0715/2/2024
CHEMISTRY A/L

SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION

THE TEACHERS' RESOURCE UNIT (TRU)

IN COLLABORATION WITH

THE REGIONAL INSPECTORATES OF PEDAGOGY AND

THE SOUTHWEST CHEMISTRY TEACHERS' ASSOCIATIONS (SOWECTA)

Monday: 18/03/2024-Afternoon   **ADVANCED LEVEL**

Subject Title	CHEMISTRY
Paper Number	Paper 2
Subject Code Number	0715

THREE HOURS

INSTRUCTIONS TO CANDIDATES:

Enter the information required in the boxes of the flap.

Answer ALL the SIX questions in this booklet.

No Mobile phones are allowed in the examination room.
The mark allocation is indicated for each question. Each question carries **20 marks.**
Verify that this booklet contains **SIX** questions and no questions are repeated and there are no blank pages.
Inform the invigilator in case this booklet contains less than six questions; questions are repeated and there are no blank pages

Blank spaces in this question booklet may be used for rough work.

In calculations, you are advised to show all the steps in your working, giving your answer at each stage.

All necessary working must be shown. No marks will be awarded to answers without brief statements showing how the answers have been obtained.

Calculators may be used.

Noiseless and non-programmable Calculators are allowed

Useful Data:

RAM: C=12.0, H=1.0, O=16.0, Ca = 40, N = 14, S = 32

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1.   (a) Define the following:

(i) A mole

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(ii) Avogadro constant

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(iii) Calculate the number of hydroxide ions present in 20 g of calcium hydroxide (Avogadro constant, $L = 6.02 \times 10^{23}$).

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(iv) 23.5 cm³ of a solution of sodium carbonate needed 25.0 cm³ of a 0.1 M hydrochloric acid for complete reaction. Calculate the concentration of the sodium carbonate solution in mol/dm³.

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(6 marks)

b) (i) What is a crystal?

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(ii) State any two pieces of information that can be obtained from X–ray diffraction technique.

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(2 marks)

c) Given the following standard enthalpies of combustion in KJ/mol:

Hydrogen = – 286, Carbon = – 394, Methane = – 890

(i) Calculate the standard enthalpy of formation of methane

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(ii) Using the following bond energy terms in KJ/mol; $C - H = +414$, $C = C = +611$, $O - H = +463$, $C - C = +347$, $C - O = +358$, calculate the enthalpy change for the reaction:

$$C_2H_{4(g)} + H_2O_{(l)} \longrightarrow C_2H_5OH_{(l)}$$

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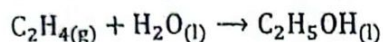
(5 marks)

d) The following is a list of standard electrode potentials.

A: $I_{2(aq)} + 2e^- \rightleftharpoons 2I^-_{(aq)};$ $E^{\ominus} = +0.55V$

B: $Fe^{3+}_{(aq)} + e^- \rightleftharpoons Fe^{2+}_{(aq)};$ $E^{\ominus} = +0.77V$

C: $MnO^-_{4(aq)} + 8H^+_{(aq)} + e^- \rightleftharpoons Mn^{2+}_{(aq)} + 4H_2O_{(l)};$ $E^{\ominus} = +1.5V$

(i) Which species will be most readily oxidized?

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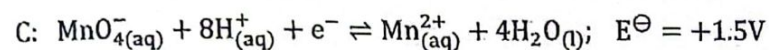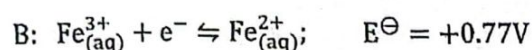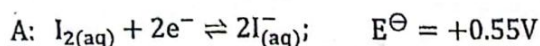
(ii) Write a cell diagram when cells A and C are coupled

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(iii) Calculate the emf of the cell setup between cells A and C.

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(3 marks)

e) Given the reaction; $2A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)}$, if 1.0 mol of A and 0.75 mol of B were placed in a 1 litre vessel and the reaction was allowed to reach equilibrium at a given temperature. At equilibrium, the amounts of A and B were found to be 0.70 mol and 0.60 mol respectively, calculate the equilibrium constant, Kc, for the reaction at that temperature.

