **(2marks)**

iii. Magnetic quantum number **(2marks)**

b) Assign all the four quantum numbers for the 15 electrons in phosphorous atom **(7marks)**

c) State Pauli Exclusion Principle **(1mark)**

d) A ball weighs 600g. If it's uncertainty in position is 9 pm, determine the uncertainty in velocity of the cricket ball **(5marks)**

e) Calculate the wave length of an electron travelling with one-fifth speed of light **(3marks)**

f) Differentiate between electronegativity and electron affinity **(1mark)**

g) Estimate the electronegativity of **S** according to Pauling given that the bond dissociation energies ($kJmol^{-1}$) for; **S-S, S-F** and **F-F** are 264, 496 and 155 kJ/mol respectively, if the electronegativity of **F** is **4.1** **(3marks)**

h) According to de Broglie, permitted $\lambda$ is given by; $\lambda = 2a/n$. using this equation and other relationships show that $E = h^2n^2/8ma^2$ **(7marks)**

i) Cyanate ion ($NCO^-$), has three possible Lewis structures.

i. Draw these three Lewis structures, and assign formal charges to the atoms in each structure.

ii. Which Lewis structure is the preferred one? **(5marks)**

j) Differentiate between radial node and radial probability **(2marks)**

**SECTION B 30 MARKS: ANSWER TWO QUESTIONS**

**QUESTION TWO (15 MARKS)**

(a) Write a note on physical significance for each of the terms below, as used in explaining Schrodinger wave equation

i. $\Psi$ **(1mark)**

ii. $\Psi^2$ **(1mark)**

(b) The wave function (z – direction) of a particle in a box is given by; $\Psi_z = B \sin(n\pi z/L)$, where B and L represents a number and length respectively. Using this equation and the Schrodinger equation show that: $E = n^2 h^2 / 8mL^2$ **(7marks)**

c) State one similarity between a Lewis base and a ligand **(1mark)**

d) Using valence bond theory explain why the complex $[Co(NH_3)_6]^{3+}$ is paramagnetic, calculate the Bohr Magneton (BM) value for the complex and predict its geometry. **(5marks)**

**QUESTION THREEE (15MARKS)**

a) Determine the total number of orbitals and their designation for the principal quantum number $n = 4$ **(3marks)**

b) An electron in a one – dimensional box requires a wave – length of 8080 nm to excite the electron from the $n = 2$ to $n = 3$ energy level. Calculate the length of the box in nm **(6marks)**

c) The particle $N_2^{2+}$ can be prepared by bombarding the $N_2$ molecules with fast moving electrons. Using molecular orbital diagram predict;

i. Draw a molecular diagram for the ion, hence write the electronic configuration of the ion **(4marks)**

ii. Calculate the bond order of the ion $N_2^{2+}$ **(2marks)**

**QUESTION FOUR (15MARKS)**

a) Define Lattice energy **(1marks)**

b) Explain using examples the difference between atomic orbital and a shell **(2marks)**

c) Calculate the energy difference in ($Jmol^{-1}$) for an electron at an energy state 4 and 6 that is confined to a box whose length is 0.6nm **(4marks)**

d) Draw a fully-labelled Born-Haber cycle for the formation of MgO and use the data given below to calculate a value for the enthalpy of lattice formation of this oxide. **(8 marks)**

| **Process** | **$\Delta H^{\ominus}$/kJ mol$^{-1}$** |
|---|---|
| $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$ | –602 |
| $Mg(s) \rightarrow Mg(g)$ | +148 |
| $Mg(g) \rightarrow Mg^{+}(g) + e^{-}$ | +738 |
| $Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$ | +1451 |
| $O_2(g) \rightarrow 2O(g)$ | +498 |
| $O(g) + e^{-} \rightarrow O^{-}(g)$ | –141 |
| $O^{-}(g) + e^{-} \rightarrow O^{2-}(g)$ | +798 |