P525/2
CHEMISTRY
Paper 2
July/August 2009
2 ½ Hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY
Paper 2
2 hours 30 minutes

INSTRUCTIONS:

- *Answer **five** questions, including **three** questions from section A and **two** questions from Section **B**.*
- *Begin each question on a fresh page.*
- *Mathematical tables and graph papers are provided.*
- *Non programmable scientific calculators may be used.*

(Where applicable, Sn = 45, Na = 23, H = 1, C = 12, Cr = 52, Cl = 35.5, O = 16)

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SECTION A

Answer any **three** questions from this section.

1. (a) Distinguish between the terms **transition element** and **d-block element** (2marks)

(b) Scandium and Zinc are not typical transition elements.

(i) Write the electronic configuration of Scandium and Zinc. (1 mark)

(Atomic number for Scandium and Zinc are 21 and 30 respectively).

(ii) State three properties in which Scandium and Zinc differ from typical transition elements. (3 marks)

(c) A hydrated compound of chromium contains 19.51% by mass of chromium, 39.96% chlorine.

(i) Calculate the empirical formula of the compound. (1½ mark)

(ii) Determine the molecular formula of the compound if its molecular mass is 266.5. (1½ mark)

(iii) Write the formula of all the possible isomers of the compound. (3 marks)

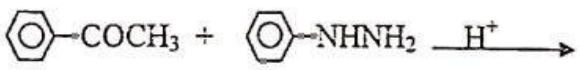
(iv) State the number of moles of silver chloride precipitated when excess silver nitrate solution is added to 0.1 mole of each of the isomer. (1 ½ mark)

(d) (i) An aqueous solution of the compound in (c) has a pH less than 7. Explain this observation. (4marks)

(ii) Sodium hydroxide solution was added to the solution in d (i), state what was observed. (2 marks)

2. (a) Complete each of the following equations and in each case suggest a mechanism for the reaction.

(i) $(CH_3)_3C\text{-}Br + CH_3CH_2\bar{O}Na^+ \xrightarrow{CH_3CH_2OH}$ (3 marks)

(ii)  (5 marks)

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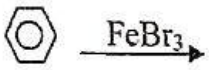
(iii) CH_3COBr +  (4 marks)

(b) The molecular formula of an aromatic compound Q is C_8H_8O.

(i) Write the structural formula of all the possible isomers of Q. (3 marks)

(ii) Name a reagent other than ammoniacal silver nitrate which can be used to distinguish between the isomers and state what is observed when each compound is reacted with the reagent. (3 marks)

(iii) When one of the isomers was reacted with ammoniacal silver nitrate, there was no observable change. Write equation(s) to show how the isomer can be prepared from benzene. (2 marks)

3. (a) In aqueous solution the manganate(VI) ion undergoes disproportionation reaction.

(i) Define the term **disproportionation reaction**. (1 mark)

(ii) Write an equation for the disproportionation of the manganate(VI) ion. (1 ½ mark)

(iii) State the oxidation state of manganese in each species in the product. (2 marks)

(b) 3.8g of solder containing tin was dissolved in excess hydrochloric acid and the solution was made up to 250 cm^3 of solution. 25.0cm^3 of this solution required 23.5cm^3 of 0.01M potassium dichromate(VI) solution.

(i) Write an equation for potassium dichromate(VI) acting as an oxidant. (1 ½ marks)

(ii) Determine the mass of tin in 3.8g of solder. (6 ½ marks)

(c) State what would be observed and write equations for the reactions which takes place when dilute sodium hydroxide is added drop wise until in excess to (7 ½ marks)

(i) Mn^{2+} (aq)

(ii) Ni^{2+} (aq)

(iii) Sn^{4+} (aq)

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(ii) Write the structure of the polymer and its monomer in c (i) above. (2 mark)

(iii) State one use of the polymer in c (i) above. (1 mark)

7. (a) Propanoic acid is a weak acid, Ka = 1.22×10^{-5} moldm^{-3}.

(i) Write an equation for the ionization of propanoic acid. (1 ½ marks)

(ii) Calculate the pH of a 0.01M solution of propanoic acid. (3 marks)

(b) Define the term **buffer solution.** (2marks)

(ii) Explain how a solution of ethanoic acid and sodium ethanoate acts as a buffer. (5 marks)

(iii) A solution was made by dissolving 7.2g of ethanoic acid and 12.0g of sodium ethanoate to make 1 litre of solution. To the solution was added 0.8cm^3 of 1M hydrochloric acid. Calculate the pH of the solution. State any assumptions you make. (6 marks)

(c) The boiling point of trimethylamine is less than that of dimethylamine. Explain this observation. (2 ½ marks)

8. (a) Discuss the similarities in the chemistry of chromium and lead. Include

(i) reactions leading to formation of complexes.

(ii) reactions with aqueous sodium hydroxide. (10 marks)

(b) The elements fluorine, chlorine and bromine belong to group(VII) of the Periodic Table. Discuss

(i) The disproportionation reactions of the elements.

(i) The oxidizing properties of the acids of the elements. (10 marks)

END

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Turn Over

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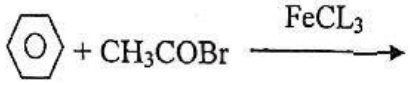
SECTION A

1. a) State four properties in which fluorine differs from iodine. (4 marks)

   b) State the conditions and write equations for the reaction between sodium hydroxide and:
   i) Fluorine (5marks)
   ii) Iodine (5marks)

   c) Compare the oxidizing powers of fluorine and iodine using their reactions with water (6 marks)

2. Complete the following equations and in each case outline a mechanism for the reaction.

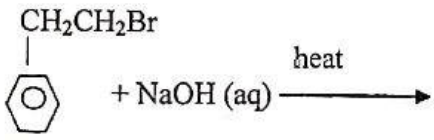
   a)  (4 marks)

   b) $CH_3\overset{\overset{O}{\|}}{C} - CH_3 + H_2NNHCONH_2 \xrightarrow{H^+} \ldots\ldots\ldots\ldots$ (5 marks)

   c) $CH_3CH_2CHO + HSO_3^-Na^+ \longrightarrow \ldots\ldots\ldots\ldots$ ($2\frac{1}{2}$ marks)

   d) $(CH_3)_{3CBr} + CH_3CH_2O^-Na^+ \xrightarrow[\text{Heat}]{CH_3CH_2OH} \ldots\ldots\ldots\ldots$ (3 marks)

   e) $CH_3CH_2OH + \text{Conc. } H_2SO_4 \xrightarrow{140^0C} \ldots\ldots\ldots\ldots$ ($3\frac{1}{2}$ marks)

   f)  (2 marks)

