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

132/2

CHEMISTRY 2
(For Both School and Private Candidates)

Time: 3 Hours **Monday, 13th May 2019 p.m.**

Instructions

1. This paper consists of sections A, B and C with a total of **ten (10)** questions.
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 and any unauthorized materials 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 $Cmol^{-1}$

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SECTION A

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

1. (a) Define the following terms giving one example in each;
   (i) A conjugate base.
   (ii) A conjugate acid base pair.
   (iii) A conjugate acid.
   (iv) Arrhenius acid.

(4 marks)

(b) Label the conjugate acids and bases in these reactions;

(i) $S^{2-}(aq) + H_3O^+(aq) \rightleftharpoons HS^-(aq) + H_2O(l)$

(ii) $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$

(iii) $NH_2^-(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + OH^-(aq)$

(iv) $CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$

(4 marks)

(c) Calculate the concentration of hydrogen ions and hydroxide ions in 0.01 M solution of
   (i) hydrochloric acid.
   (ii) acetic acid (α for CH_3COOH is 5%).

(4 marks)

(d) The K_w of water at 25 °C and 65 °C are 10^{-14} mol^2dm^{-6} and 2.92×10^{-14} mol^2dm^{-6} respectively.
   (i) State the effect of temperature in the dissociation of water.
   (ii) Calculate the $[H^+]$ at 65 °C.
   (iii) Find the pH of water at 65 °C.
   (iv) Calculate the pH of water under neutral condition at 65 °C.

(8 marks)

2. (a) Briefly explain the following;
   (i) Average rate of reaction.
   (ii) Rate constant (k).

(2 marks)

(b) (i) If you were in-charge of a chemical company, briefly explain why you would prefer a catalyst that works at room temperature rather than heating the reactants to 200 °C.
   (ii) A student defined a catalyst as "a substance that speeds up a reaction without taking part in the reaction." State what is wrong with the definition.

(3 marks)

(c) Explain the following;
   (i) Powdered sugar dissolves faster than crystalline sugar.
   (ii) It takes more time to cook rice at higher altitudes than low altitudes.
   (iii) We save fuel when we use a pressure cooker.
   (iv) There is no difference in cooking time between sea level and higher altitude when we use a pressure cooker at both places.

(6 marks)

(d) Consider the reaction with E_a= 75 $kJmol^{-1}$ at 293 K. When a catalyst is used in the same reaction at 20 °C, its E_a is lowered to 20 $kJmol^{-1}$. Calculate how fast is the catalyzed reaction with respect to uncatalyzed reaction.

(9 marks)

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3. (a) Describe the following;
   (i) The standard electrode potential. **(3 marks)**
   (ii) Electrochemical series.

(b) (i) Write the equation showing how the electromotive force(e.m.f) of the following cell changes with their ions concentration.

$Ce(s) \mid Ce^{3+}(aq) \,\vdots\, Cr^{3+}(aq) \mid Cr(s)$.

(ii) Calculate the value of the equilibrium constant for the following reaction given that;
$\varepsilon^o Ce^{3+}/Ce = -2.33$ V and $\varepsilon^o Cr^{3+}/Cr = -0.41$ V.

$Ce(s) + Cr^{3+}(aq) \rightleftharpoons Ce^{3+}(aq) + Cr(s)$. **(9 marks)**

(c) (i) Write down the expression for the cell e.m.f for the reaction below;

$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O(s)$.

(ii) State why the oxidizing power of manganate (VII) ions in (i) is quite sensitive to the concentration of hydrogen ions. **(4 marks)**

(d) Briefly explain any four methods for rusting prevention. **(4 marks)**

4. (a) (i) Define isoelectronic species.
   (ii) Name a species that will be isoelectronic with each of the following species; F^-, and Mg^{2+}. **(3 marks)**

(b) Among the elements of the second period, Li to Ne, identify the one(s)
   (i) with the highest first ionization energy.
   (ii) with the highest electronegativity.
   (iii) with the largest atomic radius.
   (iv) that is most reactive non metal.
   (v) that is the most reactive metal.
   Give reason for your answer in each case. **(5 marks)**

