## 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: 2 Hours 30 Minutes*                    *Thursday 14th February 2008 p.m.*

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### 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. All questions carry equal 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)

Constants:

Atomic masses K = 39, Cr = 52, O = 16, I = 127

This paper consists of 7 printed pages.

1  (a)  Define the following terms

   (i)    Half-life of a reaction

   (ii)   Rate law reaction

   (iii)  Activated complex

                                                    (04 marks)

   (b)  The decomposition of nitrogen (V) oxide at 45 °C is a first order reaction
        with a rate constant of $5.1 \times 10^{-4} S^{-1}$

        $$2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$$
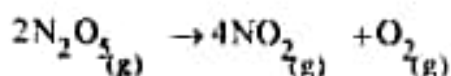
        (i)    What is the concentration of $N_2O_5$ after 192 seconds, if the initial
               concentration is $0.25$ mol $dm^{-3}$?                (02½ marks)

        (ii)   How long will it take for the concentration of $N_2O_5$ to decrease
               from $0.25$ mol $dm^{-3}$ to $0.15$ mol $dm^{-3}$?    (02½ marks)

        (iii)  How long will it take to convert 62 % of the starting material?
                                                    (04 marks)

   (c)  In the hydrolysis of ethylacetate using equal concentrations of ester and
        sodium hydroxide, the following results were obtained

        $$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$$
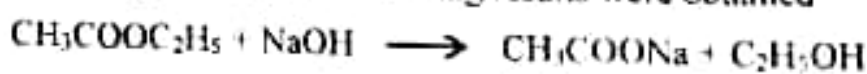
        | Time (min)            | 0     | 5     | 15    | 25    | 35    |
        |-----------------------|-------|-------|-------|-------|-------|
        | Volume of HCl ($cm^3$)| 16.00 | 10.24 | 6.18  | 4.32  | 3.41  |

        Show that the reaction is of second order

                                                    (08 marks)

2  (a)  What is the difference between solubility and solubility product?
                                                    (04 marks)

   (b)  (i)    Will a precipitate of $CaF_2$ form when 50 $cm^3$ of $5 \times 10^{-4}$M
               $Ca(NO_3)_2$ is mixed with 50 $cm^3$ of $2 \times 10^{-4}$M NaF?
               ($K_{sp}$ of $CaF_2$ is $1.7 \times 10^{-10}$)
                                                    (10 marks)

        (ii)   Comment on the solubility of $PbCl_2$ in water and in 0.1M lead
               nitrate solution
                                                    (02 marks)

   (c)  Giving an example in each case explain what is meant by

        (i)    Bronsted – Lowry concept of an acid and base.

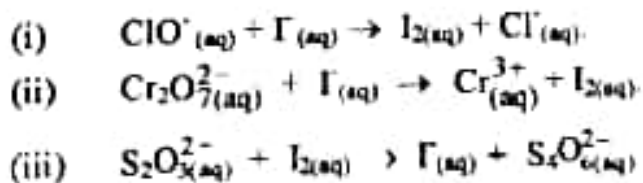                                2                                        AC

3. (a) Define the following terms
    (ii) Lewis acid **(04 marks)**
    (i) Enthalpy of solution
    (ii) Standard heat of vaporisation
    (iii) Standard enthalpy of atomisation
    (iv) Dissociation energy
    **(08 marks)**

(b) State Hess's law of heat summation. **(02 marks)**

(c) The combustion of carbon disulphide is exothermic and the enthalpy of combustion of the compound is 1108kJ mol$^{-1}$. Given that carbon dioxide and sulphur dioxide are exothermic compounds with enthalpies of formation of 405 and 293 kJmol$^{-1}$, respectively,

   (i) calculate the enthalpy of formation of carbon disulphide.

   (ii) comment on the stability of this compound at various temperatures considering the result obtained in the light of Le Chatelier's principle.
   **(10 marks)**

4. (a) (i) Define oxidation and reduction in terms of current flow.
   **(02 marks)**

   (ii) Write the oxidation state of sulphur and carbon in the following radicals

   $$S_4O_6^{2-} \text{ and } C_2O_4^{2-}$$ **(02 marks)**

(b) Balance the following reactions which take place in acidic solutions.