3. a) Explain what is meant by the term ideal solution. (3 mark)

   b) At atmospheric pressure, hydrochloric acid and water form a constant boiling point mixture having a boiling point of 110^0C and composition 20% by mass of hydrochloric acid.
   i) Define the term constant boiling point mixture. (2 marks)

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ii) Sketch a labeled diagram for hydrochloric acid and water system.[The boiling points of water and hydrochloric acid are 100^0C and 85^0C respectively] (3 marks)

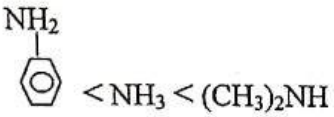
iii) Describe what would happen if a mixture of 10% hydrochloric acid is fractionally distilled. (3 marks)

c) A constant boiling point mixture of hydrochloric acid and water has a density of 1.18 gcm^{-3}. Calculate the volume of the acid required to prepare one litre of 2M hydrochloric acid solution. (3 marks)

d) The vapor pressure of ethanol at 20^0C is 43.6 mmHg while that of benzene is 75.2 mm Hg at the same temperature. The mole fraction of benzene is 0.09 for a mixture of benzene and ethanol at 20^0C.
Calculate:
i) The vapour pressure of the mixture. (4 marks)
ii) The mole fraction of benzene in the vapour phase (2 marks)

4. Explain the following observations.

a) The basic strengths of amino benzene' ammonia and dimethylamine are in the order:



$< NH_3 < (CH_3)_2NH$ (4 marks)

b) The tendency of group II elements to form complex ions is in the order;
Be > Mg > Ca > Ba. (4 marks)

c) The bond angle in water molecule is 104^0 where as that in a molecule of ammonia is 107^0. (4 marks)

d) The acid dissociation constant, Ka of bromoethanoic acid is greater than that of ethanoic acid at the same temperature. (4 marks)

e) Ammonia boils at -33^0C, Whereas phosphine boils at -88^0C (4 marks)

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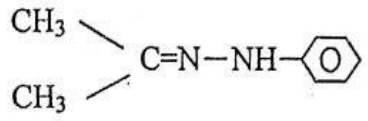
SECTION B

5. a) Draw sketch graph to show the change in pH when a 0.1 M solution of sodium hydroxide is added in portions to:
   i) $20cm^3$ of 0.1M hydrochloric acid (2 mark)
   ii) $20\ cm^3$ of 0.1 M ethanoic acid (2mark)

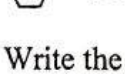
   b) Explain the shapes of the curves in (a) (13marks)

   c) $20cm^3$ of a 0.1 M sodium hydroxide solution was added to $100\ cm^3$ of 0.1 M ethanoic acid. Calculate the pH of the resultant solution.
   (Ka for ethanoic acid is 1.75×10^{-5} mol dm^{-3}] (3 marks)

6. Write equations to show how the following compounds can be synthesized.
   a)  from propene
   (5 marks)

   b) $CH_3CH_2C \equiv CH$ from ethanol (7 marks)

   c) $CH_3CO_2CH_3$ from bromoethane. ($4^1/_2$marks)

   d)  from benzene. ($3^1/_2$marks)

7. a) Write the electronic configuration and the principal oxidation states of chromium. ($2^1/_2$ marks)

   b) State three properties of chromium that show that it is a typical transition element. (3 marks)

   c) The molecular formula of chromium (iii) chloride-6-water is $CrCl_3.6H_20$.
   i) Write the formulae of all the isomers of this compound. (2 marks)
   ii) Describe briefly an experiment that can be carried out to identify the isomers given in (c) (i). (6 marks)

   d) State what is observed and write an equation for the reaction which takes place when hydrogen sulphide is bubbled into an aqueous solution of acidified potassium dichromate (vi). (3 marks)

   e) Aqueous chromium (iii) sulphate was added to a solution of sodium carbonate.
   i) State what was observed ($1^1/_2$ marks)
   ii) Write equations for the reactions which took place. (2 marks)

8. Explain each of the following observations

   a) Phenol is more acidic than phenylmethanol. (4 marks)

   b) Ammonia forms a white precipitate with aqueous manganese (ii) ions, but in the presence of ammonium chloride, no precipitate is formed. (5 marks)

   c) When sodium hydroxide solution is added drop wise to a solution, a green precipitate is formed, that dissolves to form a deep green solution. On addition of hydrogen peroxide, the solution turns from green to yellow. (6marks)

   d) The boiling points of the hydrides of group IV are in the order:
   $CH_4 < SiH_4 < GeH_4 < SnH_4$ whereas the boiling points of the hydrides of group VII are in the order HF> HCL< HBr < HI. (5marks)

END

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SECTION A

Answer any three questions from this section.

1. a) i) Define the term **standard electrode potential.** *(2 marks)*

ii) Describe how the standard electrode potential of a zinc electrode can be determined (*Diagram not required*) *(6 marks)*

b) The standard electrode potentials for some systems are given below.

Electrode	E° /V
$Mn^{3+}(aq) / Mn^{2+}(aq)$	+1.5
$V^{3+}(aq)/V^{2+}(aq)$	−0.26

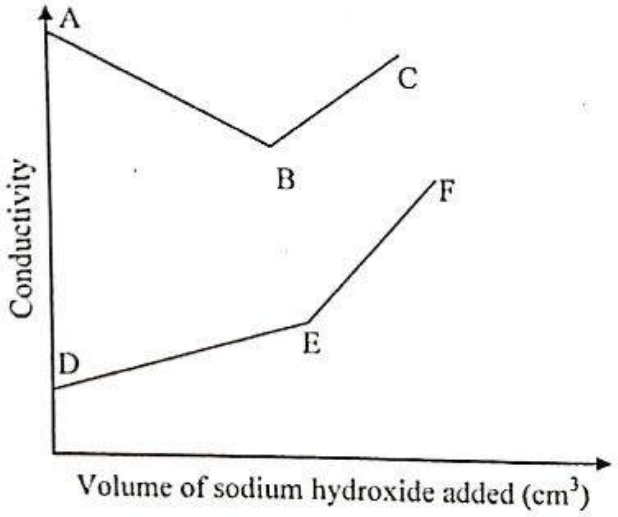
i) Write the convention for the cell formed by coupling the electrodes. *(2 marks)*

ii) Write an equation for the cell reaction. *(2 marks)*

iii) Calculate the emf of the cell formed. *(1 mark)*

iv) What deduction can you draw from your value in b) iii) above? *(1 mark)*

c) Graph ABC and DEF below show the variation of conductivities when equal volumes of 0.1m hydrochloric acid and 0.1M ethanoic acid are titrated separately with 1M sodium hydroxide solution.



