Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY

ACH 4101 : FUNDAMENTALS OF INORGANIC CHEMISTRY

SPECIAL/SUPPLEMENTARY EXAMINATION

JULY 2013 SERIES 2 HOURS

Instructions to candidates:
This paper consist of **FIVE** questions
Answer question **ONE** (compulsory) any other **TWO** questions

Z values (Cr=24, Al = 13, O=8, Co = 27, Cu = 29, Cl = 17,)
RAM (K = 39,H = 1,O = 16, Zn = 65, Mn = 55, Fe = 56, S= 32)
Speed of light C = 3.0 x 10^{8}m s^{-1} Plank constant h= 6.63 x 10^{-34} Js^{-1}

Question ONE

a) Define the following terms:
   (i) Aufbaus principle
   (ii) Election affinity
   (iii) Heisenberg Uncertainty principle **(3marks)**
b) Show how hybridization of boron atom takes place in BF_3 and indicate the shape of the molecule. **(2marks)**
c) Explain why the ionization energies of group three elements are lower compared to those of group two elements in the same period. **(3marks)**
d) Describe the Bohr's atomic theory **(4marks)**
e) State any THREE applications of radioactivity. **(3marks)**
f) Atom X (X not its actual chemical symbol) has atomic number 32.
   (i) Write its electronic configuration **(1mark)**
   (ii) With reason(s) state its group number and period **(3marks)**
g) A laser produces red light of frequency 8.26 x 10^{14} cm^{-1}. Calculate the wavelength and the wave number of this red light. **(4marks)**
h) List the names of the FOUR quantum numbers to uniquely define an electron in an atomic orbial and give their properties. **(4marks)**
i) Calculate the weight of sodium thiosulphate ($Na_2S_2O_3$ $5H_2O$) necessary to prepare

$200cm^3$ of a 0.02M solution. **(3marks)**

Question TWO

a) Explain the following terms with reference to the electromagnetic radiation:
   i) Wavelength
   ii) Frequency
   iii) Wave number **(3marks)**

b) Calculate the energy and the wavelength in nanometers of radiation emitted by the electron transition $n_i = 2$ and $n_f = 5$ in a hydrogen atom. Given that:

$$\Delta E = -2.279\ x\ 10^{-18}\left(\frac{1}{n_1^2} - \frac{1}{n_f^2}\right)J$$ **(5marks)**

c) State LE Chatelier's principle. **(2marks)**

d) Determine the percentage composition by mass of each in aluminium sulphate (Al = 27; S= 32; O =16) **(4marks)**

e) Work out the oxidation number of underlined atom in each of the following species
   i) $\underline{S}O_4^{2-}$ **(2marks)**
   ii) $K_2\underline{Cr}_2O_7$ **(2marks)**

f) The following ions are isoelectronic; Ca^{2+}, Sc^{3+}, Ti^{4+}, and S^{2-}. List them according to size in ascending order. **(2marks)**

Question THREE

a) Explain the following rules with reference to the atomic structure:
   (i) Hund's rule
   (ii) Pauli Exclusion Principle **(4marks)**

b) Write the electronic configuration of the following species:
   i) Cr^{3+} ii) Al^{+} iii) Co^{3+} iv) Cu **(4marks)**

c) Give the allowable quantum number combinations for the 3pelectrons **(4marks)**

d) Draw the Lewis Structures for the following compounds:
   (i) Aluminium oxide
   (ii) Aluminium chloride **(4marks)**

e) The first ionization energy of Mg is greater than that of NA, whereas the second ionization of Mg is lower than that of Na. Explain this observation **(3marks)**

f) Explain the statement 'dual nature of an electron' **(1mark)**

Question FOUR

a) For the following equation, identify the conjugate acid-base pairs
   (i) $NH_4^+ + H_2O \quad H_3O^+ + NH_3$
   (ii) $NH_4^+ + SEO_4^- \quad HSeO_4^- + NH_3$ **(4marks)**

b) Define the following terms:

(i) Normality

(ii) Molarity **(4marks)**

c) A 40ml solution of sulphuric acid neutralizes 0.364g of sodium carbonate.

(i) Write down the balanced equation for the above reaction **(2marks)**

(ii) Calculate the number of moles of sodium carbonate that reacted **(2marks)**

(iii) Calculate the number of moles in the 40ml of sulphuric acid **(2marks)**

(iv) Calculate the molarity of the sulphuric acid **(2marks)**

d) Explain the nature and how the following ion exchange resins function:

(i) Cation exchange resin

(ii) Anion exchange resin **(4marks)**

Question FIVE

a) Define the term half-life **(2marks)**

b) Complete the following nuclear reactions and identify X and Y.

i) $^{16}_{8}O + {}^{1}_{0}n \rightarrow {}^{13}_{6}C + X$ **(2marks)**

ii) $^{24}_{12}Mg + {}^{4}_{2}He \rightarrow Y + {}^{1}_{0}n$ **(2marks)**

c) State the properties of the major types of radiations with reference to the following factors:

(i) Effect of magnetic field

(ii) Ionizing effect

(6marks)

d) The isotope carbon – 10 with an initial count rate of 3400 disintegrations S-1 decays by positron emission with a half of 19.2 seconds. Work out the:

i) Radioactive decay constant **(2marks)**

ii) Count rate after 104 seconds **(2marks)**

e) Using the Valence Shell Electron Pair Repulsion (VSEPR) model predict the molecular geometry of the following compounds:

i. PF_5 **(2marks)**

ii. H_2O **(2marks)**