   (i) $ClO^-_{(aq)} + I^-_{(aq)} \rightarrow I_{2(aq)} + Cl^-_{(aq)}$

   (ii) $Cr_2O_7^{2-}{}_{(aq)} + I^-_{(aq)} \rightarrow Cr^{3+}_{(aq)} + I_{2(aq)}$

   (iii) $S_2O_{3(aq)}^{2-} + I_{2(aq)} \rightarrow I^-_{(aq)} + S_4O_{6(aq)}^{2-}$

   **(06 marks)**

(c) A standard solution made by dissolving 1.015 g of potassium dichromate (VI) is made up to 250 cm$^3$. A 25.00 cm$^3$ portion is added to an excess of potassium iodide and dilute sulphuric acid. The iodine liberated required 19.20 cm$^3$ of sodium thiosulphate.

The reaction equation between thiosulphate and iodine is given by:

$$S_2O_{3(aq)}^{2-} + I_{2(aq)} \rightarrow I^-_{(aq)} + S_4O_{6(aq)}^{2-}$$
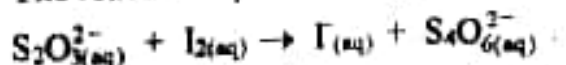
Find the concentration of the thiosulphate solution in moles per litre. **(10 marks)**

AC.80

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5.  (a) (i)  Give five (5) anomalies (peculiar) properties of nitrogen

    (ii)  Although $NH_3$ and phosphine are hydrides of group five $NH_3$ is a Lewis base while phosphine is not. Give reasons for such state
    
    (08 marks)

    (b)  Explain the following

    (i)  $SiCl_4$ hydrolyses in water but not $CCl_4$

    (ii)  When $SO_2$ is bubbled through acidified aqueous solution of $K_2Cr_2O_7$ the yellow colour of the latter turns green (use chemical equation for illustration)

    (iii)  Hardwater forms leather with soapless detergents but not with soapy detergents

    (iv)  Silver chloride salt is insoluble in water but readily soluble in aqueous ammonia.

    (v)  The boiling point of water is higher than that of $H_2S$ although the molar mass of $H_2S$ is larger than that of the water.

    (vi)  Although $HNO_3$ is an oxidizing agent, it is transported by using containers made of Aluminium.

    (12 marks)

6.  (a)  Explain briefly and concisely the following properties of transition elements, ions or molecules.

    (i)  Magnetism.

    (ii)  Coloured compound formation.

    (16 marks)

    (b)  (i)  Explain the form of the d-orbital splitting diagram for trigonal bipyramidal complexes of formular $ML_5$ and square pyramidal complexes of formula $ML_5$.

    (ii)  What would be the expected magnetic properties of such complexes of Ni (II)?

    (04 marks)

7.  (a)  Write the IUPAC names of the following complex compounds

    (i)  $[Ag(NH_3)_2]_4 [Fe(CN)_6]$

    (ii)  $[Pt (NH_3)_3 C_2O_4Cl] Cl$.

    (iii)  $K [Au(CN)_2]$

    (iv)  $NaVO_3$

    (08 marks)

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**(b)** Give explanations of the following (use chemical equations where necessary)

(i) Aluminium metal does not react with hot water or steam

(ii) $F_2$ and $Cl_2$ exit as gases, $Br_2$ exist in the liquid form while $I_2$ exist as solid

(iii) A solution of ammonium chloride has the pH less than seven

(iv) Lithium carbonate is easily decomposed thermally compared with sodium carbonate

(v) Sodium metal is very soft compared with magnesium metal.

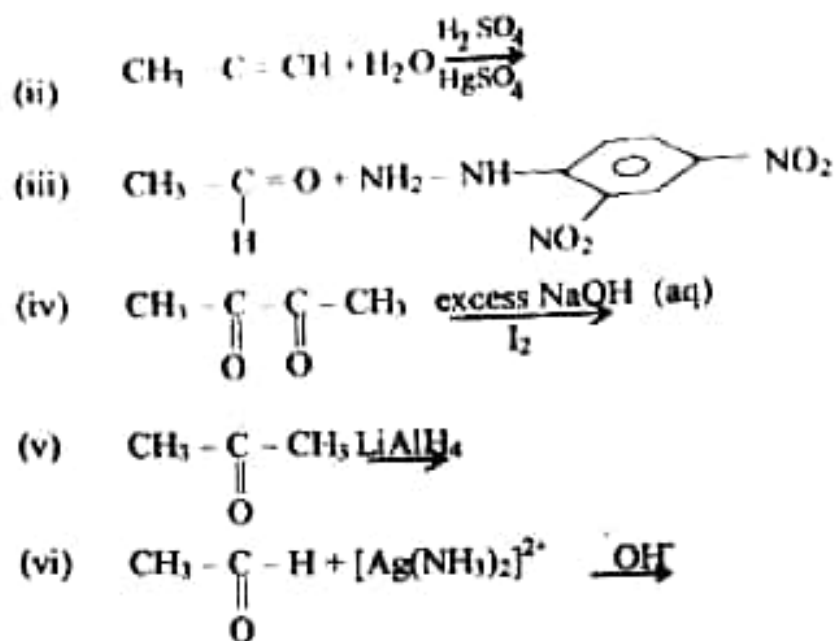(vi) Silicon tetrachloride ($SiCl_4$) can be hydrolyzed by water, but carbon tetrachloride ($CCl_4$) cannot.

