CHUKA   **UNIVERSITY**

UNIVERSITY EXAMINATIONS
RESIT/SPECIAL EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF

CHEM 102: GENERAL INORGANIC AND PHYSICAL CHEMISTRY

STREAMS: **TIME: 2 HOURS**

DAY/DATE: MONDAY 23/07/2018   **2.30 P.M – 4.30 P.M**

INSTRUCTION:

Instructions: Answer Question **ONE** (compulsory) and Any Other **TWO** Questions.

QUESTION ONE (30 MARKS)

(a) Explain the following: (i) Aufbau principle (ii) Pauli's Exclusion principle (iii) Hund's Rule

[3 Marks]

(b) Write the electronic configurations of the following species: (i) F   (ii) Mn^{2+} (iii) S^{2-} [3 Marks]

(c) Describe how to prepare 60.0 mL of 0.20 M HNO_3 solution, starting with a 4.00 M HNO_3 stock solution   [2 Marks]

(d) Write orbital diagrams for the following elements: (i) N   (ii) Co   [2 Marks]

(e) Calculate the number of carbon atoms in 5.0 g of $NaHCO_3$ [2 Marks]

(f) Calculate the percent compostion by mass of each element in CH_2Cl_2 [3 Marks]

(g)Chlorine exhibits a RAM of 35.453 and is composed of two isotopes: ^{35}Cl and ^{37}Cl. The exact masses of the isotopes are 34.969 for ^{35}Cl and 36. 966 for ^{37} Cl. Calculate the % abundance of each isotope in the naturally occurring chlorine   [4 Marks]

(h) Calculate the frequency of light having a wavelengthof 456 nm   [2 Marks]

(i) Briefly describe Bohr's theory of the hydrogen atom and how it explains the appearance of an emission spectrum   [3 Marks]

(j) Describe the trend of the following in the periodic table: (i) ionization energy (ii) electron affinity (iii) atomic size [6 Marks]

QUESTION TWO [20 MARKS]

(a) Given the following electrochemical cell:

$Ag(s)|AgNO_3(aq\ 1.0\ M)||CuSO_4\ (aq\ 1.0M)|Cu(s)$

(i) Draw a well labeled schematic diagram of the cell showing the direction electrons will flow externally [6 Marks]

(ii) Write the oxidation, reduction and overall cell equations [3 Marks]

(iii) Calculate the cell potential, given the standard reduction potentials for silver and copper are +0.80 and +0.34V respectively [1 Mark]

(b) Write the Lewis structures and determine the molecular geometry of each of the following species [6 Marks]

(i) NCl_3 (ii) $COCl_2$ (iii) SO_3^{2-}

(c) A 38.0 L gas tank at 35°C has nitrogen at a pressure of 4.65atm. The contents of the tank are transferred without loss to an evacuated 55.0 L tank in a cold room where the temperature is 4°C. Calculate the pressure in the tank [4 Marks]

QUESTION THREE [20 MARKS]

(a) An unknown organic compound is composed of carbon, hydrogen, and oxygen. A sample of the compound weighing 5.00 g is combusted in oxygen, producing 13.86g of CO_2 and 3.926g of water. Determine the simplest formula of the compound [6 Marks]

(b) Calculate the pH of a solution prepared by dissolving 1.00g of barium hydroxide in enough water to make a 250 mL solution [4 Marks]

(c) A bottle of concentrated hydrochloric acid is labeled 12.3M HCl. The specific density is given as 1.1906. Calculate:

(i) The mole fraction of HCl (2 Marks)

  (ii) The molality of HCl (2 Marks)

(iii) The mass percent of HCl (2 Marks)

(d) State whether each of the following sets of quantum numbers is permissible for an electron in an atom. If a set is not permissible, explain why [4 Marks]

(i) n = 1, l = 1, ml=0, ms= + ½ (ii) n=3, l= 1, ml = 2, ms= - ½
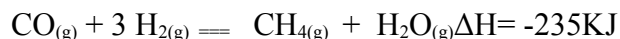
(c) n=2, l=1, ml=0, ms= + ½ (iv) n = 2, l= 0, ml=0, ms= 1

QUESTION FOUR [20 MARKS]

(a) Consider the following reaction:

$CO_{(g)}$ + 3 $H_{2(g)}$ ⟶ $CH_{4(g)}$ + $H_2O_{(g)}$ ΔH= -235KJ

(i) Write the equilibrium expression for the reaction [1 Mark]

(ii) A reaction vessel at 654°C contains CH_4 and H_2O gases both at a partial pressure of 1.00atm. Calculate the partial pressures of all the gases when equilibrium is re-established (K = 2.57)
[5 Marks]

(iii) In which direction will this system shift at equilibrium if: Explain [4 Marks]

(a) Compressed (b) Methane is added (c) Argon gas is added (d) Temperature is increased

(b) A buffer is prepared by dissolving 1.00 mol of lactic acid (K_a = 1.4 x10^{-4}) and 0.5 mol of sodium lactate in enough water to form 550 mL solution. Calculate the pH of the buffer solution
[4 Marks]

(c) Discuss the four quantum numbers that are used to characterize an electron in an atom.
[6 Marks]