i) Identify the graph for hydrochroric acid and that of ethanoic acid *(1 mark)*

ii) Explain the shapes of the graphs *(7 marks)*

2. a) i) Explain what is meant by the term **ideal solution.** *(2 marks)*

ii) Calculate the vapour pressure of a solution containing 50 g of heptanes and 38 g of octave at 20°C. The vapour pressures of pure heptane and octane are 473pa and 140 Pa respectively. *(3 marks)*

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b) Compound X (b.p 372°c) and compound Y (b.p 399°c) form an ideal solution.

i) Sketch a labeled boiling point composition diagram for a mixture of X and Y. *(3 marks)*

ii) Use your diagram to explain how pure Y can be obtained from a mixture containing 70% X. *(3 marks)*

c) i) Draw the vapour pressure- composition diagram for a methanol-cyclohexane mixture. *(2 marks)*

ii) Explain the shape of the curve with reference to Raoult's law. *(3 marks)*

d) i) 0.5 mole of an organic compound Z was shaken with 60 cm^3 of water and 30 cm^3 of benzene. Calculate the number of moles of Z in the aqueous layer.
[K_D for Z between water and benzene is 0.2] *(3 marks)*

ii) State one application of partition of solutes. *(1 mark)*

3. a) i) State two important oxidation state exhibited by carbon, silicon tin and lead. *(1 mark)*

ii) Describe how the stability of the two oxidation states varies from carbon to lead. Use the oxides to illustrate your answer. *(5 marks)*

b) State what would be observed and write equation for the reaction when the tetra chlorides of carbon silicon, tin and lead one reacted with water. *(4 marks)*

c) i) Write equation to show how lead(II) chloride can be prepared. *(2 marks)*

ii) State the type of bond which exists in the chlorides of lead. *(2 marks)*

iii) State two physical properties which show that lead(II) chloride exhibits the type of bond you have stated in ii) above. *(2 marks)*

d) State what would be observed and write equation for the reaction when
i) Lead acetate is added to potassium iodine solution. *(2 marks)*

ii) When iron (III) chloride solution is added to lead acetate solution and the mixture is boiled. *(3 marks)*

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ii) Determine the percentage purity of copper in the sample from the following data. 6.53 g improve copper was dissolved in excess dilute nitric acid and the solution made to 250 cm^3 with distilled water. To 25cm^3 was added excess potassium iodine solution and the mixture titrated with sodium thiosulphate solution. 20 cm^3 of 0.5 M sodium thiosulphate was required for complete reaction. *(6 marks)*

e) State what would be observed and write an equation for the reaction that takes place when concentrated hydrochloric acid is added to copper (II) chloride solution. *(2 marks)*

6. a) Explain the following terms as applied to chemical reactions.
i) Order of reaction *(2 marks)*
ii) Rate law *(2 marks)*

b) Describe an experiment you would carry out to show that the decomposition of hydrogen peroxide follows first order kinetics. *(6 marks)*

c) The following results were obtained for the decomposition of dinitrogen penta oxide at 45°C

Time (minutes)	0	10	20	30	40	50	60
$[N_2O_5]$/moldm^3	176	124	93	71	53	39	29

i) Plot a graph of concentration against time. *(3 marks)*

ii) Use your graph to determine the time taken for the concentration of dinitrogen pentaoxide to decrease from 140 to 70 $moldm^{-3}$ and from 100 to 50 $moldm^{-3}$ *(2 marks)*

iii) Determine the order of the reaction. *(2marks)*

iv) Calculate the rate constant for the decomposition of dinitrogen pentaoxide. *(2marks)*

v) Write an expression for the rate law. *(1mark)*

7. a) Compound M contains 61% by mass of carbon, 15.3% by mass of hydrogen, the rest being nitrogen. Calculate;

i) the empirical formula of M *(3 marks)*

ii) the molecular formula of M [vapour density of M is 29.5] *(2 marks)*

b) M reacts with nitrous acid forming gas N and a compound O.
O reacts with acidified potassium dichromate(VI) solution on warming forming compound P, which reacts with iodine and potassium hydroxide solution forming a yellow precipitate.
i) Identify the compounds O, P, and M and the gas N. *(2 marks)*

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ii) Write an equation leading to the formation of the yellow precipitate.
(2 marks)

iii) Write an equation and outline a mechanism for the reaction between P and phenylhydrazine in the presence of dilute sulphuric acid.
(5 marks)

c) Write equations to show how the following conversion can be effected. Indicate reagent(s) and conditions for the reaction.

i) P to propan-1-ol *(3½ marks)*

ii) Propene to P *(2½ marks)*

8. a) State what would be observed and write equation(s) for the reaction(s) which take place in each of the following;

i) Excess dilute sulphuric acid is added to potassium chromate(VI) solution followed by hydrogen peroxide solution. *(4½ marks)*

ii) When a mixture of lead (IV) oxide concentrated nitric acid and manganese (II) sulphate solution is heated. *(2 ½ marks)*

iii) Potassium iodine is added to copper (II) sulphate solution. *(3 marks)*

b) Explain each of the following observations.

i) The boiling point of group (VII) hydrides decreases down the group but the boiling point of hydrogen iodide is greater than that of hydrogen chloride. *(5 marks)*

ii) Atomic radius decreases along the elements sodium to chlorine
(5 marks)

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SECTION A

Answer any three questions from this section.

1. a) The molar conductivity of aluminium sulphate solutions of different concentration are shown in the table below.

Concentration ($Moldm^{-3}$)	0.0225	0.0900	0.02025	0.3600	0.5625	0.8100	1.1025
Molar conductivity $\Lambda/\ \Omega^{-1}\ cm^2mol^{-1}$	790	720	650	580	510	440	365

(i) Plot a graph of molar conductivity against square root of concentration.
(04 marks)

(ii) Determine the value of molar conductivity at infinite dilution of aluminum ions (molar conductivity at infinite dilution of sulphate ions $=160\Omega^{-1}cm^2mol^{-1}$)
(03 marks)

(iii) Explain the shape of the graph. ($04\frac{1}{2}$marks)

(b) In a conductimetric titration, $1cm^3$ portions of 1M sodium hydroxide solution were added to $25cm^3$ of 0.1M aluminium sulphate solution.

