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 **Wednesday, 16th May 2018 a.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 $Cmol^{-1}$

SECTION A

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

1. (a) Define the following:
   (i) Rate of reaction.
   (ii) Rate constant.
   (iii) Reaction mechanism.
   (iv) Molecularity of reaction.
   (v) Zero order reaction.
   (vi) Half-life. **(6 marks)**

   (b) The reaction of nitric oxide with hydrogen at 1280 °C is given by the equation
   $2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$
   This reaction was studied and the following results were obtained:

Experiment	Initial [NO](M)	Initial $[H_2](M)$	Initial rate (M/s)
1	5×10^{-3}	2×10^{-3}	1.3×10^{-5}
2	10×10^{-3}	2×10^{-3}	5×10^{-5}
3	10×10^{-3}	4×10^{-3}	10×10^{-5}

   (i) Determine the order with respect to each reactant and the overall order of the reaction.
   (ii) Establish the rate law for the reaction.
   (iii) Calculate the rate constant. **(7 marks)**

   (c) The conversion of cyclopropane to propene in the gas phase is a first order reaction with a rate constant of $6.7 \times 10^{-4}\ s^{-1}$ at 500 °C.
   (i) If the initial concentration of cyclopropane is 0.25 M, what will be the concentration after 8.8 minutes?
   (ii) How long will it take for the concentration of cyclopropane to decrease from 0.25 M to 0.15 M?
   (iii) How long will it take to convert 74% of the starting material? **(7 marks)**

2. (a) (i) Briefly explain the term oxidation–reduction reaction. **(2 marks)**
   (ii) The reaction between dichromate (VI) ions and chloride ions in acidic solution yields chlorine and chromium (III) ions as shown in the following unbalanced equation:
   $Cr_2O_7^{2-}(aq) + Cl^-(aq) \rightarrow Cr^{3+}(aq) + Cl_2(g)$
   Derive the balanced half-reaction equations and overall net equation for this redox reaction. **(3 marks)**

   (b) State which of the following are oxidation-reduction reactions:
   (i) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
   (ii) $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
   (iii) $Cr_2O_7^{2-}(aq) + 2OH^-(aq) \rightarrow 2CrO_4^{2-}(aq) + H_2O(l)$
   (iv) $O_3(g) + NO(g) \rightarrow O_2(g) + NO_2(g)$ **(2 marks)**

   (c) Identify the oxidizing agent, the reducing agent, the substance being oxidized and the substance being reduced in 2(b) (i – iv). **(6 marks)**

   (d) Calculate the e.m.f. of the following cell:
   $Pb(s)/Pb^{2+}(aq)(1 \times 10^{-3}M)//Cu^{2+}(aq)(1 \times 10^{-2}\ M)/Cu(s)$
   Given the following standard reduction potentials:
   $Pb^{2+}/Pb, E^\circ = -0.126$ V; $Cu^{2+}/Cu, E^\circ = 0.34$ V **(7 marks)**

3. (a) Define the following:
   (i) Conjugate base.
   (ii) Conjugate acid.
   (iii) Conjugate acid-base pair. **(3 marks)**

   (b) Identify the acid, base and acid-base conjugates for each of the following equations:
   (i) $H_2O + HCl \longrightarrow H_3O^+ + Cl^-$
   (ii) $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$
   (iii) $CH_3COOH + H_2SO_4 \rightleftharpoons CH_3COOH_2^+ + HSO_4^-$
   (iv) $C_6H_5NH_2 + -NH_2 \rightleftharpoons C_6H_5NH^- + NH_3$ **(8 marks)**

   (c) Calculate the concentration of sodium propanoate (CH_3CH_2COONa) that must be present in a 0.01 M solution of propanoic acid (CH_3CH_2COOH) to produce a pH of 4.30 if K_a for propanoic acid is 1.3×10^{-5}. **(5 marks)**

