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, 12th May 2015 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, $C = 3.0 \times 10^8\ m/s$
Atomic numbers: V = 23, Mn = 25, Fe = 26, Co = 27, Zn = 30, Cd = 48.
Atomic masses: Ca = 40, Cu = 63.5, Ag = 108, I = 127.

SECTION A

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

1. (a) According to Brönsted-Lowry theory, $HSO_3^-{}_{(aq)}$ ion behaves as an acid in the following reaction: $\rightleftharpoons$

$HSO_3^-{}_{(aq)}$ $H^+{}_{(aq)} + SO_3^{2-}{}_{(aq)}$

(i) Explain in terms of Brönsted-Lowry theory how HSO_3^- is acting as an acid.

(ii) Write the formula for the conjugate base.

(iii) Illustrate with an equation how HSO_3^- ion can also act as a base. **(4 marks)**

(b) Calculate the pH at the neutralization point for the reaction between 0.01 M NH_4OH and 0.01 M HCl solutions given that $K_a(NH_4^+) = 5.7 \times 10^{-10}$ mol/dm^3. **(8 marks)**

(c) An ethanoic acid/sodium ethanoate buffer containing 1.00 M CH_3COOH has a pH = 4.742. Calculate the following given that, $K_a(CH_3COOH) = 1.8 \times 10^{-5}$ mol/dm^3.

(i) Concentration of sodium ethanoate in the given buffer.

(ii) pH of the resulting solution after 0.01 mole $HCl_{(aq)}$ has been added in 1dm^3 of the buffer solution.

(iii) pH of the resulting solution after 0.01 mole NaOH solution is added in 1dm^3 of the buffer solution.

(iv) pH when 0.01 mole of NaOH is added to 1.0 dm^3 of pure water. **(8 marks)**

2. (a) Explain the following chemical phenomena with the aid of chemical reaction(s):

(i) Addition of aqueous solution of silver nitrate into dilute HCl produces a white precipitate which dissolves in aqueous ammonia solution.

(ii) Zinc sulphide is not precipitated when hydrogen sulphide is passed through a solution to which dilute HCl is added.

(iii) The passage of carbondioxide through calcium hydroxide solution changes the latter into a precipitate which dissolves into a clear solution in excess carbondioxide. **(6 marks)**

(b) (i) State whether a precipitate will form when 0.5 dm^3 of 2×10^{-3}M $BaCl_2$ is mixed with 1 dm^3 of 2×10^{-4}M Na_2SO_4 given that $K_{sp}(BaSO_4) = 1 \times 10^{-10}$ mol^{2}dm^{-6}.

(ii) Calculate the mass of $Ca(OH)_2$ which is precipitated at 25°C when 500 cm^3 of saturated solution of $Ca(OH)_2$ is mixed with equal volume of 0.4 M NaOH. $K_{sp}(Ca(OH)_2)$ at 25°C = 4.42×10^{-5}mol^{3}dm^{-9}.

(8 marks)

(c) The solubility product of lead (II) chloride ($PbCl_2$) has a value of 1.6×10^{-5} mol^{3}dm^{-9} at 298 K.

(i) Explain what is meant by this statement.

(ii) Calculate the solubility of lead (II) chloride in water at 298 K.

(iii) Calculate the solubility of the above compound in a 0.1 M solution of lead (II) nitrate at the same conditions.

(6 marks)

3. (a) Explain four factors that can affect the rate of a chemical reaction. **(4 marks)**

(b) The rate constant for the first order reaction is $3.46 \times 10^{-2} s^{-1}$ at 298 K. What is the rate constant at 350 K if the activation energy for the reaction is 50.2 $kJmol^{-1}$? **(5 marks)**

(c) Nitrogen dioxide (NO_2) reacts with fluorine (F_2) to yield nitryl fluoride (NO_2F) according to the equation $2NO_{2(g)} + F_{2(g)} \rightarrow 2NO_2F_{(g)}$. Write the reaction in terms of rate of

(i) formation of NO_2F
(ii) disappearance of F_2
(iii) disappearance of NO_2. **(3 marks)**

(d) Hydrolysis of ethyl acetate by NaOH using equal concentrations of the reactants was studied by titrating 25 cm^3 of the reaction mixture at different intervals against standard acid. Using data in the following table, establish that the reaction is a second order.