(i) Draw a sketch graph of the electrolytic conductivity against volume of sodium hydroxide solution. (02marks)

(ii) Explain the shape of the graph. (05 marks)

(c) A saturated solution of barium sulphate has an electrolytic conductivity of $3.75X\ 10^{-6}\Omega^{-1}cm^{-1}$ at 25°C. At this temperature the electrolytic conductivity of pure water is $1.23 \times 10^{-6}\ \Omega^{-1}cm^{-1}$ and the molar conductivity of barium sulphate is $250\Omega^{-1}cm^2mol^{-1}$. Calculate the solubility in $moldm^{-3}$ of barium sulphate at this temperature. ($03\frac{1}{2}$marks)

2. Group (VII) elements undergo disproportionation reaction when treated with water or alkalis.

(a) What is meant by the term disproportionation reaction? (2 marks)

(b) Describe the disproportionation reaction of:

(i) chlorine with water ($2\frac{1}{2}$marks)

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(ii) bromine with hot concentrated sodium hydroxide solution. ($2\frac{1}{2}$ marks)

(c) Iodine was added to dilute sodium hydroxide solution and the resultant mixture warmed.

(i) State what was observed ($1\frac{1}{2}$ marks)

(ii) Write equation(s) for the reaction(s) (3 marks)

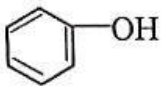
(d) Commercial bleach can be obtained by bubbling chlorine gas into cold dilute sodium hydroxide solution. $10cm^3$ of the bleach solution was diluted to $250cm^3$ with distilled water. $20cm^3$ of this solution was acidified with dilute hydrochloric acid and excess potassium iodine solution added. The liberated iodine required $9.0cm^3$ of 0.08M sodium thiosulphate solution.

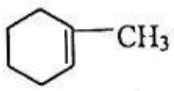
Calculate the mass of chlorine required to produce $1dm^3$ of the commercial bleach.

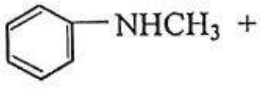
(06arks)

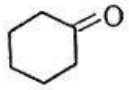
3. Complete the following equations and in each case outline a mechanism for the reaction.

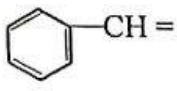
(a) $(CH_3)_2C = CHCH_3 \xrightarrow{Br_2/NaCl}$ (03 marks)

(b)  $\xrightarrow{CH_3CH_2Br/NaOH(aq)}$ (03 marks)

(c)  $\xrightarrow{HBr}$ (03 marks)

(d)  $\longrightarrow$ (04 marks)

(e)  $\xrightarrow{NaHSO_3}$ (03 marks)

 $\xrightarrow{H_2CO/H^+}$ (04 marks)

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4. (a) What is meant by the following terms:

(i) order of reaction (02 marks)

(ii) molecularity of a reaction. (02 marks)

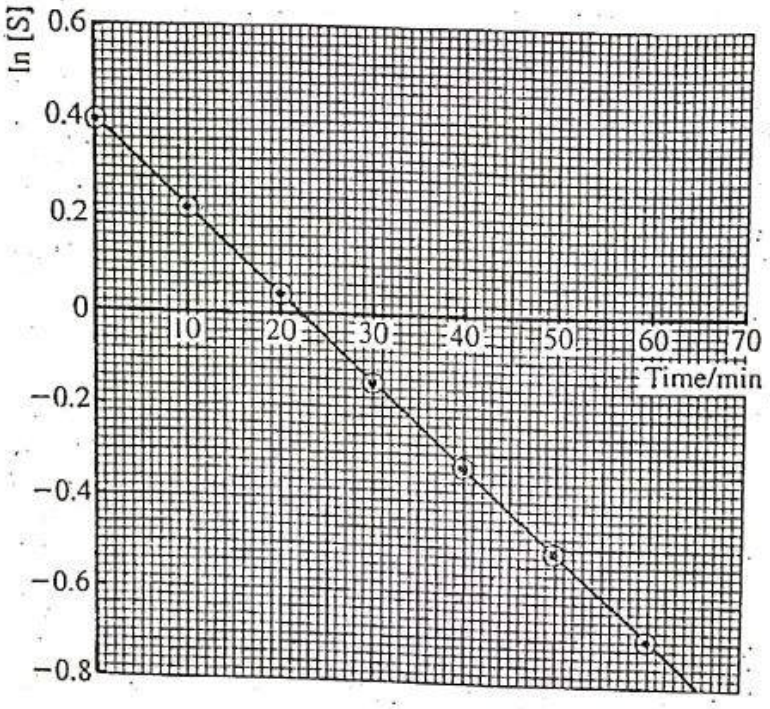
(b) Describe an experiment to show that iodination of propanone follows a zero order reaction with respect to iodine. (07 marks)

(c) Sucrose is hydrolysed in dilute acid to give a mixture of glucose and fructose

$$C_{12}H_{22}O_{11}(aq) + H_2O(l) \longrightarrow C_6H_{12}O_6(aq) + C_6H_{12}O_6(aq)$$

sucrose glucose fructose

The graph below shows a plot of the logarithm of the molar concentration of sucrose remaining at intervals of time ($In[S]=In[C_{12}H_{22}O_{11}]$)



Using the graph, determine the;

(i) Original concentration of sucrose ($1\frac{1}{2}$marks)

(ii) Order of reaction ($02\frac{1}{2}$marks)

(iii) rate constant for the reaction ($01\frac{1}{2}$marks)

(iv) half-life for the reaction (02 marks)

(d) State the conditions under which the reaction in (c)above is overall first order. (02marks)

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SECTION B

Answer two questions from this section

5. (a) Define the term "azeotropic mixture" (02marks)

(b) Use the data in the following table to draw a well labeled boiling point – composition diagram for the solutions of cyclohexane in methanol.

