CHUKA   **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURE AND ENVIRONMENT

CHEM 102: GENERAL INORGANIC AND PHYSICAL CHEMISTRY

STREAMS: **TIME: 2 HOURS**

DAY/DATE: THURSDAY 14/12/2017   **11.30 A.M – 1.30 P.M**

INSTRUCTIONS:
- **Answer question one and any other two questions.**

QUESTION ONE (30 MARKS)

(a) According to the atomic theory developed by John Dalton in 1808, an element is made of atoms. Define the following terms as relates to an element;

(i) Mass number (A)   [1mark]

(ii) Atomic number (Z)   [1marks]

(b) Taking Y a general symbol foe an element, indicate how Z and A indicate on the symbol Y.

(i) Define the term isotopes of atoms of the same element.   [1mark]

(ii) Name the three isotopes hydrogen element and give their respective atomic masses (A) .   [1½ marks]

(c) Relative atomic masses of atoms of different elements are expressed in terms of their atomic masses with that of another element, which is the most common isotope of carbon 12_6^C. What are the units of measurement of the relative atomic masses of elements?

[½ mark]

(d) Write the Lewis structures for the following molecules and polyatomic ions. In each case, the first atom is the central atom.

(i) CCl_4

(ii) NCl_3

(iii) $COCl_2$

(iv) SO_3 [4marks]

(e) Explain what is meant by molar nass of an element and how it relates to the mole of atoms of the element and the Avogadro number value is 6.022 x 10^{23}.   [2marks]

(f) Strontim (Sr) has four isotopes with the following masses; 83.913 amu (0.56%), 85.9094 amu (9.86%), 86.9089 amu (7.00%) and 87.9056 (82.58%). Calculate the atomic mass of Sr.   [2marks]

 (g) A reagent bottle is labeled 0.450 MK_2CO_3.

   (i) How many moles of K_2CO_3 are present in 45.6ml of this solution? [2marks]

      (ii) How many mL of this solution ar required to furnish 0.800 mole of K_2CO_3?.
                                                                                        [2marks]

         (iii) Assuming no volume change, how many grams of K_2CO_3 do you need to add to 2.00 L of this solution to obtain a 1.000M solution of K_2CO_3?   [2marks]

(h) If 50 ml of his solution is added to enough water to make 125mL of solution, what is the molarity of the diluted solution?   [2marks]

(i) (i) Derive the ideal gas law, explaining each term used in the law equation.
                                                                                        [2marks]

   (ii) Explain how the ideal has law is used to determine the density of any gas.
                                                                                        [2marks]

      (iii) Explain how the real gases deviated from the ideal gases in obeying the ideal gas law.   [4marks]

QUESTION TWO (20MARKS)

(a) Electrons in atoms of elements are described using four quantum numbers.
   (i)   State the four quantum numbers.   [2marks]
   (ii)   State the significance of each quantum number.   [2marks]

(b) Electrons in atoms occupy different orbital.
      (i)   Give two characteristics of an orbital.   [2marks]
      (ii)   Write the electronic configuration for the elements V(V = 23) [2marks]

(c) The periodic table shows the arrangement of elements according to the atomic numbers.
      (i)   What do the elements in the same group have in common? [2marks]
      (ii)   What do the elements in the same period have in common? [2marks]
      (iii)   Give one major difference between the metals and non-metals.
                                              [2marks]
      (iv)   Why are generally metals electropositive while non-metals are electronegative?   [2marks]

(d) Explain briefly how the following properties of the elements vary across a period and down a group in the periodic table,
      (i)   Atomic radius.   [1mark]
      (ii)   Ionization energy   [1½ marks]
      (iii)   Electro negativity   [1½ marks]

QUESTION THREE (20MARKS)

(a) Atoms combine to form compounds through covalent bonding. Differentiate between a sigma bond and Pi bond.   [2marks]

(b) Explain briefly how the mass spectrometer is used to measure both the relative atomic masses of individual atoms and their isopic abundances with the help of a graph.
                                                             [3 ½ marks]

(c) Give the formula of an ion or molecule in which an atom of;
      (i)   N forms three bonds using sp3 hybrid orbitals.   [1½ marks]
      (ii)   N froms two Pi bonds and one sigma bond.   [1½ marks]
      (iii)   O forms one sigma and one Pi bond.   [1½ marks]
      (iv)   C forms four bonds in three of which it uses sp2 hybrid orbitals.
                                                    [1½ marks]

(d) Describe the geometry of the species in which there are, around the central atom,
      (i)   Four single bonds, two unshared pair electrons.   [2marks]
      (ii)   Five single bonds.   [2marks]
      (iii)   Two single bonds, two unshared pairs of electrons.   [2marks]
      (iv)   State Avogadro's law.   [2marks]

(e) (i) State Avogadro's law.   [½ mark]

(f) (ii) A sample of an ideal gas at 0.93 atm and 25° occupied a volume of 17.3 L. This gas was transferred to a 3.7 L container without a temperature change. Calculate the pressure of the gas under the new conditions.   [2marks]

QUESTION FOUR (20MARKS)

(a) According to the definition of bronsted –Lowry of an acid base, the Bronsted-Lowry acid base reaction may be represented as HB (aq) +A –(aq) = HA (aq) +B- (aq)
  (i) Identify in the equation the bronsted Lowry acids and bases. [2marks]
  (ii) Express the equation for the ionic product of water (Kw) [3marks]
  (iii) Explain the equation for the pH of a solution. [3marks]

(b) Given that the K_w for water is 10^{-14}, calculate at 25° C.
  (i) The $[H^+]$ and pH of a tap water sample in which $[OH^{-J}] = 2.0$ x 10^{-7}. [4marks]
  (ii) The $[H^+]$ and $[OH^{-J}$ of human blood at pH 7.40. [4marks]
  (iii) The pOH of a solution in which $[H^+] = 5.0$ $[OH^-]$. [5marks]