(12 marks)

## SECTION C

**8** **(a)** Show how ethanol reacts with:

(i) a mixture of amalgamated zinc (Zn/Hg) and concentrated hydrocholoric acid

(ii) hydroxylamine ($H_2N$-OH)

(iii) sodium hydrogen sulphite ($NaHSO_3$)

(06 marks)

**(b)** Two compounds A and B, all carbonyl compounds, have the same molecular formular, $C_3H_6O$

(i) Draw possible structural formulae for A and B

(ii) Describe tests (reagents, conditions and observations with each compound) that would show that A and B are carbonyl compounds.

(iii) Suggest the class of another compound having the same molecular formula that is not a carbonyl compound. What type of isomerism does it exhibit with respect to the above two compounds i.e A and B?

(08 marks)

**(c)** Complete the following equations by giving the structural formulae of the products of the reaction. Assume that the reaction proceeds to completion.

(i) $CH_3 - C = O + CH_3 - MgCl$ $\xrightarrow{\text{Hydrolysis}}$

$\qquad \qquad |$

$\qquad \quad CH_3$

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(ii) $CH_3 - C \equiv CH + H_2O \xrightarrow[HgSO_4]{H_2SO_4}$

(iii) $CH_3 - \underset{H}{C} = O + NH_2 - NH - \underset{NO_2}{\underset{|}{\bigcirc}} - NO_2$

(iv) $CH_3 - \underset{\underset{O}{\|}}{C} - \underset{\underset{O}{\|}}{C} - CH_3 \xrightarrow[I_2]{excess\ NaOH\ (aq)}$

(v) $CH_3 - \underset{\underset{O}{\|}}{C} - CH_3 \xrightarrow{LiAlH_4}$

(vi) $CH_3 - \underset{\underset{O}{\|}}{C} - H + [Ag(NH_3)_2]^{2+}\ \underline{OH}$

(06 marks)

9. (a) (i) Define the term dissociation constant of ethanoic acid in aqueous solution.

(ii) Give a detailed account of the effect of substituents on the acidity of alphatic carboxylic acid.

(iii) Under what conditions is the pH of an aqueous solution of an acid equal to the pKa of the acid?

(06 marks)

(b) Show how you would attempt the following transformation
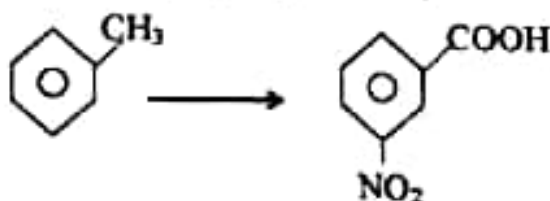


(04 marks)

(c) An aromatic carboxylic acid A (Mr = 166) contains 57.83 % of carbon, 3.64 % of hydrogen and 38.53 % of oxygen by mass.

(i) Calculate the molecular formula of A.
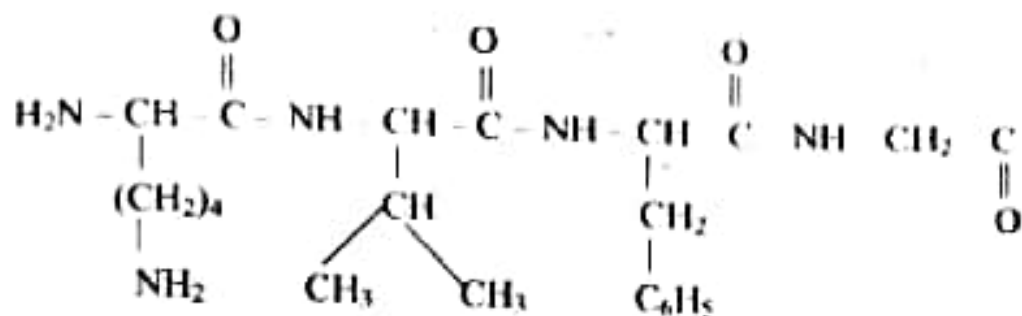
(ii) Draw three possible structures of the acid.