[Boiling points of pure cyclohexane and methanol are 81°C and 65°C respectively] (07 marks)

Mole fraction of methanol in		Boiling point of the mixture(^{0}C)
Liquid mixture	Vapour above the mixture	
0.12	0.27	70
0.31	0.47	60
0.50	0.56	55
0.82	0.69	57
0.94	0.83	61

(i) Determine the boiling point and composition of the azeotropic mixture (02marks)

(ii) Explain why the azeotropic mixture cannot be separated into pure components by fractional distillation . (03 marks)

(iii) Describe what happens when a liquid mixture containing 2 moles of cyclohexane and 8 moles of methanol is fractionally distilled. (04 marks)

(c) Explain why the solution in which a non-volatile solute is dissolved in methanol boils above 65°C. (02 marks)

6. Explain the following observations.

a) The acidic strength of the oxo-acids of chlorine is in the order $HClO_4 > HClO_3 > HClO_2 > HClO$ (04 marks)

b) Chloro benzene is less reactive than chloroethane towards nucleophilic substitution reactions. (04 marks)

c) When dilute sulphuiric acid is added to an aqueous solution of potassium manganate (VI), the solution turns from green to purple with formation of a black precipitate. (04 marks)

d) When excess chlorine gas was bubbled through an aqueous solution of sodium thiosulphate and barium chloride solution then added to the resultant mixture, white precipitate was formed. (04 marks)

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e) When ammonia solution was added to a saturated solution of silver phosphate, its solubility increased but when silver nitrate solution was added to the solution, the solubility of silver phosphate decreased. (04 marks)

7. When 0.10g of an organic compound **X** containing carbon, hydrogen and oxygen only was subjected to combustion, it gave 0.227g of carbon dioxide and 0.0929g of water. 0.368g of **X** when vaporized at 37° C and 760mmHg it occupied a volume of 161.4cm^3

(a) (i) Calculate the empirical formula of **X** (04 marks)

(ii) Deduce the molecular formula of **X** (03 marks)

(b) Determine the structural formulae and their IUPAC names of all the possible isomers of **X**. (03 marks)

(c) **X** reacts with hydroxyl amine in acidic medium but does not react with ammoniacal silver nitrate solution. Identify **X**. (01 marks)

d) Write equations to show how

(i) **X** can be synthesized from ethanol. (04 marks)

(ii) **X** can be converted to ethanoic acid. (04 marks)

e) Write equation for the reaction between X and dilute sodium hydroxide solution at room temperature. (01 mark)

8. (a) Describe how pure copper can be obtained from copper pyrites. (10 marks)

(b) Discuss the reaction of copper with.

(i) Sulphuric acid ($03\frac{1}{2}$marks)

(ii) air ($02\frac{1}{2}$marks)

(c) An aqueous solution of ethane- 1,2-diamine was added to a solution of copper (II) sulphate.

(i) State what was observed ($1\frac{1}{2}$marks)

(ii) Write equation(s) for the reaction(s) that took place. ($2\frac{1}{2}$marks)

END

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P525/2
CHEMISTRY
Paper 2
July/August 2014
$2^1/_2$ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

(Principal Subject)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

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- Non programmable, silent scientific electronic calculators may be used.
- Illustrate your answers with equations where applicable.
- Where necessary use C = 12 , H = 1 , O = 16 , Na = 23, Cl = 35.5, $R = 8.314JK^{-1}mol^{-1}$, latm = 101325Pa.

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SECTION A

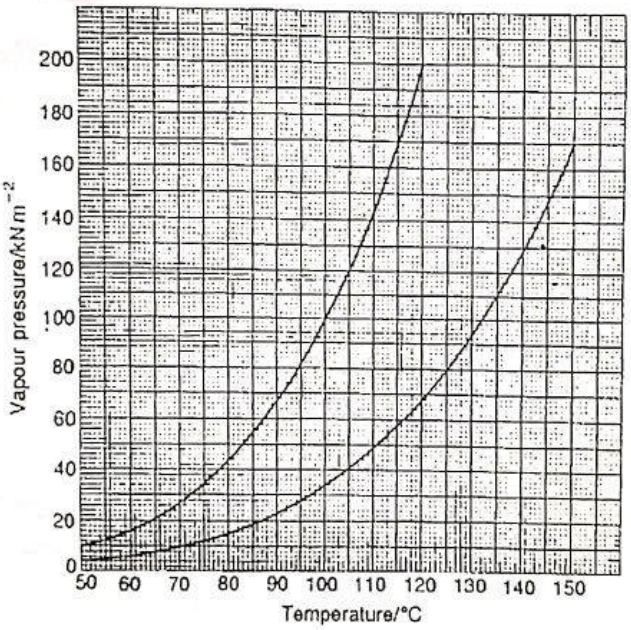
Answer **three** *questions from this section.*

1. Na, Mg, Al, Si, P, S and Cl are the elements of the third period of the periodic table.
   (a) (i) Write the formulae of the possible chlorides of the elements. (04marks)
   (ii) Discuss the reactions of the chlorides in (i) with water. (10marks)

   (b) State what would be observed and write equation for the reaction when;
   (i) Chlorine gas was bubbled through a dilute aqueous solution of sodium hydroxide. (2½marks)
   (ii) Sulphur was added to hot concentrated nitric acid. (3½marks)

2. (a) (i) What is meant by the term steam distillation. (02marks)
   (ii) Explain the principles of steam distillation in the separation of mixtures. (05marks)

   (b) The graph below shows the equilibrium vapour pressures of water and chlorobenzene as a function of temperature.
   Chlorobenzene and water are immiscible liquids.



   (i) Determine the vapour pressures of chlorobenzene and water at 93°C and at $101KNm^{-2}$. (02marks)
   (ii) Calculate the percentage composition by mass of the distillate at 93°C.(04marks)
   (iii) Explain the shape of the graph. (04marks)

   (c) State;
   (i) Two advantages of steam distillation.
   (ii) One disadvantage of steam distillation.
   (03marks)

3. (a) A gaseous hydrocarbon X consists of 11.11% by mass of hydrogen.
   (i) Calculate the empirical formula of X. (2½marks)
   (ii) If the vapour density of X is 27, determine the molecular formula of X. (2marks)
   (iii) Write the structural formulae and I.U.P.A.C names of all the possible isomers of X. (04marks)

   (b) 1 mole of X reacts completely with 1 mole of hydrogen gas in the presence of nickel catalyst at 150°C. Identify X. (01mark)

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(c) When X was warmed with a mixture of concentrated sulphuric acid and water, substance Y was formed. Y was readily oxidized to compound Z when treated with hot acidified potassium dichromate solution.
Identify;
(i) Y (01mark)
(ii) Z (01mark)

(d) Write equation for the reaction and suggest a mechanism for the reaction when;
(i) X was warmed with a mixture of concentrated sulphuric acid and water. (04marks)
(ii) Z was reacted with acidified solution of semi carbazide. (4½marks)

4. (a) Sodium thiosulphate solution reacts with hydrochloric acid according to the following equation.

$$Na_2S_2O_{3(aq)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + S_{(s)} + SO_{2(g)} + H_2O_{3(l)}$$

