THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/2

CHEMISTRY 2
(For Both School and Private Candidates)

Time: 3 Hours

Tuesday, 10th May 2016 a.m.

Instructions

1. This paper consists of **ten (10)** questions in sections A, B and C.
2. Answer **five (5)** questions choosing at least **one (1)** question from each section.
3. Each question carries **twenty (20)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. For calculations you may use the following constants:

   Gas constant, R = 8.31 J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K^{-1} dm^3
   GMV = 22.4 dm^3
   1 litre = 1dm^3 = 1000 cm^3
   1 Faraday = 96,500 $Cmol^{-1}$
   Velocity of light, C = 3.0 x 10^8 m/s
   Atomic numbers: Mn = 25, S = 16, Cl = 17, C = 6, O = 8, Ti = 22, Cu = 29.
   Atomic masses: H = 1, C = 12, N = 14, Na = 23, S = 32, O = 16, I = 127, Pb = 207.

SECTION A

Answer at least **one (1)** question from this section.

1. (a) Derive an expression relating K_c and K_p for the decomposition of phosphorus pentachloride. $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$. **(8 marks)**

   (b) The equilibrium constant for the reaction $2HCl_{(g)} \rightleftharpoons H_{2(g)} + Cl_{2(g)}$ is $K_1 = 4.17 \times 10^{-34}$ at 25 °C and the equilibrium constant for the reaction $I_{2(g)} + Cl_{2(g)} \rightleftharpoons 2ICl_{(g)}$ is $K_2 = 2.1 \times 10^{5}$ at 25 °C. Calculate the equilibrium constant for the reaction, $2HCl_{(g)} + I_{2(g)} \rightleftharpoons 2ICl_{(g)} + H_{2(g)}$. **(7 marks)**

   (c) Briefly explain five factors that affect rate of chemical reaction. **(5 marks)**

2. (a) Define the following terms:
   (i) Standard electrode potential.
   (ii) Redox reaction.
   (iii) Corrosion. **(3 marks)**

   (b) Briefly explain how voltaic cells differ from electrolytic cells. **(2 marks)**

   (c) Write a balanced ionic equation and identify the oxidants and reductants in each of the following chemical reactions:
   (i) Iron (II) sulphate solution reacts with an acidified potassium dichromate solution.
   (ii) Iodine and sodium thiosulphate solution react together.
   (iii) Copper (II) sulphate solution and potassium iodide solution react together. **(9 marks)**

   (d) Explain the function of moisture in the rusting process. **(1 mark)**

   (e) Using the following half reactions,
   $Au^{3+} + 3e^- \rightarrow Au$ $\quad E° = 1.50$ v
   $NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$ $\quad E° = 0.96$ v
   predict whether 1 M HNO_3 will dissolve gold metal to form a 1 M Au^{3+} solution. **(5 marks)**

3. (a) Calculate the values of $[H^+]$ and $[OH^-]$ in a 0.005 M solution of NaOH. **(4 marks)**

   (b) The pH of a 0.1 M solution of a weak base is 10.6. Calculate the ionization constant of the base. **(4 marks)**

   (c) Calculate the number of grams of sodium acetate (CH_3COONa) which are to be added to 500 cm^3 of 0.12 M acetic acid (CH_3COOH) to give a buffer solution of pH = 4.60, given that $k_a(CH_3COOH) = 1.8 \times 10^{-5}$. **(4 marks)**

   (d) The solubility product of lead (II) chloride, $PbCl_2$ has a value of 1.6×10^{-5} Mol^3dm^{-9} at 298 K. Calculate the solubility of lead (II) chloride at 298 K. **(4 marks)**

   (e) Give the difference between the following terms:
   (i) Solubility and solubility product.
   (ii) Reaction quotient and equilibrium constant. **(4 marks)**

4. (a) Write the chemical formulae for the compounds; potassium hexacynocobaltate (III) and potassium hexacyanoferrate (II). **(2 marks)**

(b) Observe the complex ion $[Co(NH_3)_3(H_2O)_2Cl]^+$, then answer the following questions:
(i) Identify the ligands and the charge on each of them.
(ii) Write the geometry of the complex ion. **(3 marks)**

