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 **Monday, 08th May, 2017 p.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 $0.082\ atm\ mol^{-1}\ K^{-1}\ dm^3$
   $GMV = 22.4\ dm^3$
   $1\ litre = 1dm^3 = 1000\ cm^3$

SECTION A

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

1. (a) Distinguish between the following terms:
   (i) Average rate and instantaneous rate.
   (ii) Elementary step and rate-determining step.
   (iii) Molecularity and order of reaction.
   (iv) Activated complex and activation energy. **(8 marks)**

   (b) Determine the rate law and the rate constant, k, for the following reaction using the data provided:
   $2N_2O_{5\,(g)} \rightarrow 4NO_{2\,(g)} + O_{2\,(g)}$

Initial $[N_2O_5]$ M	Initial rate ($M\,s^{-1}$)
0.186	9.68×10^{-4}
0.372	19.34×10^{-4}
1.490	77.67×10^{-4}

(6 marks)

   (c) The reaction between methane and diatomic sulphur is given by the equation
   $CH_{4\,(g)} + 2S_{2\,(g)} \rightarrow CS_{2\,(g)} + 2H_2S_{\,(g)}$

   At 550 °C the rate constant for this reaction is 2.2 L mol^{-1} s^{-1} and at 625 °C the rate constant is 12.8 L mol^{-1} s^{-1}. Calculate E_a (activation energy) for the reaction. **(6 marks)**

2. (a) Give the oxidation numbers of all atoms in the following compounds:
   (i) Cl_2
   (ii) Cl_2O_7
   (iii) $Na_2Cr_2O_7$. **(3 marks)**

   (b) Balance the following equations for redox reactions:
   (i) $Cr_2O_7^{2-}(aq) + Br^-(aq) + H^+(aq) \rightarrow Cr^{3+}(aq) + H_2O(l) + Br_2(s)$
   (ii) $MnO_4^-(aq) + I^-(aq) \rightarrow MnO_2(s) + I_2(s)$ in basic medium. **(5 marks)**

   (c) 25 cm^3 containing 3.16 g per litre of $KMnO_4$ were acidified and mixed with 20 cm^3 of KI solution. The liberated iodine was titrated against $Na_2S_2O_3.10H_2O$ solution containing 31.64 g/L.
   (i) Write balanced ionic equations representing the reactions described.
   (ii) Calculate the molarity of $Na_2S_2O_3.10H_2O$ if 26.70 cm^3 of it were required to reach the end point. **(6 marks)**

   (d) The molar conductivities at infinite dilution at 25 °C of NH_4Cl, NaOH and NaCl are 129.8, 217.4 and 108.9 S cm^2 mol^{-1}, respectively. For 0.01 M NH_4OH molar conductance is 9.33 S cm^2 mol^{-1}. Calculate the ionization constant of NH_4OH. **(6 marks)**

3. (a) Define the following:
   (i) Common ion effect.
   (ii) Buffer solutions.
   (iii) Ionic product of water.
   (iv) Salt hydrolysis. **(4 marks)**

   (b) Briefly explain each of the following observations:
   (i) Ammonia (NH_3) is one of the Lowry-Brønsted bases.
   (ii) Al^{3+} ion behaves as a Lewis acid when it is in water.
   (iii) Lead (II) chloride is soluble in concentrated HCl solution.
   (iv) Aqueous aluminium nitrate solution turns blue litmus paper red. **(6 marks)**

   (c) For each of the following pairs, write an equation to show how the pair reacts to form a conjugate acid and a conjugate base. For each reaction, identify the acid, base, conjugate acid and conjugate base.
   (i) Bicarbonate ion and water.
   (ii) Ammonia and water.
   (iii) Nitrous ion and hydroxonium ion.
   (iv) Ammonium ion and carbonate ion. **(6 marks)**

   (d) Briefly explain how an acidic buffer solution works to maintain its pH value when a small amount of acid is added to it. **(4 marks)**

4. (a) Silver chloride has a measured solubility of 1.024×10^{-4} mol/dm^3 at 18 °C. Calculate its K_{sp} value. **(4 marks)**

   (b) (i) Briefly describe the term "common ion effect". **(2 marks)**
   (ii) Calculate the solubility of solid CaF_2 in a 0.05 M NaF solution. The K_{sp} of CaF_2 is 4.0×10^{-11}. **(8 marks)**

   (c) Should a precipitate of barium fluoride be obtained when 100 mL (millilitres) of 0.25 M NaF and 100 mL of 0.015 M $Ba(NO_3)_2$ are mixed? Support your answer by calculations. The K_{sp} of BaF_2 is 1.7×10^{-6}. **(6 marks)**

SECTION B

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

5. (a) (i) State the periodic law. **(1 mark)**
   (ii) What is the advantage of arranging elements in the periodic table on the basis of atomic numbers rather than atomic masses? **(1 mark)**
   (iii) Give three (3) diagonal similarities between Be and Al. **(3 marks)**

   (b) Basic characters of elements in the modern periodic table always increase down the group. Justify this statement by considering the oxides of group V elements. **(5 marks)**

(c) Explain the following:

(i) Silicon has a higher melting point than it is expected.