The rate equation for the reaction is given below;

$$\text{Rate} = K[HCl]^2[Na_2S_2O_3]$$

State and explain how the rate of reaction would be affected if;
(i) The concentration of hydrochloric acid is doubled while that of sodium thiosulphate is kept constant. (1½marks)
(ii) The concentration of sodium thiosulphate is halved while that of hydrochloric acid is kept constant. (1½marks)
(iii) The concentration of hydrochloric acid is halved while that of sodium thiosulphate is doubled. (1½marks)
(iv) The concentration of hydrochloric acid and that of sodium thiosulphate are both halved. (1½marks)

(b) Describe an experiment to show that the order of reaction in (a) is first order with respect to sodium thiosulphate. (06marks)

(c) The table below shows the rate constants K at various temperatures for the reaction between hydrogen and iodine to form hydrogen iodide; $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

Temperature T(K)	500	550	600	650	700
K $(dm^3mol^{-1}s^{-1})$	6.81×10^{-4}	2.64×10^{-2}	0.56	7.31	66.67

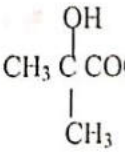
(i) Plot a graph of $\log_{10} K$ against $\frac{1}{T}$. (04marks)
(ii) Use your graph to determine the activation energy, Ea for the reaction. (02marks)

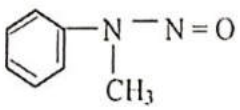
(d) State how a catalyst increases the rate of reaction. (02marks)

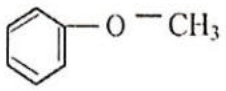
SECTION B

Answer **two** *questions from this section.*

5. Write equations to show how each of the following compounds can be synthesized.
In each case indicate the reagent(s) and condition(s) for the reaction.

(a)  from propene. (04marks)

(b)  from benzoyl chloride. (04marks)

(c)  from chlorobenzene. (3½marks)

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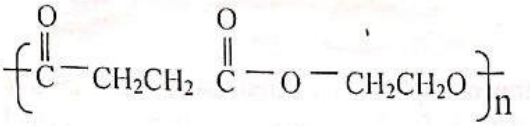
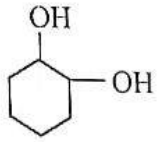
(d)  from ethyne. (4½marks)

(e)  from phenol. (04marks)

6. (a) (i) Distinguish between eutectic mixture and an azeotropic mixture. (02marks)

(ii) Briefly explain how the mixtures in (i) above are formed. (3½marks)

(b) The table below shows the melting points of various mixtures of ethanoic acid and water.

% of ethanoic acid	0	20	40	60	80	100
Melting point (°C)	0	-10	-20	-19	-1	18

i) Draw a well labeled melting point composition diagram for ethanoic acid- water system. (05marks)

ii) Determine the eutectic temperature and composition of the eutectic mixture. (02marks)

iii) Explain the phase changes which would take place if a liquid mixture containing 20% ethanoic acid at 15°C was cooled to -30°C. (04marks)

iv) 135g of the liquid mixture of composition 16% ethanoic acid at 5°C was cooled to -22°C.
Calculate the mass of ice that will crystallize out. (02½marks)

(c) State two similarities between a eutectic mixture and an azeotropic mixture. (01mark)

7. Explain each of the following observations.

(a) Caesium chloride exhibits 8:8 coordination while sodium chloride exhibits 6:6 coordination. (03marks)

(b) Both trimethyl amine and nitrogen trichloride adopt trigonal pyramidal structure but the bond angles are different. (04marks)

(c) When Fehling solution was warmed with methonic acid, a red precipitate is formed whereas the same reagent when warmed with propanoic acid there is no observable change. (04marks)

(d) An aqueous solution of sodium nitrate is neutral to litmus while as an aqueous solution of sodium nitrite turns red litmus blue. (04marks)

(e) Both magnesium and sodium when burnt in air form white solids but the solid formed from magnesium dissolved with effervescence of a colourless gas while the solid from sodium dissolved without effervescence. (05marks)

8. (a) (i) Define the term transition element. (1n...

(ii) Both zinc and manganese are d-block elements but zinc is not regarded as a typical transition element. Explain this observation. (02½marks)

(b) Manganese occurs naturally in the ore pyrolusite, MnO_2. Describe briefly how;

(i) Pure manganese can be obtained from the ore. (05marks)

(ii) the percentage of manganese in the ore can be determined. (04marks)

(c) Describe the reactions of;

(i) Zinc with air. (3marks)

(ii) Manganese with sulphuric acid. (3marks)

(d) State what would be observed and write equation for reaction when manganese (II) sulphate solution was mixed with concentrated nitric acid and sodium bismuthate. (01½marks)

END

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CHEMISTRY
Paper 2
July/August 2015
$2^1/_2$ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

(Principal Subject)

Paper 2

2 hours 30 minutes

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  $R = 8.314JK^{-1}mol^{-1}$, 1 atm = 101325Pa.

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Turn Over

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SECTION A

Answer any **three** *questions from this section.*

1. (a) State the equilibrium law. (02marks)

   (b) Potassium manganate(VI) reacts with water according to the following ionic equation; $3MnO_4^{2-}(aq)+2H_2O(l) \rightleftharpoons 2MnO_4^-(aq) + MnO_2 + 4OH^-(aq)$

   49.25g of potassium manganate (VI) are shaken with 1.2 moles of water in a 2 litre vessel until equilibrium is attained at 30^0C. At equilibrium 8.96g of potassium hydroxide is formed.

   (i) Calculate the equilibrium constant, Kc for the reaction at 30^0C and indicate its units. (07 marks)

   (ii) State and explain the effect on the equilibrium constant and equilibrium position if the carbon dioxide gas was bubbled through the mixture at equilibrium at 30^0C. (04 marks)

   (c) Discuss the effect of pressure and catalyst on equilibrium reactions. (07 marks)

2. A saturated organic compound **P** contains carbon, hydrogen and oxygen only. When $20cm^3$ of **P** was exploded with excess oxygen, there was a contraction of $70cm^3$ which occurred. When the residual gases were treated with concentrated potassium hydroxide solution there was a further contraction of $120cm^3$ which occurred. In another experiment, $20cm^3$ of **P** when exploded in excess oxygen, $120cm^3$ of steam was formed.

   (a) Determine the molecular formula of **P**. (04 marks)

   (b) P is neutral to litmus but reacts with sodium metal to form compound **Q** and hydrogen gas.

   (c) Identify;
   (i) **P** (01 mark)
   (ii) **Q** (01 mark)

   (d) Write the equation and suggest a mechanism for the reaction between
   (i) P and hot orthophosphoric acid. (04 marks)
   (ii) P and ethanoyl chloride. (04 marks)
   (iii) Q and phenylchloromethane. (03 marks)

   (e) P was warmed with acidified chromium (VI) oxide.
   (i) State what was observed. (01 mark)
   (ii) Write equation for the reaction. (01 mark)
   (iii) Name the main organic product. (01 mark)

3. The data in the table below shows the changes in pH when 0.1M sodium hydroxide solution was added to $25.0cm^3$ of a weak acid (HA).