(c) Briefly explain why bivalent titanium ion $[Ti^{2+}]$ is paramagnetic. **(1.5 marks)**

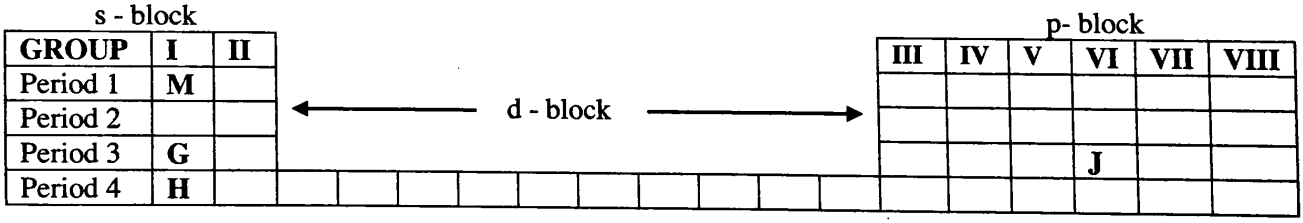
(d) Give the IUPAC names of the following compounds:
(i) $Cu_2[Fe(CN)_6]^{2-}$
(ii) $[Cu(NH_3)_4SO_4]$
(iii) $Ag(NH_3)_2Cl$
(iv) $[Ni(NH_3)_6]Cl_2$
(v) $[Cr(en)_2Cl_2]^+NO_3^-$. **(7.5 marks)**

(e) Find oxidation state of the central metal ion or atom in the following compounds:
(i) $KMnO_4$
(ii) $[Pt(NH_3)_4][PtCl_4]$
(iii) $[Co(H_2NCH_2CH_2NH_2)_3]_2(SO_4)_3$
(iv) $[Co(NH_3)_4Br_2]_2SO_4$. **(6 marks)**

SECTION B

Answer at least **one (1)** question from this section.

5. Study a portion of periodic table indicated below and answer questions in part (a) and (b).



(a) (i) Identify with reason the block in which elements A, C, D and E are to be found if their electronic configurations are as follows:
A: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$
C: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
D: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
E: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2$.
(ii) Write the molecular formula of a compound formed when D combines with E. **(5 marks)**

(b) (i) Justify that, the first ionization energy of J is larger than that of G although both are found in the same period.
(ii) Account for the increase of metallic nature from M to H. **(4 marks)**

(c) Briefly explain each of the following trends:
(i) Some members in the periodic table are said to be related diagonally.
(ii) Fluorine is more reactive than other members of the halogen group. **(4 marks)**

(d) Describe how hydrides of the elements in period 3 react with water. **(7 marks)**

6. (a) Briefly explain the following observations. Support your explanation with equation(s) where applicable.
   (i) Anhydrous magnesium chloride cannot be prepared by heating the hydrated crystals of $MgCl_2.6H_2O$.
   (ii) Most metal carbonates are prepared by precipitation method but aluminium carbonate has never been prepared by this method.
   (iii) Aqueous aluminium nitrate turns blue litmus red.
   (iv) Zinc oxide is amphoteric.
   (v) Lead (II) chloride is soluble in concentrated hydrochloric acid.
   (vi) Addition of ammonia solution to aqueous copper (II) sulphate gives a pale blue precipitate initially and deep blue solution when more ammonia is used. **(13 marks)**

   (b) Write the chemical formulae of three oxides of lead and give their uses. **(4 marks)**

   (c) Give two important uses of lead and two hazards of lead in life. **(3 marks)**

7. Briefly explain the following:
   (a) (i) Metals do not occur as nitrate in nature.
   (ii) Activity series of metals.
   (iii) A metal A is found in free state in nature while metal B is found in the form of its compound. Which of the two metals will be nearer to the top of the activity series of metals?
   (iv) Aluminium cannot be extracted by reducing alumina with carbon.
   (v) Limestone is added to the blast furnace in the extraction of iron from haematite. Support with equations. **(10 marks)**

   (b) Describe methods that are applied in extracting metals which are
   (i) very reactive
   (ii) less reactive. **(10 marks)**

SECTION C

Answer at least **one (1)** question from this section.