Time (minute)	0	5	15	25
Volume of acid used (cm^3)	16.00	10.24	6.13	4.32

(8 marks)

4. (a) Define the following terms:
(i) Electric double layer
(ii) Electrode potential
(iii) Standard electrode potential. **(3 marks)**

(b) Given that Zn^{2+}/Zn $E^{\ominus} = -0.76$ V and Cu^{2+}/Cu $E^{\ominus} = 0.337$ V;
(i) Calculate the e.m.f. of the cell.
(ii) Briefly explain what would be the effects on the e.m.f. if the $[Zn^{2+}]$ or $[Cu^{2+}]$ is altered.
(iii) What will be the e.m.f. of the cell if zinc electrode system is replaced by silver electrode system given that Ag^{+}/Ag $E^{\ominus} = 0.80$ V? **(9 marks)**

(c) (i) State Faraday's laws of electrolysis.
(ii) List at least two importance of the second law of electrolysis.
(iii) An electric current is passed through three cells in series containing solutions of copper sulphate, silver nitrate and potassium iodide respectively. What weights of silver and iodine will be liberated when 2 g of copper is being deposited? **(8 marks)**

SECTION B

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

5. (a) Explain the following phenomena with the aid of chemical equation(s) where possible
   (i) Common reductants are useless in the manufacture of aluminium from its ore.
   (ii) Aluminium chloride is a good Lewis acid.
   (iii) Molecular mass of $AlCl_3$ in vapour state is twice the expected value.
   (iv) Aluminium oxide shows basic properties by reacting with HCl. **(6 mark**

   (b) Describe the process of aluminium extraction starting with bauxite under the following stages:
   (i) Purification of the ore from impurities.
   (ii) Electrolysis of aluminium. **(10 marks**

   (c) Evaluate any four uses of aluminium which reflect its physical and chemical properties. **(4 marks)**

6. (a) (i) Write the electronic configurations of the following species: Mn^{2+}, V^{3+} and Fe^{3+}.
   (ii) Give reason(s) why in manganese the oxidation state of +2 is more stable than the oxidation state of +3.

   (4 marks)

   (b) Briefly explain each of the following phenomena:
   (i) The radii of Fe, Co and Ni show a much smaller variation in size than those of Na, Mg and Al.
   (ii) Cadium has two electrons in the outermost shell as does magnesium but they are not classified in the same group.
   (iii) Iron element exhibits magnetic properties while zinc element does not.

   (6 marks)

   (c) (i) Account for the different coordination numbers between $[FeCl_4]^{2-}$ and $[FeF_6]^{4-}$.
   (ii) What are the origins of magnetism in transition elements?
   (iii) Use the 3d electron configuration in cobalt (III) ions to explain why $[CoF_6]^{3-}$ is paramagnetic while $[Co(CN)_6]^{3-}$ is diamagnetic.
   (iv) Briefly explain why $[Fe(CN)_6]^{4-}$ is said to be an inner orbital complex while $[CoF_6]^{3-}$ is said to be an outer orbital complex. Determine the type of hybridization exhibited by each of the two complexes.

   (10 marks)

7. (a) What is the basic difference between Mendeleev's periodic law and the Modern periodic law?

   (1 mark)

   (b) A neutral atom of a certain element has 17 electrons.
   (i) Write its ground state electronic configuration.
   (ii) Classify the element into s, p, d or f block.
   (iii) Determine whether it is diamagnetic or paramagnetic.
   (iv) What is the principal oxidation number of the element? **(4 marks)**

(c) Study the following hypothetical elements placed in various groups and periods of part of the periodic table and then answer the questions that follow:

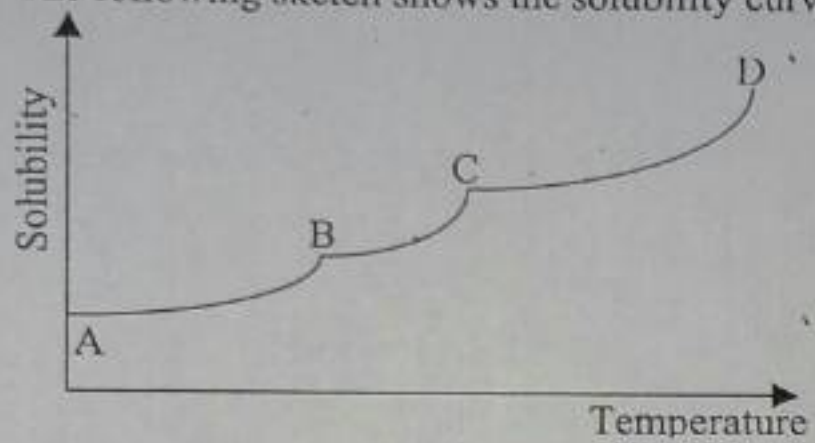
GROUP/PERIOD	I	II	III	IV	V	VI	VII	O
2	A	B	C	D	E	F	G	H
3	I	J	K	L	M	N	O	P

Giving reason(s) identify;

