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, 13th May, 2014 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, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ or $0.082 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$
   $\text{GMV} = 22.4 \text{ dm}^3$
   1 litre $= 1 \text{dm}^3 = 1000 \text{ cm}^3$.
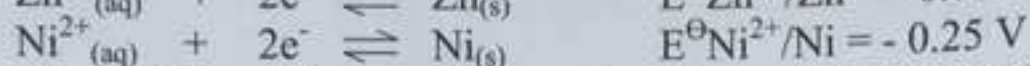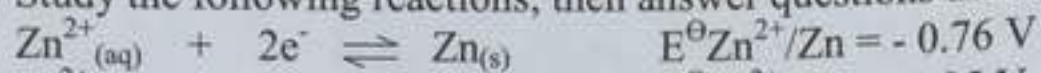   Atomic masses: $H = 1$, $N = 14$, $O = 16$, $S = 32$

SECTION A

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

1. (a) Give a brief explanation for each of the following terms:
   (i) Electrochemical series.
   (ii) Electrochemical equivalent.
   (iii) Redox series. **(8 marks)**
   (iv) Redox reaction.

   (b) Study the following reactions, then answer questions that follow:
   $$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)} \qquad E^\ominus Zn^{2+}/Zn = -0.76 \text{ V}$$
   $$Ni^{2+}_{(aq)} + 2e^- \rightleftharpoons Ni_{(s)} \qquad E^\ominus Ni^{2+}/Ni = -0.25 \text{ V}$$
   (i) Which is the feasible reaction; the reduction of Ni^{2+} by zinc or the reduction of Zn^{2+} by nickel? Give reasons.
   (ii) Write a balanced redox equation for the feasible reaction.
   (iii) Determine the cell diagram.
   (iv) Calculate the e.m.f. of the cell. **(8 marks)**

   (c) Sodium chlorate (I) is converted by heat to sodium chlorate (V) and sodium chloride according to

   the equation $3NaOCl \xrightarrow{\Delta} NaClO_3 + 2NaCl$. By using oxidation numbers show which particles in the equation have undergone
   (i) oxidation
   (ii) reduction. **(4 marks)**

2. (a) (i) Describe the term homogenous catalyst and give a typical reaction as an example to support your description.
   (ii) Dinitrogen pentaoxide decomposes to nitrogen dioxide and oxygen as shown in the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$. Write the equation to show how the rate of change of concentration of N_2O_5 is related to the rates of change of concentration of NO_2 and O_2.
   (iii) The rates of change in the concentration of reactants and products in a certain reaction are related as follows:

   $$\frac{-d[CH_4]}{dt} = -\frac{1}{2}\frac{d[O_2]}{dt} = \frac{1}{2}\frac{d[H_2O]}{dt} = \frac{d[CO_2]}{dt}.$$ Write a balanced equation for the reaction and show clearly how you obtained it. **(10 marks)**

   (b) At 25° C the rate constant of a certain reaction is 4.7×10^{-3} s^{-1} and the activation energy is 33.6 kJmol^{-1}. Determine the following:
   (i) Order of the reaction.
   (ii) Rate constant of the reaction at 75°C. **(5 marks)**

   (c) The following table contains data which were collected at 298 K for the reaction $4H_{2(g)} + 2NO_{2(g)} \rightarrow 4H_2O_{(l)} + N_{2(g)}$.

[H$_2$]	[NO$_2$]	Rate (mols^{-1})
0.6	0.37	0.18
0.6	0.74	0.72
1.2	0.74	0.72

Page 2 of 6

(i) Write down the rate expression for the reaction.
(ii) Calculate the order of reaction with respect to each reactant. (5 marks)

3. (a) Given that the dissociation constant K_a for propanoic acid is 1.35×10^{-5} mol/dm^3, calculate the pH of the following solutions:
  (i) Propanoic acid solution of molarity of 0.05 mol/dm^3.
  (ii) A solution containing 0.05 mol/dm^3 propanoic acid and 0.05 mol/dm^3 sodium propanoate. (6 marks)

  (b) For each of the following reactions write the formula of the acid and its conjugate base:
  (i) $NH_3 + HCl \rightleftharpoons NH_4^+ + Cl^-$
  (ii) $H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2NO_3^+$
  (iii) $NaNH_2 + NH_4Cl \rightleftharpoons NaCl + 2NH_3$. (6 marks)