(c) Write a chemical equation representing the following;
   (i) In moist air copper corrodes to produce a greenish layer on the surface.
   (ii) Chlorination of calcium hydroxide produces a bleaching powder.
   (iii) Adding concentrated H_2SO_4 in sugar produces a dense brownish black mass.
   (iv) Action of phosphorus on concentrated HNO_3.
   (v) Oxidation of hydrogen peroxide with potassium permanganate in acidic medium.
   (vi) Action of zinc on dilute nitric acid. **(6 marks)**

(d) Element **A** burns in nitrogen to give an ionic compound **B**. **B** reacts with water to give **C**. **C** reacts with CO_2 to give **D**. Also **C** gives a milky colouration on bubbling with CO_2. Excess bubbling of **C** gives a clear solution **E**. Use chemical equations to identify **A, B, C, D** and **E**. **(6 marks)**

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SECTION B

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

5. (a) With the aid of chemical equation, show how the following oxides can be prepared;
   (i) Calcium oxide (Direct method).
   (ii) Magnesium oxide (Direct method).
   (iii) Copper oxide (Indirect method).
   (iv) Zinc oxide (Indirect method). **(8 marks)**

   (b) With the aid of chemical equation, show how the following carbonates can be prepared;
   (i) Sodium carbonate.
   (ii) Magnesium carbonate.
   (iii) Zinc carbonate. **(6 marks)**

   (c) State three uses of metal oxides. **(6 marks)**

6. (a) (i) Explain how do $[PtCl_2(NH_3)_2]$ and $[Pt(NH_3)_6]Cl_4$ differ in electrolytic conductance.
   (ii) Write the hybridization states of Pt in compounds at 6 (a) (i). **(5 marks)**

   (b) Identify the coloured complexes from the following and give one reason for each compound of your selection.
   (i) $[Ti(NO_3)_4]$.
   (ii) $[Cu(NH_3)_4]BF$.
   (iii) $[Cr(NH_3)_6]Cl_3$.
   (iv) $K_3[VF_6]$. **(5 marks)**

   (c) (i) Distinguish paramagnetism from diamagnetism.
   (ii) With reasons, identify the paramagnetic and diamagnetic compound in $[Fe(CN)_6]^{4-}$ and $[FeF_6]^{6-}$. **(4 marks)**

   (d) An element **X** with common oxidation state of +2 is obtained as a white gelatinous precipitates when sodium hydroxide is added to its ionic solution. When excess amount of the alkali is used, the precipitate dissolves. The precipitate also dissolves when an aqueous solution of ammonia is added in excess amount. Deduce element **X** using proper chemical equations from the given information. **(6 marks)**

7. (a) (i) State four significance of soil colloids.
   (ii) Briefly explain two effects of soil pH on plant growth. **(6 marks)**

   (b) Why is it important to manage the soil pH? **(4 marks)**

   (c) A certain soil sample was analyzed in the laboratory and found to contain the following ions in meq/100 g of oven dry soil: $K^+ = 0.28$, $Mg^{2+} = 0.12$, $Ca^{2+} = 1.00$, $Na^+ = 0.03$ and $H^+ = 10.00$. If the cation exchange capacity (C.E.C) of the soil is 3.83 meq/100 g of oven dry soil, calculate the percentage base saturation (PBS). **(4 marks)**

   (d) A 21 g of soil sample was dried in oven and lost its weight by 1 g. The soil was analyzed and found to contain 0.0015 g of Ca^{2+}. Calculate the concentration (in meq/100 g oven dry soil) of calcium in the soil sample (Ca = 40 $gmol^{-1}$). **(6 marks)**

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SECTION C

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

8. (a) An alcohol with a formula $C_6H_{11}OH$ does **not** react with bromine or bromine water.
   (i) What does the information about bromine tell you?
   (ii) Identify the number of rings the compound possess.
   (iii) Draw the structure of the alcohol.
   (iv) Suggest the name for alcohol in (a)(ii).

