MURANGA UNIVERSITY COLLEGE

(CONSTITUENT COLLEGE OF JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY)

EXAMINATION

DIPLOMA IN ANALYTICAL CHEMISTRY

ASC 1303: INORGANIC CHEMISTRY

Date: 20th July 2015 TIME: 3 HOURS

Instruction to the Candidate

i. This paper consists of TWO sections; A and B.
ii. Answer all the questions in section A and any Three from section B.
iii. Each question in Section A carries 4 marks while each question in section B carries 20 marks

SECTION A (40 MARKS)

Answer ALL the questions in this section

1.) Define the terms;
   a.) Lewis Acid (1 mark)
   b.) Lewis Base (1 mark)
   c.) Explain why orthoboric acid (H_3BO_3) acts as a Lewis acid. (2 marks)

2.) Although both diamond and graphite are allotropes of carbon consisting only of carbon atoms that are covalently bonded, diamond is hard while graphite is soft and slippery. Explain these observations (4 marks)

3.) Large quantities of magnesium are used in the extraction of the element titanium (Ti). In the process, titanium (IV) Chloride is reacted with magnesium to produce magnesium chloride and titanium.
   a.) Write the equation for this reaction (1 mark)
   b.) What mass of magnesium is required to react with 5.8 tonnes of titanium (IV) Chloride (3 marks)

(Ti=47.9, Cl=35.5, Mg=24.3)

4.) Compare the properties of water and liquid ammonia as solvents for the group I metals. (4 marks)

5.) a.) Explain the term reduction in terms of electron movement (1 mark)

b.) Consider the following standard electrode potentials;

$Fe^{2+} + 2e \quad \rightarrow Fe_{(s)} + E^{\circ}/v = -0.44$

$Zn^{2+}_{(aq)} + 2e \quad \rightarrow Zn_{(s)} + E^{\circ}/v = -0.76$

Deduce with reasons, the species reduced if the two half cells are connected in a electrochemical cell. (3 marks)

6.) The atomic numbers of the elements X and Y are 38 and 51 respectively.
   a.) Write the electronic configurations of X and Y (1 mark)
   b.) State the period and group to which X and Y belong (2 marks)
   c.) Predict the formulas of oxides of X and Y (1 mark)

7.) a.) State four properties of transition metals (2 marks)
   b.) Distinguish between Oxidation number and co-ordination number in transition metals (2 marks)

8.) Use the electron-pair repulsion theory to predict the shapes of the following molecules;
   a.) BF_3 (1 mark)
   b.) ClF_3 (1 mark)
   c.) Account for the difference in the shapes of the two molecules above (2 marks)
   (B=5, F=9, Cl=17)

9.) a.) Explain the storage requirements of alkali metals. (2 marks)
   b.) Write balanced chemical equations for the following reactions ;
      i.) Potassium heated in chlorine gas (1 mark)
      ii.) Sodium heated in a stream of ammonia gas (1 mark)

10.) a.) State Fajans rules of covalency. (2 marks)
   b.) State with reasons the compound with least ionic character between Lithium chloride and potassium chloride (2 marks)

SECTION B (60 MARKS)

Answer ANY THREE (3) questions in this section

11.) a.) Discuss the following properties with respect to the simple hydrides of group IV of the periodic table;
   i.) Preparation (two general methods) (4 marks)
   ii.) Structure (2 marks)
   iii.) Volatility (2 marks)
   iv.) Type of Bonding (2 marks)

   b.) Explain the following observations;

   i.) CCl_4 is unreactive to water while $SiCl_4$ is rapidly hydrolysed (2 marks)

   ii.) SnI4 is coloured orange while the iodides of other group (IV) elements are white (2 marks)

   iii.) HF is the weakest of all the hydrohalic acids (2 marks)

   v.) Electrical conductivity of metals decreases with increasing temperature when
   vi.) the metal is heated
   vii.) (2 marks)

viii.) Chlorides NCl_3, PCl_3 and PCl_5 exists but NCl_5 does not (2 marks)