  (c) Calculate the amount of ammonium sulphate in grams which has to be added to 500 cm^3 of 0.2 M NH_3 to yield a solution of pH = 9.35, given that Kb for $NH_3 = 1.78 \times 10^{-5}$ mol/dm^3. (5 marks)

  (d) Predict whether the following salt solutions will be acidic, basic or nearly neutral. Explain briefly your prediction.
  (i) NH_4Br (ii) $CaCl_2$ (iii) KCN (3 marks)

4. (a) Briefly explain;
  (i) Five factors that affect ionization energy of elements.
  (ii) Four causes of anomalous behaviour of the first element in a group of the periodic table.
  (iii) The cause of the diagonal relationship. (9 marks)

  (b) Give four reactions which show how beryllium of group IIA is related to aluminium in group IIIA. (8 marks)

  (c) Discuss brieflly the trends of oxides of elements of period three (3) in the periodic table. (3 marks)

SECTION B

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

5. (a) Differentiate the following terms:
  (i) Electrolytic cell and electrochemical cell.
  (ii) Molarity and molality.
  (iii) Anode and cathode.
  (iv) Positive pole and negative pole. (8 marks)

  (b) 200 cm^3 of 0.0040 M $BaCl_2$ are added to 600 cm^3 of 0.0080 M K_2SO_4. Find out whether there will be formation of a precipitate given that $K_{sp}(BaSO_4) = 1.1 \times 10^{-10}$. (6 marks)

  (c) Calculate the number of moles of silver chloride (AgCl) which will saturate 250 cm^3 of 0.0001 M sodium chloride solution, given that $K_{sp(AgCl)} = 1.6 \times 10^{-10}$ mol^{2}m^{-6}. (6 marks)

Page 3 of 6

6. (a) Explain briefly why transition elements:
   (i) have variable oxidation states
   (ii) form coloured compounds   **(6 marks)**
   (iii) exhibit magnetic properties.

(b) Give IUPAC name for each of the following compounds and state the oxidation state of the central metal atom:
   (i) $K_3[Co(NO_2)Cl_3Br_2]$
   (ii) $[Ag(NH_3)_2]^+$
   (iii) $[AuCl_4]^-$ **(8 marks)**
   (iv) $[Pd(CN)_6]^{2-}$.

(c) Consider the following reaction of the complex compound to form acidic solution:
   $$[Fe(H_2O)_6]^{3+} + 3Cl^-_{(aq)} + H_2O_{(l)} \rightleftharpoons [Fe(H_2O)_5OH]^{2+} + H^+_{(aq)} + 3Cl^-_{(aq)}$$
   (i) Name the two ligands in the complex structure on the right side of the equation above and explain how they act as ligands.
   (ii) Draw a diagram showing shape of the complex ion on the right side of the equation and name its shape.
   (iii) Explain why it is more difficult to remove a proton from $[Fe(H_2O)_5OH]^{2+}$ than from $[Fe(H_2O)_6]^{3+}$.   **(6 marks)**

7. (a) (i) What does the term froth flotation mean as used in metal extraction?
   (ii) Write down processes which occur after froth flotation of copper pyrites ($CuFeS_2$) ore from which bluster copper (impure) is obtained. Support with equation$_{(s)}$ where necessary.   **(9 marks)**

(b) Analyse the stages involved in the purification of bauxite ore and explain why it is necessary to purify before electrolysis.   **(11 marks)**
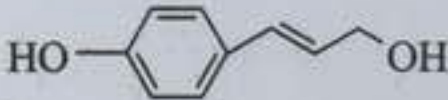
SECTION C

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

8. (a) Briefly explain six advantages and four disadvantages of using manures.   **(10 marks)**

(b) (i) Differentiate immobilization from ammonification.
   (ii) Describe how farm manure should be handled and stored.   **(6 marks)**

(c) A certain soil requires 80 kg N per hectre so as to fulfill plant requirements of nitrogen. Calculate in kilogram the quantity of ammonium sulphate fertilizer required to meet this demand.   **(4 marks)**

9. (a) Give the structural formulae of the following compounds:
   (i) Methylphenyl ether
   (ii) Methanol
   (iii) Propanone
   (iv) Methyl ethanoate
   (v) 3-phenyl-1-pentene.