(6 marks)

   (b) (i) Show the structure and IUPAC name of the resulting organic compound when propan-1-ol reacts with ethanoic acid in mineral acid.
   (ii) Phenol has a structure very much like ethanol. Draw the structure of the molecules and predict whether anything would happen if the two liquids are mixed with hot benzoyl chloride in acidic medium.

(9 marks)

   (c) (i) Can alcohols act as nucleophiles? Give reason for your answer.
   (ii) If you were using PCl_5 or $SOCl_2$ to test for the presence of OH^- groups, explain why the chemicals and apparatus must be dry.

(5 marks)

9. (a) An unknown compound with a molecular mass of 86 amu contains 69.8% carbon, 11.6% hydrogen and the rest is oxygen. The compound does not reduce Fehling's solution but gives a positive Iodoform test. Describe the possible structures of the compound. **(11 marks)**

   (b) By using the chemical reactions, show how propanone reacts with the following compounds:
   (i) Hydroxylamine.
   (ii) Hydrazine.
   (iii) Phenyl hydrazine.
   (iv) Phosphorus pentachloride.

(6 marks)

   (c) Explain the following statements:
   (i) *o*- hydroxybenzaldehyde is a liquid at room temperature while *p*-hydroxybenzaldehyde is a high melting solid.
   (ii) It is incorrect to name butanone as butan-2-one.

(3 marks)

10. (a) Show the initiation step and propagation step for the following polymerization types for Polytetrafluoroethene (PTFE) polymer:
   (i) Free radical polymerization.
   (ii) Cationic polymerization.
   (iii) Anionic polymerization.

(7.5 marks)

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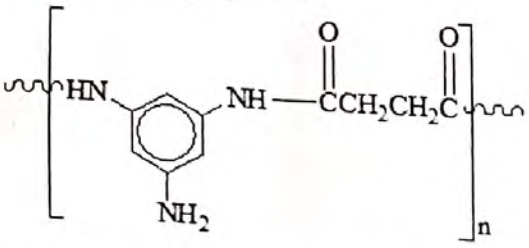
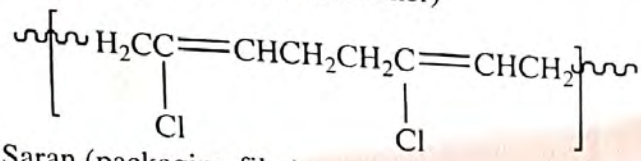
(b) Give the IUPAC names of monomers in the following polymers;

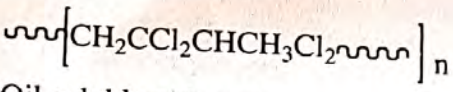
(i) Semi aromatic polyamide



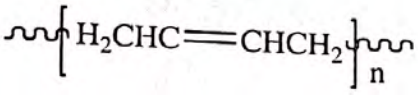
(ii) Neoprene (oil resistant elastomer)



(iii) Saran (packaging film)

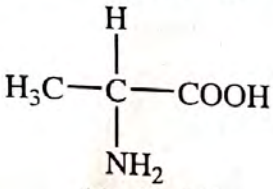


(iv) Oil soluble polymer

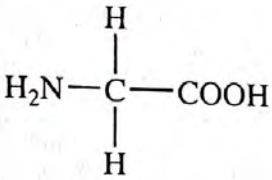


(6 marks)

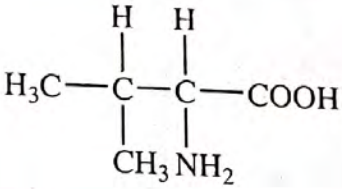
(c) Alanine(A), Glycine(G) and Valine(V) with the following structures are among the natural amino acids for protein synthesis.



Alanine(A)



Glycine(G)



Valine(V)

(i) Identify the functional groups in those amino acids.
(ii) Show how polymerization of those monomers can be done.
(iii) Provide the common name of the resulting polymer in (ii).
(iv) Write the minor product common to all in (ii).
(v) What name is given to the bond combining the three amino acids? **(6.5 marks)**

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