   (d) Calculate the pH of 0.02 M acetic acid (CH_3COOH). The dissociation constant (K_a) of acetic acid is 1.8×10^{-5}. **(4 marks)**

4. (a) Write the solubility product constant (K_{sp}) expressions for the solubility equilibria of each of the following compounds:
   (i) Copper (I) bromide.
   (ii) Bismuth sulphide, (Bi_2S_3).
   (iii) Copper (II) iodate, $Cu(IO_3)_2$.
   (iv) Silver chromate, Ag_2CrO_4. **(4 marks)**

   (b) The $[Ag^+]$ of a solution is 4×10^{-3}. Calculate the $[Cl^-]$ that must be exceeded before AgCl can precipitate. The K_{sp} of AgCl is 1.0×10^{-10}. **(4 marks)**

   (c) 25 cm^3 of 0.001 M $BaCl_2$ solution were mixed with 40 cm^3 of 0.002 M Na_2SO_4 solution. Will $BaSO_4$ precipitate from this solution? Support you answer by calculation. The K_{sp} of $BaSO_4$ at 25 °C is 1.12×10^{-10} mol^2dm^{-6}. **(6 marks)**

   (d) (i) Outline four factors which affect the solubility of sparingly soluble salts.
   (ii) Calculate the solubility of AgCl in 0.20 M $AgNO_3$ solution. K_{sp} (AgCl) = 1.0×10^{-10}. **(6 marks)**

SECTION B

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

5. (a) Why hydrogen element was placed in group I in the modern periodic table? **(2 marks)**

   (b) Account for the following:
   (i) The cationic size of an element is smaller than its atomic size.
   (ii) Group I elements are called alkaline metals.
   (iii) Group II elements melt at higher temperatures than group I elements.
   (iv) Some compounds are said to be polarized. **(6 marks)**

(c) Briefly explain the following facts:
(i) Every first member of the group in the periodic table behaves anomalously from othe members.
(ii) Some elements in the periodic table show diagonal relationships.
(iii) Some elements are called d-block elements.
(iv) The compounds of Sc^{3+} are colourless. **(6 marks)**

(d) The valency shell electronic configuration of element X is represented as $6s^2 6p^3$.
(i) Give the block, group and period of element X in the periodic table.
(ii) Give the possible oxidation state of element X.
(iii) Give the formula of the oxide of X. **(6 marks)**

6. (a) Briefly describe the extraction process of tin from its chief ore. **(8 marks)**

(b) Briefly describe the chemical extraction of aluminium from its chief ore. **(12 marks)**

7. (a) (i) Classify the following oxides as amphoteric, basic or acidic: Al_2O_3, Na_2O, ZnO and CaO. **(2 marks)**

(ii) Using five examples, briefly explain the uses of sulphates of selected metals in different fields. **(5 marks)**

(b) Explain these facts with suitable equations:
(i) The aqueous solution of iron (III) chloride is acidic.
(ii) Gaseous iron (III) chloride at low temperature exists as a dimer and is a covalent compound.
(iii) Red hot iron decomposes steam reversibly.
(iv) The aqueous solution of sodium hydrogen carbonate is alkaline. **(4 marks)**

(c) Why iron (III) carbonate does not exist? **(3 marks)**

(d) With suitable examples, describe the chemistry of zinc oxide (ZnO). **(6 marks)**

SECTION C

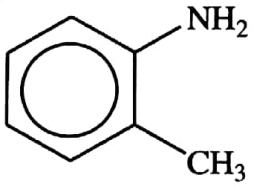
Answer at least **one (1)** question from this section.