(10 marks)

10. (a) Define the following terms and give one example in each case.

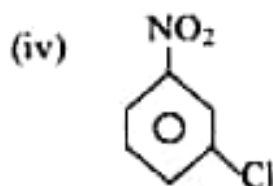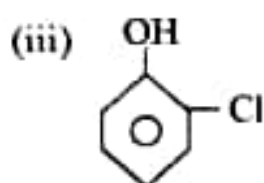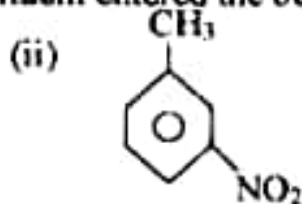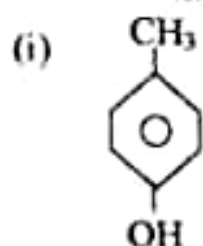(i) Condensation polymerisation.

(ii) Addition polymensation.

(04 marks)

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**(b)** The structure drawn below represents a polymer



$$H_2N - CH - \overset{\overset{\displaystyle O}{\|}}{C} - NH - CH - \overset{\overset{\displaystyle O}{\|}}{C} - NH - CH - C - NH - CH_2 - \overset{\overset{\displaystyle O}{\|}}{C}$$

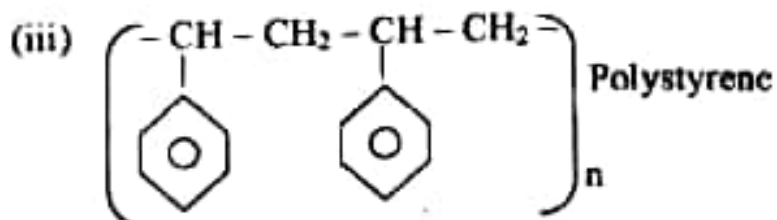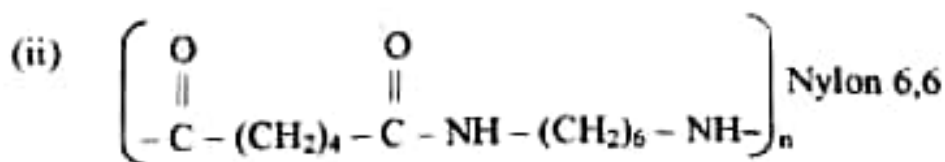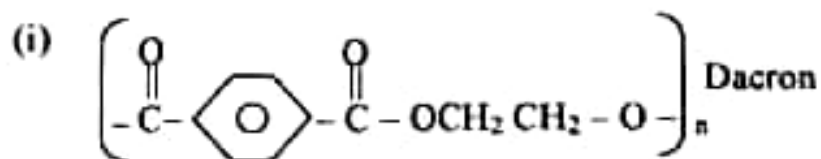with side groups: $(CH_2)_4$, $NH_2$; $CH$ with $CH_3$, $CH_3$; $CH_2$, $C_6H_5$

(i)    Name two classes of compounds to which the large molecule could belong

(ii)    If the compound is hydrolysed by boiling with hydrochloric acid, four smaller molecules would be formed from the structure drawn above. Draw the structural formula of each of these molecules

**(06 marks)**

**(c)** Which of the following substituent entered the benzene ring first?

(i)    $CH_3$ / $OH$ substituted benzene

(ii)    $CH_3$ / $NO_2$ substituted benzene

(iii)    $OH$ / $Cl$ substituted benzene

(iv)    $NO_2$ / $Cl$ substituted benzene

**(04 marks)**

**(b)** Write the complete structures of the monomers which were used to prepare each of the following polymerization reaction.

(i)
$$\left[ -\overset{\overset{\displaystyle O}{\|}}{C} - \langle O \rangle - \overset{\overset{\displaystyle O}{\|}}{C} - OCH_2\ CH_2 - O - \right]_n \quad \text{Dacron}$$

(ii)
$$\left[ -\overset{\overset{\displaystyle O}{\|}}{C} - (CH_2)_4 - \overset{\overset{\displaystyle O}{\|}}{C} - NH - (CH_2)_6 - NH- \right]_n \quad \text{Nylon 6,6}$$

(iii)
$$\left[ -CH - CH_2 - CH - CH_2 - \right]_n \quad \text{Polystyrene}$$

**(06 marks)**

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