12.)a.) Distinguish the following terms;

i.) Natural and Artificial radioactivity (2 marks)

ii.) Nuclear fission and Nuclear fusion (2 marks)

c.) Name the three fundamentals of radiations and state two characteristic properties of each radiation (6 marks)

d.) The half-life of a radioactive carbon-14 is 5730 years. An archeological sample contains 42% of the carbon -14 normally found in nature. Calculate the age of the archeological sample. (6 marks)

e.) Calculate the binding energy per nucleon (in MeV) for the isotope $^{56}_{26}Fe$ give the masses of the following; (4 marks)

1 Fe=55.93494 a.m.u

1neutron=1.008665 a.m.u

1proton=1.00783 a.m.u

1a.m.u=931 MeV

13.)a.) State in order the FIVE main stages that are involved during the determination of relative atomic masses of atoms by mass spectrometry (5 marks)

b.) Calculate the relative atomic mass of chlorine from the following data

Isotope	Relative isotopic mass	Fractional abundance
$^{35}_{17}Cl$	34.97	0.7553
$^{37}_{17}Cl$	36.95	0.2447

(2 marks)

b.) Give four similarities between silicon and boron (2 marks)

c.) i.) Explain the term Silicones (2 marks)

ii.) List three applications of silicones (3 marks)

d.) When a white substance A was treated with dilute hydrochloric acid, a colourless gas B was evolved, which turned moist litmus paper red. On bubbling the gas B through lime water a precipitate C was formed, but passage of further gas resulted in a clear solution D. A small sample of A was moistened with concentrated hydrochloride acid, placed on a platinum wire and introduced into a Bunsen burner flame where it caused a green flame colouration. On strong heating of A decomposed giving a white solid E which turned red litmus paper blue.

Name compounds A, B, C, D, E (6 marks)

14.)a.) Define the following terms as used in transition metals;

i.) Chelating agents (1 mark)

ii.) Donor atom (1 mark)

iii.) Ligand (1 mark)

iv.) Counter ion (1mark)

b.) State any ***two*** factors that favour the formulation of complexes (2 marks)

c.) write the formula of each of the following complexes;

i.) Potassium Hexacyanoferrate (II) (2 marks)

ii.) Hexaammine cobalt (III) ion (2 marks)

iii.) Hexachloroplatinate (II) ion (2 marks)

iv.) Tetraamminedichorochromium (III) ion (2 marks)

d.) Name and state the shape of each of the following complexes;

i.) $[Co(NH_3)_6]Cl_3$ (4 marks)

ii.) $[Ag(NH_3)_2]Br$ (4 marks)

iii.) $K_4[Fe(CN)_6]$ (4 marks)

iv.) $[Cr(NH_3)_6](NO_3)_3$ (4 marks)

15.) a.) i.) Name one ore from which aluminum is extracted (1 mark)

ii.) Write the formula of the ore in (a)(i) above (1 mark)

b.) Aluminum is purified by the process of electrolysis

i.) Explain why cryolite is added during this process (2 marks)

ii.) Explain why aluminium and oxygen are discharged at their respective electrodes (3 marks)

iii.) Explain why the anode is replaced periodically during the electrolysis process (2 marks)

iv.) Name two alloys of aluminium (2 marks)

c.) The contact process of the manufacture of sulphuric acid involves the reaction below

$$SO_2 + O_2 \rightleftharpoons SO_3 \quad H = -192\ KJ/mol$$

i.) State ***two*** conditions that will favour high yields of Sulphur trioxide (2 marks)

ii.) Explain why vanadium pentoxide is preferred as catalyst in the above reaction reaction rather than platinum (1 marks)

iii.) Explain why Sulphur trioxide has to be dissolved in concentrated sulphuric acid to form oleum rather than dissolving it directly with water (2 marks)

iv.) Sketch a diagram of sulphur extraction from earth's crust (4 marks)