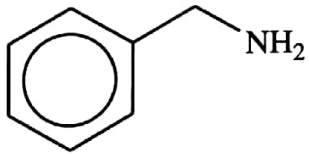
8. (a) Outline any six control measures which are useful in minimizing the chemical pollution of water bodies. **(6 marks)**

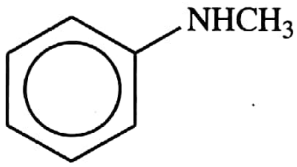
(b) Outline any four possible causes of environmental degradation. **(6 marks)**

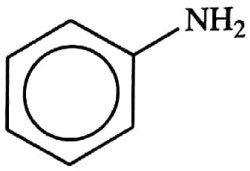
(c) Briefly explain eight effects of air pollution to living organisms. **(8 marks)**

9. (a) Giving reasons, arrange the following amines in order of increasing basic strength:









(4 marks)

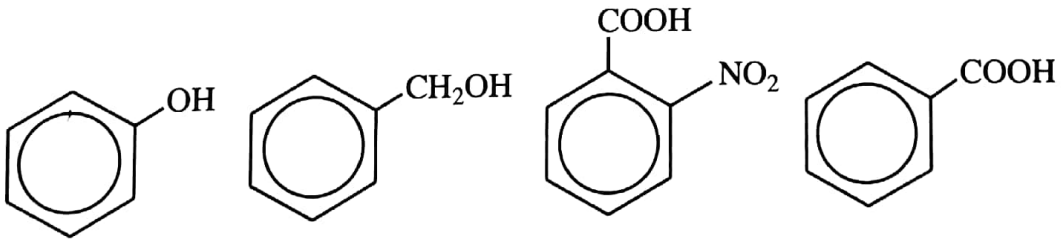
(b) Show how *n*-propylamine could be prepared from each of the following compounds:
(i) *n*-Propylbromide.
(ii) *n*-Propylalcohol.
(iii) *n*-Butylalcohol.
(iv) Propanitrile. **(8 marks)**

(c) In two steps, describe how you would convert benzene into aniline (phenylamine) **(3 marks)**

(d) Give the structures and names of the organic products formed when phenylamine reacts with the following:
(i) Ethanoic anhydride.
(ii) Aqueous bromine.
(iii) Ethanoic anhydride followed by bromine water.
(iv) Sodium nitrite and hydrochloric acid below 10 °C. **(5 marks)**

10. (a) Arrange the following compounds in the order of increasing acidic strength.

(i)

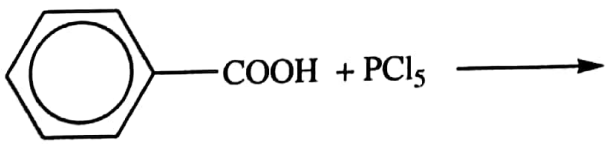


(ii) Ethanoic acid, propanoic acid, methanoic acid, 2-chloroethanoic acid and 2-methylpropanoic acid. **(4 marks)**

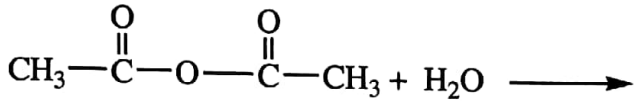
(b) Provide the major products of the following reactions:

(i) $CH_3CH_2OH + KMnO_4, H_2O, H^+ \longrightarrow$

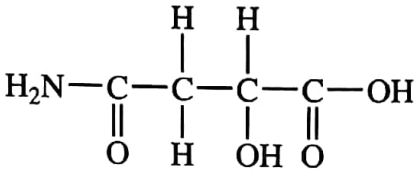
(ii)



(iii) $CH_3COOH + C_2H_5OH \xrightarrow{H^+}$

(iv)  **(6 marks)**

(c) A compound with the following structural formula was extracted from certain yellow flowers:



From your knowledge in organic chemistry, give the products that will be formed when this compound is treated with:

(i) Nitrous acid.
(ii) Ethanol.
(iii) $LiAlH_4$.
(iv) Potassium dichromate.
(v) PCl_5.

(7.5 marks)

(d) Briefly explain the uses and hazards of carboxylic acids. **(2.5 marks)**