(ii) Graphite is used as a lubricant as well as a cell electrode but not diamond.

(iii) The first ionization energy of boron is lower than that of beryllium although boron is towards the right across period 2 in the periodic table. **(6 marks)**

8.

(d) A researcher decided to place a newly discovered element at the bottom of group (VII). What would be the expected physical and chemical properties of the new element? Give your answers based on

(i) the state of the element at room temperature and pressure.

(ii) redox properties of the element.

(iii) atomicity.

(iv) reaction with alkali. **(4 marks)**

9.

6. (a) Identify four general principles or steps which are followed during metal extraction. **(2 marks)**

(b) With the aid of chemical equation(s), analyse the process of extracting tin (Sn) from its ore cassiterite under the following subheadings:

(i) Thermal reduction of the ore

(ii) Purification of the ore from the impurities.

(iii) Its two uses in real life. **(8 marks)**

(c) Extraction of aluminium and its purification from bauxite ($Al_2O_3.2H_2O$) can be represented by sequence of steps of events using boxes with relevant information. Design and formulate the major events sequentially to summarise the extraction which eventually leads to purification of this metal. (Diagram of the electrolytic cell and details of chemical reactions involved are not required). **(10 marks)**

7. (a) With reference to the elements of period III of the periodic table, give the formula of the oxide with the following properties:

(i) The most basic oxide.

(ii) The amphoteric oxide. **(2 marks)**

(b) Briefly explain the action of water on chlorides of period III elements. **(6 marks)**

(c) Give reasons to support the following:

(i) When salts of iron are exposed in air they turn from blue green colour to brown.

(ii) Concentrated nitric acid renders aluminium passive.

(iii) Zinc and tin are used to protect iron from rusting. **(6 marks)**

(d) With the help of chemical equations, state the physical changes that will be observed and their inference in each of the following experiments:

(i) Sodium oxalate solution is added into potassium permanganate solution in acidic medium.

(ii) A hydrogen sulphide solution is added into potassium dichromate solution. **(6 marks)**

SECTION C

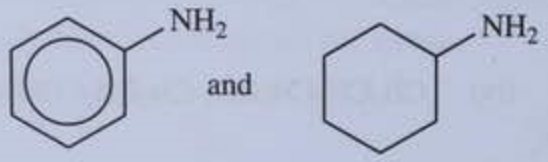
Answer at least **one (1)** question from this section.

8. (a) Briefly describe the following:
   (i) Ozone layer.
   (ii) Greenhouse effect.
   (iii) Acid rain. **(9 marks)**

   (b) With the aid of chemical equations, describe how the ozone layer is formed and depleted or destroyed. **(8 marks)**

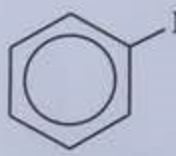
   (c) Outline six effects of ozone layer depletion. **(3 marks)**

9. (a) For the following pairs of organic compounds, briefly explain which compound in each pair is more basic than the other.
   (i)



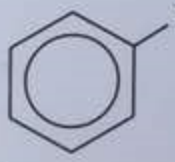
   (ii) $CH_3–NH_2$ and $CH_3–NH–CH_3$. **(4 marks)**

   (b) Give the products of the following organic reactions:
   (i) $CH_3C{\equiv}N + H_2O, H^+ \longrightarrow$
   (ii) $CH_3CH_2CONH_2 + LiAlH_4, H_2O \longrightarrow$
   (iii)



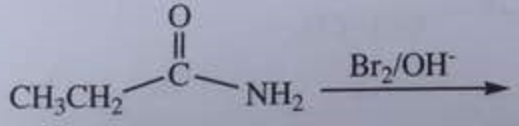
$+$ Conc. HCl, Sn $\longrightarrow$

   (iv) $CH_3CH_2NH_2 + HNO_2(aq) \longrightarrow$
   (v)



$+$ $NaNO_2$, conc. HCl $\longrightarrow$

   (vi)



(6 marks)

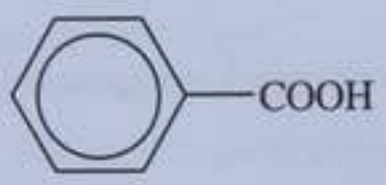
(c) Briefly describe the laboratory preparation of dimethylamine from methane. **(2 marks)**

(d) An organic compound **A** was treated with nitrous acid and yielded compound **B** and nitrogen gas was evolved. Compound **B** has a composition of 60% C, 13.33% H and 26.67% O. Compound **B** has a vapour density of 30. When compound **B** was oxidized using H_2CrO_4 it yielded compound **C**. Compound **C** forms oxime with hydroxylamine. Compound **C** also reacts with Fehling's solution to form brick red precipitate.