              (5 marks)

(b) Give the structure and the name of the product(s) formed in the following reactions:

(i)

$$+ \quad HNO_3 \quad \xrightarrow{H_2SO_4}$$

(ii)

$$+ \quad HNO_3 \quad \xrightarrow{H_2SO_4}$$

(5 marks)
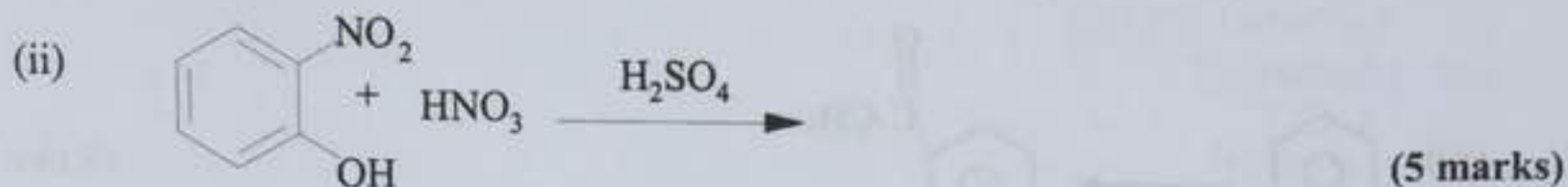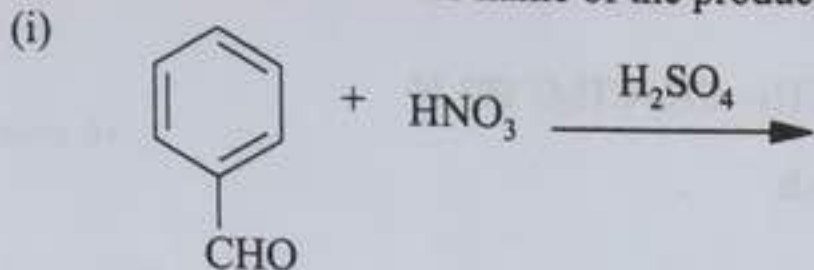
(c) Identify stronger acid among the following pairs and give reason(s) for your choice.

(i)

and

(ii)

and

(iii) $CH_2F - \overset{O}{\underset{\|}{C}} - OH$ and $CH_2Cl - \overset{O}{\underset{\|}{C}} - OH$ (6 marks)
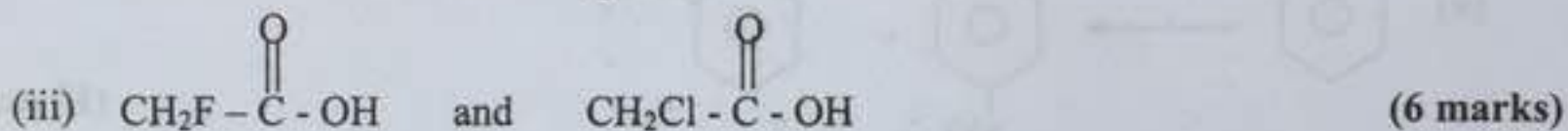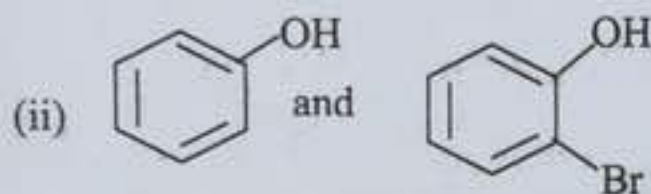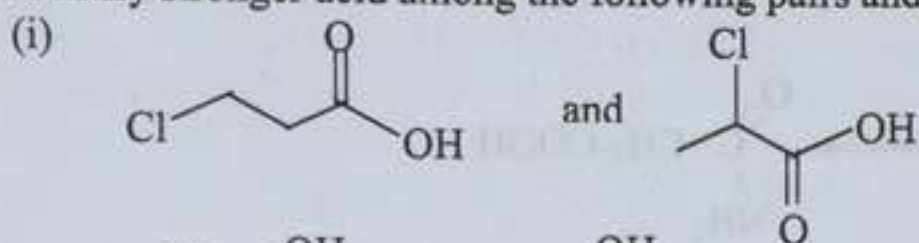
(d) Write balanced chemical equation for the reaction of $HO-\langle\rangle-\langle\rangle-OH$ with each of the following:
(i)   Sodium metal
(ii)   Dilute $KMnO_4$
(iii)   Acetic acid
(iv)   Hydrogen under finely divided nickel.   (4 marks)