(i) an element which is most likely to have the highest electron affinity.
(ii) an element which is likely to have the highest electronegativity.
(iii) an element which is likely to have least first ionization energy.
(iv) a pair of elements which is likely to form the strongest electrovalent bond.
(v) two elements which are likely to have strongest reducing properties.
(vi) two elements which form neither negative nor positive ions. **(6 marks)**

(d) (i) Define the term deliquescence and explain what makes a hydrated salt to deliquesces.

(ii) The following sketch shows the solubility curve of calcium chloride in water:



Explain the discontinuities in the solubility curve. **(3 marks)**

(iii) Briefly explain at least three hazards associated with the useful applications of sulphur and lead or their compounds.

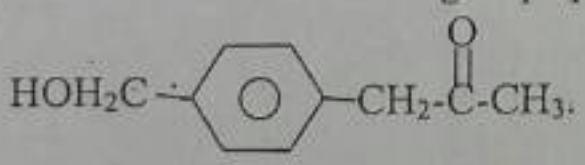
(6 marks)

SECTION C

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

8. (a) For each of the following compounds, give the structures and the names of two functional isomers:
(i) C_3H_6O (ii) $C_2H_4O_2$ (iii) C_2H_6O. **(6 marks)**

(b) Name all the functional groups present in the following compound:



(4 marks)

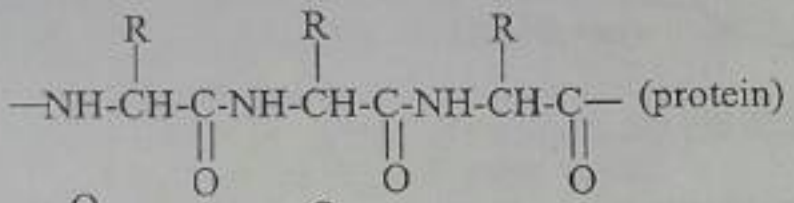
(c) Predict the product(s) formed when the compound in (b) above reacts with
(i) warm mixture of iodine and NaOH
(ii) sulphur dichloride oxide ($SOCl_2$)
(iii) acidified $K_2Cr_2O_7$ at 60 °C – 80 °C
(iv) H_2 and nickel at 140 °C. **(10 marks)**

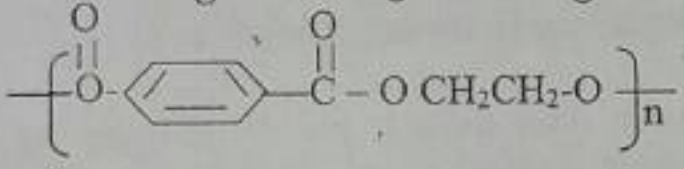
9. (a) Define the following terms:
(i) Polymer
(ii) Additional polymerization
(iii) Condensation polymerization. **(3 marks)**

(b) (i) Name at least four common natural polymers.
(ii) Giving example, differentiate a thermosetting polymer from a thermoplastic polymer.
(4 marks)

(c) Using example of polymerization of vinyl chloride (C_2H_3Cl) to form PVC, show the following steps:
(i) Initiation step
(ii) Propagation step
(iii) Termination step. **(6 marks)**

(d) Draw the complete structures of monomers which were used to prepare the following condensation polymers:

(i) 

(ii) 

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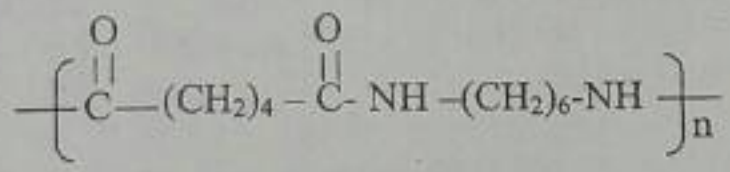
(iii) 

nylon. **(7 marks)**

10. Conservation of water against pollution is of paramount importance for human health and development. Discuss this statement using the following sub headings:
(i) Categories of water pollution.
(ii) Causes of water pollution (4 causes).
(iii) Effects of water pollution (4 effects).
(iv) Control measures to be taken (4 measures). **(20 marks)**