Volume of NaOH solution added (cm^3)	pH	Volume of NaOH solution added (cm^3)	pH
0	2.50	24.0	5.35
3.0	3.13	24.5	5.69
6.0	3.50	24.90	6.40
9.0	3.75	25.0	8.35
12.0	3.97	25.1	11.30
15.0	4.18	25.5	12.00
18.0	4.41	27.0	12.59
21.0	4.72		

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(a) Plot a graph of pH against volume of NaOH added. (04 marks)

(b) Use the graph to determine.

(i) the pH at the end point. (01 mark)

(ii) molarity of the acid. (05 marks)

(c) Explain the shape of the graph in (a). (06 marks)

(d) Determine the PKa of the acid. (04 marks)

4. (a) (i) Describe how group(IV) elements react with chlorine. (07marks)

(ii) Write equations for the reactions between sodium hydroxide solution and the products in a(i) above. (03marks)

(b) The melting points of group (IV) elements of the periodic table are shown in the table below.

Element	C	Si	Ge	Sn	Pb
Atomic number	6	14	32	50	82
Melting point °C	3550	1410	937	232	327

(i) Define the term melting point. (01 mark)

(ii) Plot a graph of melting point against atomic number. (04 marks)

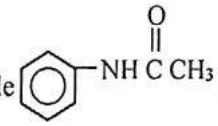
(iii) Explain the shape of the graph. (05 marks)

SECTION B

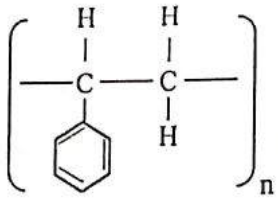
Answer any **two** questions from this section.

5. Using equations only show how the following conversions can be effected.

(a) Cyclohexanol from benzene and fuming sulphuric acid. (04 marks)

(b) Phenylethaneamide  from benzenediazonium salt. (05 marks)

(c) $CHCl_3$ from propene. (04 marks)

(d)  from benzene and ethanoylchloride. (4½ marks)

(e) Propanoic acid from propene. (2½ marks)

6. Give the following electrode potentials.

Reaction			$E^0_{/V}$
1. $MnO_4^-(aq) + 8H^+(aq) + 5e$	⟶	$Mn^{2+}(aq) + 4H_2O(l)$	+1.52V
2. $\frac{1}{2}S_2O_8^{2-}(aq) + e$	⟶	$SO_4^{2-}(aq)$	+2.01V
3. $\frac{1}{2}Cl_2(g) + e$	⟶	$Cl^-(aq)$	+1.36V

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(a) Draw a well labelled cell diagram for the cell formed by combining half-cells 1 and 2 (03½ marks)

(b) Write
(i) the overall cell reaction for the cell formed in(a) above (1½ mark)
(ii) cell notation for the cell formed in (a) above (1½ mark)

(c) State what is observed at the anode for the cell formed in (a) above. (01mark)

(d) Calculate;
(i) e.m.f of the cell formed in (a) above. (02 marks)
(ii) the standard free energy change for the cell in (a) above. (02 marks)

(e) Half – cells 1 and 3 are arranged . .
(i) State what is observed at each electrode and explain your answer.
(ii) Write the overall equation for the reaction. (04 marks)

(f) Describe briefly how the standard electrode potential of a chlorine half-cell can be determined. (05 marks)

7. Explain each of the following observations.

(a) Lead(IV) oxide does not react with dilute hydrochloric acid but reacts with cold concentrated hydrochloric acid to form a bright yellow liquid. (04 marks)

(b) Ethanol can be dehydrated by concentrated sulphuric acid at 170^0C whereas 2-methylpropane-2-o1 can be dehydrated by the same acid at 100^0C. (03½ marks)

(c) 0.1M urea solution and 0.2M ethanoic acid have the same freezing point when benzene is used as a solvent. (03 marks)

(d) A mixture of water and bromobenzene boils at 98.6^0C whereas the boiling points of water and bromobenzene are 100^0C and 150^0C respectively. (03½ marks)

(e) When aqueous sodium hydroxide is added to aluminium nitrate solution, a white precipitate is formed which dissolves in excess alkali to form a colourless solution. When ammonia solution is used, a white precipitate is formed insoluble in excess. (06marks)

8. (a) Describe briefly how pure copper.
(i) can be obtained from blister copper. (04marks)
(ii) can react with mineral acids. (04 marks)

(b) Describe an experiment to determine the percentage of copper in a copper(II) salt. (06marks)

c) Potassium hexacyanoferrate(II) solution was added to copper(II) sulphate solution drop wise until in excess.
(i) State what was observed. (1mark)
(ii) Write equation for the reaction. (1½ marks)

(e) When copper (I) oxide was added to dilute sulphuric acid, a blue solution and reddish brown precipitate were formed. Explain this observation. (2½ marks)

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CHEMISTRY
Paper 2
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$2^1/_2$ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

(Principal Subject)

Paper 2

2 hours 30 minutes

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SECTION A

Answer three questions from this section.

1. (a) Phenolphthalein can be used as an acid- base indicator.
   (i) What is meant by the term **acid- base indicator?** (01mark)
   (ii) Describe briefly how phenolphthalein works as an acid- base indicator. (06marks)
   (iii) The indicator constant, Ki for phenolphthalein is 5.012×10^{-10} moldm^{-3}. Determine the approximate pH working range for phenolphthalein. (02marks)

   (b) 25cm^3 of 0.12M ethanoic acid was pipetted into a clean conical flask and 2-3 drops of phenolphthalein indicator added and the mixture titrated with 0.2M sodium hydroxide solution until the equivalence point had reached, when 15cm^3 of sodium hydroxide had been used.
   (i) What is meant by the term equivalence point? (01mark)
   (ii) State the colour change at equivalence point. (01mark)
   (iii) Calculate the pH of the mixture at equivalence point. (05marks)
   (Ka for ethanoic acid $= 1.75 \times 10^{-5}$moldm^{-3} and Kw for water $= 1.0 \times 10^{-14}$ mol^{2}dm^{-6})

   (c) Sketch a graph of pH against volume of sodium hydroxide for the titration in (b) and explain the shape of the graph. (04marks)