10. (a) (i)   Describe aldol condensation.
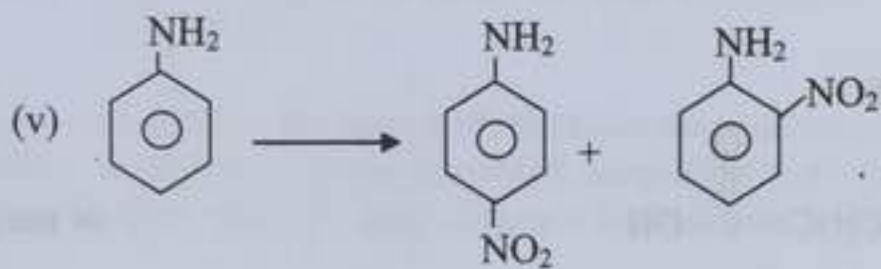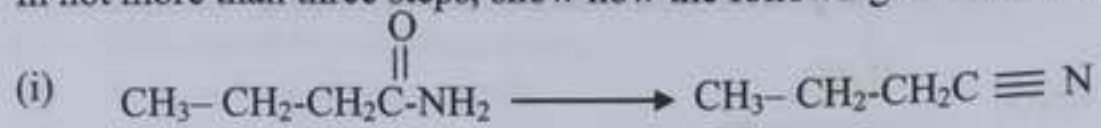(ii)   Explain why $(CH_3)_2CO$ and CH_3CHO can undergo aldol condensation, whereas $(CH_3)_3C$-CHO and $(CH_3)_3C$-CHO cannot.   (4 marks)

(b) Describe how the following molecules can be distinguished from each other:

(i) $CH_3 - \overset{O}{\underset{\|}{C}} - Cl$ and $H - \overset{O}{\underset{\|}{C}} - CH_2$-Cl

(ii)

and
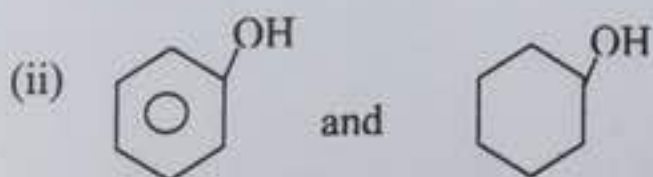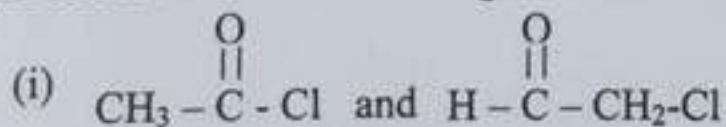
(iii) HCOOH and CH_3COOH.   (6 marks)

(c) In not more than three steps, show how the following conversions can be achieved:

(i) $CH_3-CH_2-CH_2\overset{\overset{\displaystyle O}{||}}{C}-NH_2 \longrightarrow CH_3-CH_2-CH_2C\equiv N$

(ii) $\longrightarrow$ benzene with CH(CH$_3$)$_2$ substituent

(iii) $\longrightarrow$ benzene with $\overset{\overset{\displaystyle O}{||}}{C}-CH_3$ substituent

(iv) $\overset{\displaystyle O}{\underset{\displaystyle NH_2}{\overset{\displaystyle \diagdown}{C}}}-CH_2-COO^-NH_4^+ \longrightarrow \overset{\displaystyle O}{\underset{\displaystyle NH_2}{\overset{\displaystyle \diagdown}{C}}}-CH_2-COOH$

(v)   benzene with NH$_2$ $\longrightarrow$ benzene with NH$_2$ and NO$_2$ (para) + benzene with NH$_2$ and NO$_2$ (ortho)

(10 marks)