CHUKA **UNIVERSITY**

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY, BACHELOR OF SCIENCE BIOCHEMISTRY, BACHELOR OF SCIENCE BIOMEDICAL, BACHELOR OF SCIENCE MATHEMATICS, BACHELOR OF SCIENCE INDUSTRIAL CHEMISTRY AND BACHELOR OF EDUCATION SCIENCE

CHEM 110: INORGANIC CHEMISTRY I

STREAMS: BSC (CHEM, BIOCHEM, BIOMED, MATH, INDU CHEM), BED (SCI)
TIME: 2 HOURS

DAY/DATE: THURSDAY 17/12/2020 **11.30 AM – 1.0 PM**

INSTRUCTIONS:

Answer Question One (Compulsory) and any other Two Questions

QUESTION ONE [30 MARKS]

(a) State the postulates and limitations of the Bohr's atomic model. **(4 marks)**

(b) A sample of a liquid consisting of only C, H and O and having a mass of 0.5438g was burned in pure oxygen and 1.039g of CO_2 and 0.6369g of H_2O were obtained. Calculate the empirical formula of the compound. **(4 marks)**

(c) Write the electronic configuration of the following species. **(4 marks)**

(i) Si (ii) Mn^{3+} (iii) Br (iv) S^{2-} (v) Al^{3+}

(d) Draw the orbital diagrams of the following: **(2 marks)**
(i) C (ii) $[Ar]4s^2 3d^4$

(e) Copper metal has two naturally occurring isotopes. Copper-63 which has relative abundance of 69.17% and isotopic mass 62.94amu and copper-65 which has relative abundance of 30.83% and isotopic mass 64.93amu. Calculate the atomic weight of copper. **(3marks)**

(f) Describe the Rutherford model of the atom. **(3 marks)**

(g) Calculate the wavelength lines (in nanometers) using the Balmer- Rydberg's equation when n2= 1 and n1=2 **(3 marks)**

(h) Calculate the molarity of a solution made by dissolving 2.35g of H_2SO_4 in water and dissolving it to a final volume of 50 mL **(2 marks)**

(i) Explain why the following combinations of quantum numbers are not possible (**2 marks**)
(i) n = 2; l = 2; ml = +1 (ii) n = 3; l = 1; ml = −2

(j) Draw the Lewisstructure of O_3 and calculate the formal charges on O atoms (**3 marks**)

QUESTION TWO [20 MARKS]

(a) Consider the following species: NO_3^-, BF_3, NO_2, XeF_4:
(i) Write the Lewis structure of each species (**6 marks**)

(ii)Write the resonance structures of the NO_3^- ion (**1½ marks**)

(iii) Determine the formal charge of boron in BF_3 (**½ mark**)

(iv) Determine the molecular geometry and the bond angles of the XeF_4 and BF_3 (**2 marks**)

(b) An aqueous solution of hydrogen peroxide (H_2O_2) is 30% by mass and has a density of 1.11 g/ml. Calculate: (**6 marks**)

(i) the molarity of the solution (ii) the molality of the solution (iii) the mole fraction of H_2O_2

(c) Calculate the energy in Kilojoules per mole of photons of FM radio waves with the frequency of 102.5MHz **(2 marks)**

(d) Calculate the speed of an electron that has a de Broglie wavelength of 100 nm (**2 marks**)

QUESTION THREE [20 MARKS]

(a) State the postulates of Dalton's atomic theory **(3 marks)**

(b) Discuss the following intermolecular forces **(6 marks)**

(i) Dipole-dipole forces (ii) Dispersion forces
(c) Consider a Haber process in which 25.0 kg of N_2 and 5 kg of H_2 are reacted to form ammonia.

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$$

(i). Determine whether $N_2(g)$ or $H_2(g)$ is the limiting reactant **(2 marks)**

(ii) Determine the amount of ammonia that formed in this reaction **(2 marks)**

(iii) Calculate the number of moles of excess reagent remaining at the end of the reaction **(2 marks)**

(iv) If 14000g of NH_3 is actually produced, calculate the % yield **(1 mark)**

(d) Explain the period trends of the following properties **(4 marks)**
(i) atomic radii (ii) ionization energy

QUESTION FOUR [20 MARKS]

(a) Sketch and label the Born-Haber cycle for KF(s) **(5 marks)**

(b) Describe the four quantum numbers of an atomic orbital **(6 marks)**

(c) Balance the following half-reaction in basic media **(5 marks)**

$ClO_3^-(aq) + H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + H_2(aq)$

(d) Stomach acid, a dilute solution of HCl in water can be neutralized by reaction with sodium hydrogen carbonate $NaHCO_3$ according to the following equation.

$$HCl(aq) + NaHCO_3(aq) \longrightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

How many mL of 0.125 M $NaHCO_3$ solution are needed to neutralize 18.0 mL of 0.1M HCl? **(4 marks)**
