

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 0.5438 g was burned in pure oxygen and 1.039 g of CO₂ and 0.6369 g of H₂O 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) Mn³⁺ (iii) Br (iv) S²⁻ (v) Al³⁺
- (d) Draw the orbital diagrams of the following: **(2 marks)**
- (i) C (ii) [Ar]4s²3d⁴
- (e) Copper metal has two naturally occurring isotopes. Copper-63 which has relative abundance of 69.17% and isotopic mass 62.94 amu and copper-65 which has relative abundance of 30.83% and isotopic mass 64.93 amu. Calculate the atomic weight of copper. **(3 marks)**
- (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) $n = 2; l = 2; m_l = +1$ (ii) $n = 3; l = 1; m_l = -2$

(j) Draw the Lewis structure 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 102.5 MHz (2 marks)

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

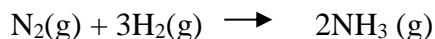
QUESTION THREE [20 MARKS]

(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.



(i). Determine whether $\text{N}_2(\text{g})$ or $\text{H}_2(\text{g})$ 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)

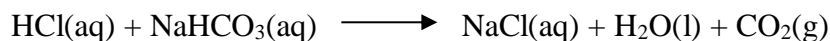
(iv) If 14000g of NH_3 is actually produced, calculate the % yield (1 mark)

- (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)
- $$\text{ClO}_3^- (\text{aq}) + \text{H}_2\text{SO}_4 (\text{aq}) \longrightarrow \text{Al}_2(\text{SO}_4)_3 (\text{aq}) + \text{H}_2 (\text{aq})$$

(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.



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