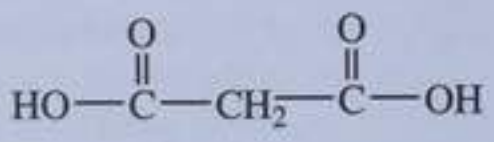
(i) Work out to suggest the structures of compounds **A**, **B** and **C**. **(6 marks)**

(ii) Give the chemical equations for the reactions mentioned. **(2 marks)**

10. (a) Name the following organic compounds:

(i) 

(ii) $CH_3-CH(CH_3)-CH_2CH_2COOH$

(iii) 

(iv) $CH_3CH_2CH(OH)\text{-}CH_2CH_2COOH$

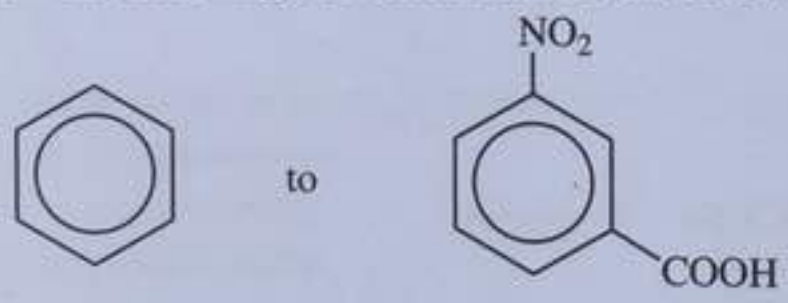
(4 marks)

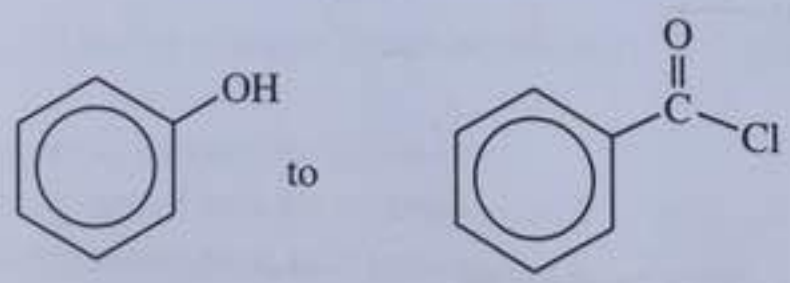
(b) What are the effects of the following on the acidity of carboxylic acids?

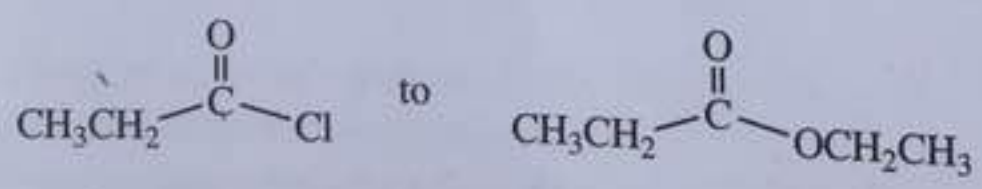
(i) Chlorine as a withdrawing atom.

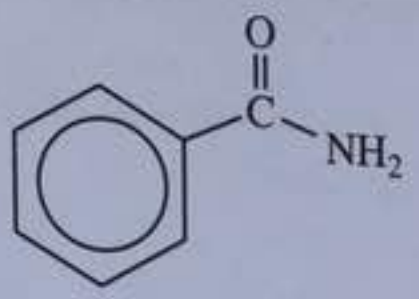
(ii) Large sized alkyl group. **(4 marks)**

(c) Show how the following conversions can be carried out:

(i) 

(ii) 

(iii) 

(iv) CH_3CH_3 to 

(7 marks)

(d) Lactic acid ($CH_3CH(OH)CO_2H$) occurs naturally in sour milk. The compound can be synthesized from ethanol by the following route:

$$CH_3CH_2OH \xrightarrow{U} CH_3CHO$$

$$CH_3CHO \xrightarrow{V} CH_3CH(OH)CN$$

$$CH_3CH(OH)CN \xrightarrow{W} CH_3CH(OH)COOH$$

(i) Give the reagents and conditions if any, for steps U, V and W above.

(ii) Give the names of the organic reactions represented by steps V and W.

(iii) Name the lactic acid by IUPAC system. **(5 marks)**