P525/2

CHEMISTRY

PAPER 2

JULY/AUG 2022

2 ½ HOURS

ASSHU MBARARA JOINT MOCK EXAMINATIONS 2022

Uganda Advanced Certificate of Education

CHEMISTRY

PAPER 2

2 HOURS 30MINUTES

INSTRUCTIONS TO CANDIDATES

- *Answer **five** questions including three questions from section **A** and any **two** questions from section **B***
- *Write the answers in the answer booklet(s) provided*
- *Begin **each** question on a fresh page of the answer booklet.*
- *Illustrate your answers with equation where necessary.*
- *Mathematical tables and squared papers are provided*
- *Silent non programmable scientific electronic calculators may be used.*
- *Where necessary* use the following; C=12, H= 1, O= 16.

SECTION A (60 MARKS)

Answer three questions from this section. Any additional question answered will <u>not</u> be marked

1. An organic compound T contains 80.00% of carbon, 6.67% of hydrogen and the rest being oxygen.

   (a) Calculate the empirical formula of T (2 mks)

   (b) T was steam distilled at 91°C and standard pressure, and the distillate was found to contain 55.9% by mass of T. (The vapour pressure of water at 91°C is 0.84 atmospheres)

   Determine the molecular formula of T. (3 mks)

   (c) T burns with a sooty flame and forms an orange precipitate with 2,4-dinitrophenyl hydrazine solution

   (i) Name the functional group present in T (½ mk)

   (ii) Write the structural formulae and IUPAC names of all isomers of T. (3 mks)

   (d) When T was treated with a solution of silver nitrate in excess ammonia solution. There was no observable change. Identify T. (½ mks)

   (e) Write the mechanism for the reaction between T and

   (i) Saturated sodium hydrogen sulphite solution. (3 mks)

   (ii) 2 – nitro phenyl hydrazine in acidic medium (4 mks)

   (f) Describe how compound T can be converted to poly(phenylethene) (4 mks)

   (Equations are **<u>not</u>** required)

2.(a) Define the terms

(i) activation energy (1 mk)

(ii) order of reaction (1 mk)

(b) Ethanol decomposes thermally to form methane and carbon monoxide according to the following equation.

$CH_3CHO(g) \rightleftharpoons CH_4(g) + CO(g)$

Calculate the standard enthalpy of decomposition of ethanol. (The standard enthalpies of combustion of ethanol, methane and carbon monoxide are -1187, -884 and -283.5 $KJmol^{-1}$ respectively) (3 mks)

(c) The activation energy for the catalyzed and unanalyzed decomposition of ethanol are 136 and 190 $KJmol^{-1}$ respectively.

(i) Draw the reaction profiles using the same axes for the catalyzed and uncatalysed reactions. (4 mks)

(ii) Explain the effect of a catalyst on the rate of decomposition of ethanol. (1 mk)

(d) The table below shows the rates of decomposition of ethanol at different concentrations.

Concentration , C ($moldm^{-3}$)	0.20	0.30	0.40	0.50
Rate ($moldm^{-3}S^{-1}$)	$1.5x10^{-3}$	$3.37x10^{-3}$	$5.98\ x10^{-3}$	$9.35\ x10^{-3}$

(i) Plot a graph of rate of decomposition against square of concentration (3 ½ mks)

(ii) Deduce the order of reaction (1 ½ mks)

(iii) Write the rate equation and hence calculate the rate constant for the decomposition of ethanol. (3 mks)

(e) Explain what happens to the rate of decomposition of ethanol when the concentration of ethanol is tripled. (2 mks)

3. The contact process involves catalytic oxidation of sulphur dioxide according to the following equation $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

(a) Name;

(i) One source of sulphur dioxide and one source of oxygen for use in the contact process. (1 mk)

(ii) The catalyst used in the contact process. (½ mk)

(b) Into a one litre vessel, sulphurdioxide and oxygen were mixed in a molar ratio 2:1 at different temperatures. At equilibrium the percentage of sulphurtrioxide in the mixture of gases was 64.7% at 732°C and 56.0% at 856 °C.

(i) Calculate the values of equilibrium constant, Kc at 732°C and 856°C. (6 ½ mks)

(ii) Explain whether oxidation of sulphurdioxide to sulphur trioxide is endothermic or exothermic reaction. (2 mks)

(c) Write equation to show how sulphur trioxide is converted o sulphuric acid, (3 mks)

(d) Describe the reactions of sulphuric acid and

(i) Ammonium iodide (2 mks)

(ii) Calcium phosphate (2 mks)

(e) Describe how a named detergent can be prepared from sulphuric acid (3 mks)

4.(a) Describe how sodium hydroxide is prepared on a large scale. (5 mks)

(b) Discuss the reactions of sodium hydroxide with;

(i) Fluorine (4 mks)

(ii) Silicon (iv) oxide (2 mks)

(iii) Chromium (2 mks)

(c) Explain the reactions that take place when sodium hydroxide solution is added drop wise until in excess to a solution containing;

(i) Aluminium ions (4 mks)

(ii) Manganese (II) ions (3 mks)

SECTION B (40 MARKS)

Answer two questions from this section .any additional questions answered will not be marked.

