

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE  
OF BACHELOR OF SCIENCE IN CHEMISTRY

CHEM 110: INORGANIC CHEMISTRY I

STREAMS: B.Sc (BIOCHEM), B.Sc (BIOMED), BED (SCIE) B.Sc (GEN)

TIME: 2 HOURS

DAY/DATE: THURSDAY 7/12/2017

8.30 A.M - 10.30 A.M

---

INSTRUCTIONS:

- Answer Question ONE and any other TWO Questions
- Do not write on the question paper

QUESTION ONE: [30 MARKS]

- (a) (i) State the law of definite proportions. [1 Mark]
- (ii) Calculate the percent composition of Cu, Fe and S in  $\text{CuFeS}_2$  [3½ Mark]
- (b) A sample of a compound contains 5.60 g N, 14.2 g Cl, and 0.800 g H. Determine the simplest formula of the compound. [3½ Marks]
- (c) (i) Calculate the molarity of 29.0 g of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) in 545 mL of solution. [3 Marks]
- (ii) Water is added to 25.0 mL of a 0.866 M  $\text{KNO}_3$  solution until the volume of the solution is exactly 500 mL. Calculate the molar concentration of the final solution. [1½ Marks]
- (d) State the postulates of Bohr atomic theory. [3 Marks]
- (e) Hydrogen atoms absorb energy such that the electrons are excited to the energy level  $n=7$ . The electrons then undergo the following transitions: (1)  $n = 7$  to  $n = 1$ ; (2)  $n = 7$  to  $n = 2$  and  $n = 2$  to  $n = 1$ .
- (i) Determine which transition will produce a photon with the shortest wavelength. [½ Mark]

## CHEM 110

- (ii) Calculate the wavelength of the photon emitted when an electron moves from  $n = 7$  to  $n = 2$  energy levels. [2 Marks]
- (f) State whether the following set of quantum numbers ( $n, l, m_l, m_s$ ) are possible for an electron in an atom. [2 Marks]
- (i)  $(2, 0, 0, +\frac{1}{2})$
  - (ii)  $(1, 1, 0, +\frac{1}{2})$
  - (iii)  $(0, 0, 0, -\frac{1}{2})$
  - (iv)  $(2, 1, -2, +\frac{1}{2})$
- (g) Write the ground state electronic configuration of each of the following species. [3 Marks]
- (i) Si
  - (ii)  $\text{Fe}^{2+}$
  - (iii)  $\text{Se}^{2-}$
- (h) Write the Lewis structures of the following molecules or ions (central atom is underlined) [7 Marks]
- (i)  $\underline{\text{Br}}\text{I}_3$
  - (ii)  $\underline{\text{Cl}}\text{O}_4^-$
  - (iii)  $\underline{\text{B}}\text{F}_3$
  - (iv)  $\underline{\text{N}}\text{H}_4^+$

### QUESTION TWO [20 MARKS]

- (a) (i) Calculate the frequency of electromagnetic radiation with a wavelength of 478 nm. [1½ Marks]
- (ii) Calculate the wavelength of a neutron traveling at a speed of 4.15 km/s [2 Marks]
- (b) Discuss the four quantum numbers that describe the position of electrons in an atom. [7½ Marks]
- (c) Determine the maximum number of electrons that can be contained in:
- (i) 2s orbital
  - (ii) 2p subshell
  - (iii) Second shell [2 Marks]
- (d) Draw orbital diagrams for the following elements
- (i) Nitrogen
  - (ii) Nickel [2 Marks]
- (e) Discuss the following properties in the periodic table; [5 Marks]
- (i) Ionization energies
  - (ii) Atomic radii
  - (iii) Electron affinity

## CHEM 110

### QUESTION THREE [20 MARKS]

- (a) State the postulates of Dalton's atomic theory. [3½ Marks]
- (b) Calculate the number of hydrogen atoms in 39.6 g of ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$  [3 Marks]
- (c) Yttrium-90 is used in the treatment of cancer, particularly non-Hodgkin's lymphoma:  
(i) Determine the number of protons, neutrons and electrons in an atom of Y-90 [1½ Marks]  
(ii) Determine the nuclear symbol for Y-90. [½ Mark]
- (d) Strontium has four isotopes with the following masses: 83.9134 amu (0.56%), 85.9094 amu (9.865%), 86.9089 amu (7.00%), and 87.9056 amu (82.58%). Calculate the average atomic mass of strontium. [2 Marks]
- (e) Lead is a heavy metal that remains in the bloodstream, causing mental retardation in children. It is believed that  $3 \times 10^{-7}$  g of Pb in 1.00 mL of blood is a health hazard. Calculate the number of atoms present in  $3 \times 10^{-7}$  g of lead. [2 Marks]
- (f) Dimethylhydrazine is composed to carbon, hydrogen and nitrogen atoms. Determine the molecular formula of dimethylhydrazine give that its simplest formula is  $\text{CH}_4\text{N}$  and molar mass is 60.10 g/mol. [1½ Marks]
- (g) An ethanol water solution is prepared by dissolving 10.00 mL of ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$ , ( $d=0.789$  g/mL). Calculate the concentration of ethanol in this solution expressed as:  
(i) Mass percent  
(ii) Mole fraction [6 Marks]

### QUESTION FOUR

- (a) Consider the following species:  $\underline{\text{N}}\text{O}_2\text{F}$ ;  $\underline{\text{C}}\text{O}_3^{2-}$ ; and  $\text{SF}_4$   
(i) Write the Lewis structures of the species (central atom is underlined) [6 Marks]  
(ii) Determine the molecular shapes of the species [3 Marks]  
(iii) Determine the polarity of the  $\text{NO}_2\text{F}$  molecule. [1 Mark]  
(iv) Determine the hybridization of carbon in  $\text{CO}_3^{2-}$ . [1 Mark]
- (b) Explain, with the aid of formal charges, which Lewis structure is more likely to be correct for  $\text{Cl}_2\text{O}$  molecule. [3 Marks]

- (c) Discuss with the aid of suitable examples, the van der Waals forces that hold molecules together. [6 Marks]
- .....