WESTERN JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY
Paper 2
2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- Answer **FIVE** questions, including **THREE** questions from section A and any **TWO** from section **B**.

- **Begin**each question on a fresh page.

- Mathematical tables and graph papers are provided.

- Non-programmable scientific electronic calculators may be used.

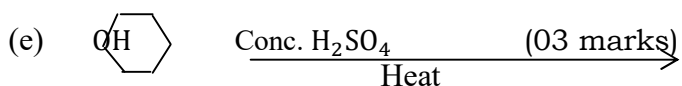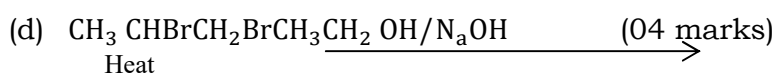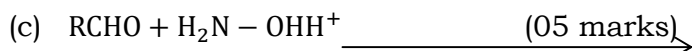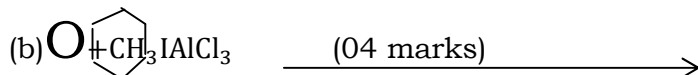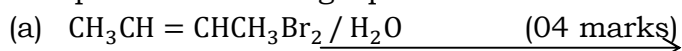- Use equations where necessary to illustrate your answers.

SECTION A

Attempt three questions only.

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

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

(a) Define pH. (01 mark)

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

(c) Use the graph to determine;
   (i) The pH at the end point. (01 mark)
   (ii) Molarity of the acid. (05 marks)

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

(e) Determine the pK_a of the acid. (04 marks)

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

(a) $CH_3CH = CHCH_3 Br_2 / H_2O$ _____ (04 marks)

(b) $O + CH_3 IAlCl_3$ _____ (04 marks)

(c) $RCHO + H_2N - OHH^+$ _____ (05 marks)

(d) $CH_3 CHBrCH_2 BrCH_3 CH_2 OH/N_aOH$ _____ (04 marks)
   Heat

(e) OH $\xrightarrow[\text{Heat}]{\text{Conc. } H_2SO_4}$ (03 marks)

3. (a)(i) State two important oxidation states exhibited by group (iv) elements. (01mark)

(ii) Describe how group (iv) elements react with chlorine. (06 marks)

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

(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/℃	3550	1410	937	232	327

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

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

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

4.   (a) The formation of an ionic compound from its elements takes place in a series of steps. In one of the steps, the energy change is "lattice energy".

(i)   Explain what is meant by the term "lattice energy".   (02 marks)

(ii) Outline the theoretical principles used to evaluate lattice energy of potassium chloride from thermochemical data.   (04 marks)

(iii) The electronic affinity of a halogen atom X is $348 KJmol^{-1}$ while the first ionization energy of a group (1) metal, M, is $495\ KJmol^{-1}$. When gaseous M^+ combine with X^- to form a crystal, the energy released is $788 KJmol^{-1}$.   Calculate the enthalpy of formation of MX.   (04 marks)

(b) Benzene may be nitrated by using a mixture of concentrated nitric acid and concentratedsulphuric acid.

(i) What is the role of sulphuric acid?   (01 mark)

(ii) What is the nature of the species that actually reacts with benzene ring in nitration?   (01 mark)

(iii) Outline the mechanism of reaction in (b)(ii).   (02 marks)

(iv) Would you expect it to be easier or more difficult to nitrate methylbenzene than benzene? Explain   (03 marks)

(v) Why is it difficult to introduce additional nitro groups into benzene ring after it has been mono-nitrated?   (03 marks)

SECTION B

Attempt two questions only

5.   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℃, whereas 2-methyl propan -2 -0l can be dehydrated at 100℃.   (03 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 bromo benzene boils at 98.6℃ whereas the boiling point of water and bromo benzene is 100℃ and 150℃ respectively.   (03 marks)

(e) When aqueous sodium hydroxide is added to aluminum nitrate solution, a white precipitate is formed which dissolves in excess alkali to form a colorless solution. When ammonia solution is used, a white precipitate is formed insoluble in excess.   (05 marks)

(f) Nitric acid is always kept in dark bottles.   (02 marks)

6. Consider the metals copper and aluminium.
(a) (i) Name one ore of each metal. (01 mark)
(ii) Give the formula of the metal compound contained in the ore in each case.(01 mark)

(iii) Show how each named ore is purified. (06 marks)

(iv) Outline briefly the main chemical process involved in extracting a pure sample of copper metal from its ore. (05 marks)
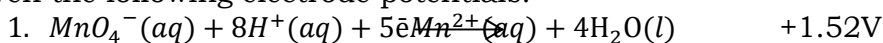
(b) (i) Give two uses of each metal in Uganda. (02 marks)

(ii) Starting from copper how would you obtain copper (i)chloride? (02 marks)

(iv) Starting from aluminium how would you obtain anhydrous aluminiumchloride? (02 marks)

(c) Aluminium is more reactive than zinc yet aluminium foil does not react with dilute hydrochloric acid. Explain (01 mark)

7. Given the following electrode potentials.

1. $MnO_4^-(aq) + 8H^+(aq) + 5\bar{e} \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$ +1.52V

2. $\frac{1}{2}S_2O_8^{2-}(aq) + \bar{e} \rightleftharpoons SO_4^{2-}(aq)$ +2.01V

3. $\frac{1}{2}Cl_2(g) + \bar{e} \rightleftharpoons Cl^-(aq)$ +1.36V

(a) Draw a well labeled cell diagram for the cell formed by combining half cells 1 and 2. (3½marks)

(b) Write;

(i) The overall cell reaction for the cell formed in (a) above. (1½marks)
(ii) Cell notation for the cell formed in (a) above. (1½ marks)
(c) State what is observed at the anode for the cell in (a). (01 mark)

(d) Calculate;

(i) The $e.m.f$ of the cell formed in (a) (02 marks)

(ii) The standard free energy change for the cell in (a) (02 marks)

(e) Half-cells 1 and 3 are arranged,

(i) State what is observed at each electrode and explain your answer. (03 marks)

(ii) Write the overall equation of the reaction. (01 mark)

(f) Describe briefly how the standard electrode potential of a chlorine half-cell can be determined (4½marks)

8. (a)(i) What are the basic raw materials used in the production of soap? (02 marks)
(ii) Write the equation for the reaction involved in the production of soap. (02 marks)
(iii) Describe briefly how soap is separated from the reaction mixture. (02 marks)

(b)(i) Describe briefly how a synthetic detergentmay be prepared in the laboratory.(03marks)
(ii) State the main difference between a soap and a detergent. (01 mark)
(iii) What is the advantage of using a detergent instead of soap in washing? (02 marks)

(c) Sodium triphosphate and a little sodium perborate are normally added to some laundry detergents.

(i) What is the function of sodium triphosphate in the detergent? (02 marks)
(ii) Explain how some detergents containing phosphates may cause pollution.(03 marks)
(iii) What role does sodium perborate play during washing? (01 mark)
(iv) Name another inorganic substance that is usually added to a detergent and state its role. (02 marks)

END