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(2 marks)

f) (i) What is a buffer solution?

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(ii) Calculate the pH of an acid buffer made from a solution of 0.05 M ethanoic acid and 0.2 M sodium ethanoate (Ka (CH_3COOH) = 2.0×10^{-5} moldm^{-3}).

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(2 marks)

(TOTAL = 20 MARKS)

2. (a) Thorium, $^{238}_{90}Th$ decays to a radioactive isotope of radium, $^{234}_{88}Ra$ by alpha emission. The half-life of thorium is 8.4 hours.

(i) Write a balanced equation to represent the above change.

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(ii) How many hours will it take for the activity of thorium to reduce to 12.5 % of its original value?

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(3 marks)

(b) The first ionization energies of the elements in period 2 are given below.

Li	Be	B	C	N	O	F	Ne
520	900	801	1086	1402	1314	1681	2081

(i) Write an equation to represent the first ionization energy of oxygen.

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(ii) Account for the general increase in first ionization energy from Lithium to Neon.

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(iii) Explain why the first ionization energy of boron is less than that of beryllium

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(3 marks)

c) Trichloromethane ($CHCl_3$, BP = 16.8^{0}C) and ethoxyethane ($C_2H_5OC_2H_5$, BP = 34.6^{0}C) show negative deviation from Raoult's law.

(i) What do you understand by negative deviation from Raoult's law?

....

....

(ii) State two experimental evidences to show that there is negative deviating negatively from Raoult's law.

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(iii) In the grid provided below, sketch and label for the above mixture, the vapour pressure -- composition curve.
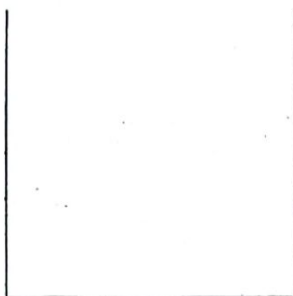
(5 marks)

d) Identify the nature of the binding forces responsible for the following:

(i) The rigidity of candle wax

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....

(ii) The electrical conductivity of high-tension aluminum cables.

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....

(iii) The breaking down of sodium chloride crystal lattice as it dissolves in water.

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(3 marks)

e) The data below was obtained for the reaction between ethanoic acid and ethanol in the presence of an acid catalyst.

$$CH_3COOH_{(l)} + CH_3CH_2OH_{(l)} \rightleftharpoons CH_3COOCH_2CH_{3(l)} + H_2O_{(l)}$$
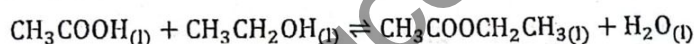
| Experiment | Concentrations in mol/dm³ | | | Rate / $(moldm^{-3}S^{-1})$ |
	$[CH_3COOH_{(l)}]$ $(moldm^{-3})$	$[CH_3CH_2OH_{(l)}]$ $(moldm^{-3})$	$[H^+]$ $(moldm^{-3})$	
1	0.30	0.05	0.05	5.7×10^{-5}
2	0.30	0.10	0.05	5.7×10^{-5}
3	0.30	0.05	0.10	1.2×10^{-4}
4	0.36	0.05	0.05	7.1×10^{-5}

(i) Deduce the order of the reaction with respect to:

$[CH_3COOH_{(l)}]$

....

....

$[CH_3CH_2OH_{(l)}]$

....

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$[H^+]$

....

....

(ii) Write the rate law for the reaction

....

(iii) From experiment 1, calculate the value of the rate constant, K, indicating its units.

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....

(iv) State one postulate of the collision theory

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....

(6 marks)

(TOTAL = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3.a) Complete the table below for the most stable hydrides of period 2 elements.

	Li	Be	B	C	N	O	F	Ne
Formula of hydride								
Acid/base character								

(5 marks)

b) State and explain the trend in atomic radius across the elements Li to Ne.