2. Carbon, silicon, germanium, tin and lead are elements of Group(IV) of the Periodic Table.
   (a) (i) Write the outer most electronic configuration of Group(IV) elements. (01mark)
   (ii) State the oxidation states of Group(IV) elements. (01mark)
   (iii) State how the stability of the oxidation states vary down the group. (02marks)

   (b) Describe the reactions of the elements with
   (i) water (06marks)
   (ii) concentrated sulphuric acid. (06marks)

   (c) Write equations for the reactions between
   (i) silicon (IV)oxide and hot concentrated hydrofluoric acid. (1½marks)
   (ii) trileadtetraoxide and warm dilute nitric acid. (1½marks)
   (iii) tin(II) chloride solution and iron(III) sulphate solution. (1½marks)

3. (a) A gaseous alkene **Y** diffuses 0.57735 times faster than nitrogen gas. Determine the molecular formula of **Y.** (03marks)

   (b) On ozonolysis followed by hydrolysis, **Y** produced propanal and propanone as the major organic products. Identify **Y.** (01mark)

   (c) Write the equation and suggest a mechanism for the reaction between
   (i) Y and benzene in the presence of an acid. (04marks)
   (ii) Y and bromine water. (04marks)
   (iii) propanal and phenyl hydrazine in acidic medium. (04marks)

   (d) Using equations only show how **Y** can be synthesized from propyne. (04marks)

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4. (a) (i) Define the term lattice energy. (01mark)

(ii) State two factors that affect lattice energy. (01mark)

(b) Thermo dynamic data for aluminium, fluorine and aluminium fluoride are given below.

The standard enthalpy of formation of aluminium fluoride	$= -1301 kJmol^{-1}$
The standard enthalpy atomization of aluminium	$= +314 kJmol^{-1}$
The standard enthalpy bond dissociation of fluorine	$= +158 kJmol^{-1}$
First ionization energy of aluminium	$= +577 kJmol^{-1}$
Second ionization energy of aluminium	$= +1820 kJmol^{-1}$
Third ionization energy of aluminium	$= +2740 kJmol^{-1}$
First electron affinity of fluorine	$= -348 kJmol^{-1}$

(i) Draw an energy level diagram for formation of aluminium fluoride. (4½marks)

(ii) Use the diagram you have drawn to determine the lattice energy of aluminium fluoride. (03marks)

(iii) Given that the hydration energies of aluminium ions and fluoride ions are –4690 and -364kJmol^{-1} respectively. Calculate the enthalpy of solution of aluminium fluoride and comment on the solubility of aluminium fluoride in water. (4½marks)

(c) The electrode potentials of aluminium and zinc are shown below.

$Al^{3+}(aq) + 3e \rightleftharpoons Al(s)$ $\quad E^{\theta} = -1.66V$

$Zn^{2+}(aq) + 2e \rightleftharpoons Zn(s)$ $\quad E^{\theta} = -0.76V$

The two half cells are combined to form a cell

(i) Write the overall cell reaction (1½marks)

(ii) Calculate the emf of the cell (1½marks)

(iii) Calculate the standard free energy for the cell. (02marks)

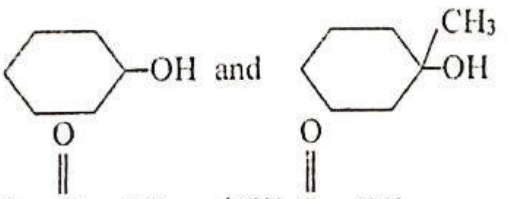
(iv) State whether the cell is feasible or not. Give a reason for your answer. (01marks)

SECTION B

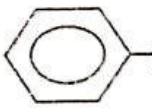
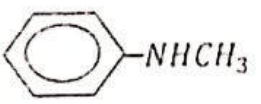
Answer two questions from this section.

5. (a) Name a reagent that can be used to distinguish between the following pairs of organic compounds and in each case state what would be observed and write equation for the reaction if any when the reagent is treated with each compound in the pair.

(i) CH_3CHO and CH_3CH_2CHO (04marks)

(ii)  and (04marks)

(iii) $H-\overset{O}{\overset{\|}{C}}-OH$ and $CH_3\overset{O}{\overset{\|}{C}}-OH$ (04marks)

(iv)  and  (04marks)

(b) Using equations only show how phenylethanoate can be synthesized from benzene. (04marks)

Turn Over

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6. (a) 2-nitrophenol and 4-nitrophenol can be prepared by reacting phenol with dilute nitric acid.
   (i) write equation for the reaction. (01mark)
   (ii) Which of the two products has a higher melting point. Explain your answer. (06marks)

   (b) 2-nitrophenol and 4- nitrophenol can be separated by steam distillation.
   (i) What is meant by steam distillation? (01marks)
   (ii) With aid of a labeled diagram , describe how a mixture of 2- nitrophenol and 4- nitrophenol can be separated by steam distillation. (06marks)

   (c) When 50g of a mixture of 2-nitrophenol and 4- nitrophenol was steam distilled at 97°C and 750mmHg , a distillate was found to have a mass of 35g. The vapour pressure of water at 97°C is 654mmHg. Determine the percentage by mass of 4-nitrophenol in the mixture. (04marks)

   (d) State two advantages of steam distillation over fractional distillation. (02mark)

7. Explain each of the following observations

   (a) Ethene reacts with bromine to form 1,2- dibromoethane. But when the reaction is carried out in the presence of sodium chloride solution, 1- bromo- 2- chloroethane is formed. (05marks)

   (b) The solution of 0.1M hydrochloric acid has a pH of 1 whereas that of 0.1M hydrofluoric acid is 3.8. (04marks)

   (c) When cold concentrated hydrochloric acid was added to lead (IV) oxide, brown solid dissolves to form a pale yellow liquid. However on slight warming, there was effervescence of a gas. (04marks)

   (d) Hydrogen fluoride can be prepared by reacting calcium fluoride with concentrated sulphuric acid. However hydrogen bromide cannot be prepared from calcium bromide and concentrated sulphuric acid. (04marks)

   (e) When ammonium thiocyanate solution was added to iron (III) chloride solution, a red blood solution was formed. (03marks)

8. (a) What is meant by the term **ore**? (01mark)

   (b) Briefly describe how the following ores can be purified.
   (i) zinc blende (04marks)
   (ii) bauxite (06marks)

   (c) Write equation(s) to show how aluminium metal can be extracted from the purified ore in (b) (ii) above. (1½marks)

   (d) Describe how
   (i) aluminium reacts with sulphuric acid (05marks)
   (ii) zinc reacts with sodium hydroxide. (2½marks)

END

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