5.(a) State Kohlrauch's law of independent migration of ions. (1 mk)

(b) At 298K, a solution containing 5.3g per litre of anhydrous nickel (II) ethanoate, $(CH_3COO)_2Ni$ has an electrolytic conductivity f 5.43×10^{-3} $\Omega^{-1}cm^{-1}$.

Determine the

(i) Molar conductivity of nickel (II) ethanoate solution (Ni = 58.7, C= 12, H = 1, O= 16) (3 mks)

(ii) Molar conductivity of ethanoate ions in the solution. (The molar conductivity of nickel (II) ion is 99.2 $\Omega^{-1}cm^2mol^{-1}$) (2 mks)

(c) The table below shows the molar conductivity of nickel (II) ethanoate at different square roots of concentration, $\sqrt{c}$.

$\sqrt{c}$ (mol ^{½} dm $^{-3/2}$)	0.1	0.2	0.3	0.4	0.5	0.6
λ ($\Omega^{-1}cm^2mol^{-1}$)	162	142	121	100	80	60

(i) Plot a graph of molar conductivity, λ against square root of concentration.$\sqrt{C}$ (3mks)

(ii) Explain the shape of the graph you have drawn. (2 ½ mks)

(iii) From the graph , determine the molar conductivity of nickel (II) ethanoate at infinite dilution (1 mk)

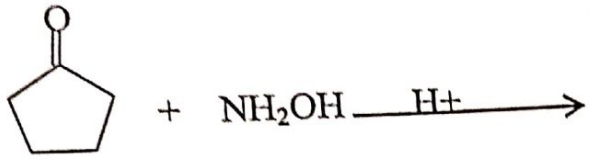
(d) Given that the molar conductivities of hydrochloric acid and nickel (II) chloride at infinite dilution are 426.2 and 252.0$\Omega^{-1}cm^2mol^{-1}$. (2 ½ mks)

(i) Molar conductivity of ethanoic acid at infinite dilution (2 ½ MKS)

(ii) Ionisation constant Ka of 0.01M ethanoic acid (The molar conductivity of 0.01M ethanoic acid is 16.3 $\Omega^{-1}cm^2mol^{-1}$) (3 mks)

(iii) pH of 0.01M ethanoic acid solution (2 mks)

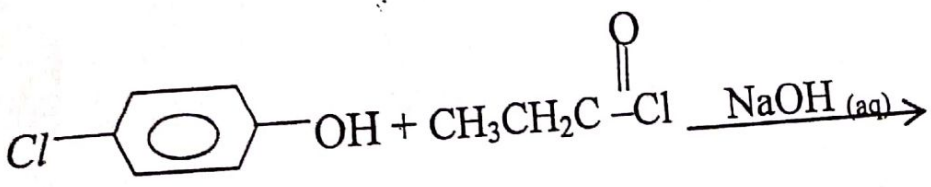
6. Complete each of the following reaction equations and in each case. Write a mechanism for the reaction.

(a)  (5 mks)

(b) $CH_3CH_2\underset{\displaystyle Cl}{\overset{|}{C}}(CH_3)_2 \xrightarrow[\text{Heat}]{CH_3^-ONa^+/CH_3OH}$ (3 mks)

(c)  $+ \text{Conc } HNO_3 \xrightarrow[\text{Heat}]{\text{conc.}H_2SO_4}$ (4 mks)

(d) $CH_3\underset{\displaystyle OH}{\overset{|}{C}}HCH_2CH_3 \xrightarrow[\text{Heat}]{\text{conc.}H_3PO_4}$ (4 mks)

(e)  (4 mks)

7.(a) The atomic numbers of calcium and ion are 20 and 26 respectively. Write the electronic configuration of the atom of each element.

(1 mk)

(b) The melting points of calcium and iron are 842°c and 1538°c respectively. Explain the difference in melting points. (2 mks)

(c) (i) State three properties in which iron differs from calcium.

(1 ½ mks)

(ii) Describe the reactions that take place during extraction of iron from spathic iron ore. (6 mks)

(d) Discuss the reactions of iron with

(i) Water (2 mks)

(ii) Sulphuric acid (4 mks)

(e) The rusting of iron is an electro-chemical process which takes place in presence of moist air. Explain the chemical reactions that take place during rusting of iron.

(2 ½ mks)

8. Explain each of the following observations and illustrate your answer with equations where necessary.

(a) Magnesium carbonate decomposes when heated while sodium carbonate does not decompose.

(4 mks)

(b) An aqueous solution of phenol is acidic to litmus while an aqueous solution of ethanol is neutral to litmus.

(4 mks)

(c) When excess chlorine is bubbled through sodium thiosulphate solution, followed by barium chloride solution a white precipitate is formed.

(4 mks)

(d) 2-methylpropene reacts with bromine water to form 1-bromo-2-methylpropan-2-*ol* as a major product instead of 1, 2-dibromo-2-methylpropane

(5 mks)

(e) When carbon dioxide gas was bubbled through an aqueous solution potassium manganate (VI), the green solution turned purple and black precipitate was formed.

(3 mks)

END