8. (a) (i) Name three human activities which increase amount of carbon dioxide in the atmosphere.
   (ii) Describe greenhouse effect.
   (iii) List three climatic effects caused by rise in temperature due to greenhouse effect. **(6 marks)**

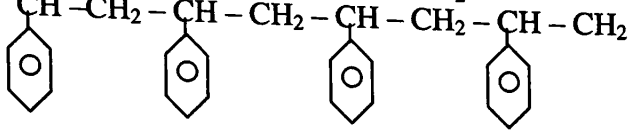
   (b) (i) Define cation exchange capacity of a soil sample.
   (ii) Briefly explain how cation exchange capacity of a soil sample is measured. **(3 marks)**

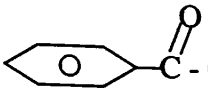
   (c) A certain soil contains the following cations in meq/100 g of oven-dry soil:
   $Na^+ = 2.00$; $K^+ = 3.00$; $Mg^{2+} = 10.00$; $Ca^{2+} = 15.00$; $Al^{3+} = 4.00$ and $H^+ = 5.50$. Calculate the
   (i) percentage base saturation
   (ii) quantity in grams of sodium present in 100 g of oven-dry soil. **(8 marks)**

(d) A certain soil has been identified to have a pH < 5. Identify two major ions which prevail in this soil and two compounds which can be used to raise the pH of this soil. **(3 marks)**

9. (a) Arrange the following compounds in the order of decreasing basic strength:
NH_3, $C_6H_5NH_2$, $CH_3CH_2NH_2$, $CH_3-\underset{\displaystyle CH_3}{\underset{|}{N}}-CH_3$ and $CH_3-\underset{\displaystyle H}{\underset{|}{N}}-CH_3$. **(4 marks)**

(b) (i) Give the structural formulae of hexane-1,6-dioic acid and 1,6-diaminohexane.
(ii) Explain why the pair of molecules in (i) is suitable for polymerization.
(iii) Give the structure of the polymer which might be formed by the pair of molecules in (i).
(iv) Show the repeating unit of the polymer formed by this pair of compounds. **(8 marks)**

(c) Indicate the monomer and the polymerization method which are likely to be used in making each of the following commercial polymers:
(i) $CF_2-CF_2-CF_2-CF_2-CF_2-CF_2$
(ii) 
(iii) $NH\text{-}(CH_2)_5\text{-}CO\text{-}NH\text{-}(CH_2)_5\text{-}CO\text{-}NH(CH_2)_5CO_2$. **(6 marks)**

(d) State why  and $HOCH_2CH_2OH$ cannot form a polymer. **(2 marks)**

10. (a) Acetic acid, ethyl alcohol and acetaldehyde in the form of solutions are given in three different test tubes. By which chemical tests, could these be identified from one another? **(6 marks)**

(b) Arrange the following compounds in the order of decreasing acidic strength:
(i) CH_3COOH, CH_3CH_2COOH and $HCOOH$.
(ii) $ClCH_2COOH$, Cl_3CCOOH and $Cl_2CHCOOH$. **(2 marks)**

(c) Identify the structures and the names of the compounds represented by letters in the following reaction sequences:

(i) $CH_3\text{-}\overset{\displaystyle O}{\overset{\|}{C}}\text{-}CH_3 \xrightarrow{LiAlH_4} A \xrightarrow{HBr} B \xrightarrow{alc.\ KOH} C.$

(ii) $CH\equiv CH \xrightarrow[H^+/Hg^{2+}]{H_2O} D \xrightarrow[H_2O/H^+]{CH_3MgBr} E \xrightarrow[H_2SO_4]{K_2Cr_2O_7} F.$ **(6 marks)**

(d) Ozonolysis of an alkene, (C_6H_{12}), followed by its hydrolysis yielded two products P and Q. P gives a positive iodoform test but a negative Tollen's test. Q give a positive Tollen's test, but a negative iodoform test. Identify structures and names of the alkene and products P and Q. **(6 marks)**