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(2 marks)

c) Write balanced equations for the action of heat on:

A: $LiNO_3$

....

B: KNO_3

....

C: $Mg(NO_3)_2$

....

(3 marks)

d) (i) State any two reasons why the chemistry of lithium and its compounds differs from the rest of group I elements, but resembles that of group II elements and their compounds.

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(ii) Sketch a graph that shows the variation of the first ionization energies of the group I elements as the group I is descended.

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(iii). Account for the shape of your graph.

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(4 marks)

e) (i) "Inert pair effect" is a term commonly associated with group IV elements. What do you understand by "inert pair effect"?

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....

(ii) Explain how the oxidation states of group (IV) elements are affected by the "inert pair effect".

....
....

(iii) Write balanced chemical equations to show the reaction of water with:
A: CCl_4:

....

B: $SiCl_4$:

....

(iv) Why does carbon catenate extensively?

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....

(6 marks)
(TOTAL = 20 marks)

4.) a) Ammonium nitrate and ammonium sulphate are important fertilizers in agriculture.

(i) With an explanation, state which of the two is a better nitrogen containing fertilizer?

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(ii) What effect will too much addition of this 'better' fertilizer have on the pH of the soil? Explain your answer.

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(4 marks)

b) Fluorine, chlorine bromine and iodine are some elements of group VII and exist as diatomic molecules.

(i) Which of the molecules will have the lowest bond dissociation energy? State a reason.

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....

(ii) What are the functions of:

A: Fluorine in tooth paste?

....
....

B: Chlorine in treated water?

....
....

C: Iodine in kitchen salt?

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....

(4 marks)

c) (i) Write down balanced equations for the laboratory preparation of HCl and HI

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....
....

(ii) Explain why the boiling point of HF is higher than that of HCl.

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(4 marks)

d) Transition metals exhibit characteristic properties. Explain how the following characteristic properties of transition metals arise.

(i) Variable oxidation states

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(ii) Formation of coloured compounds

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....

....

(iii) formation of complex ions.

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(6 marks)

(e) Given the complex ion $[Fe(CN)_6]^{4-}$, indicate the coordination number and oxidation state of the central metal ion

Coordination number: ....

Oxidation state: ....

(2 marks)
(TOTAL = 20 marks)

SECTION C : ORGANIC CHEMISTRY

5.) A solid organic compound obtained from a natural plant was isolated by extraction using an organic solvent. A 1.0 g portion of this compound gave on combustion 1.7765 g carbon dioxide, 0.973 g of water. An analysis of the compound revealed that the compound contained carbon, hydrogen and oxygen only. Another analysis of the compound showed that its most significant peak corresponded to a mass-to-change ratio of 76.

a) State the analytical technique or experimental approach that could be used to:

(i). Obtain the mass-to-change ratio of 76.

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(ii) Determine the bond types between the C, H, and O atoms of this compound.

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(2 marks)

b) (i) Determine the empirical formula of the compound

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(ii) Determine the molecular formula of the compound

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(5 marks)

c) Another organic compound was found to contain carbon, hydrogen and chlorine. Describe briefly how you would confirm the presence of chlorine in the compound.

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(2 marks)

d) Giving reagents, reaction conditions and observations, give chemical tests to distinguish between the following organic compounds.

(i) CH_3COCH_3 and CH_3CHO

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....

(ii) $CH_3CH=CH_2$ and CH_3COOH

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(6 marks)

e) Given the organic compounds;   A: $CH(CH_3)_2CH_2CH_2CH_2OH$,

B: $CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle Br}{|}}{C}} - CH_3$ C: $CH_3CH(NH_2)COOH$

)   Identify the type of isomerism exhibited by compounds B and C

Compound B : ....
Compound C : ....

i)   Draw the structures of the isomers of compound C

....
....
....

) Name compound A...

(5 marks)
(TOTAL = 20 marks)

6. a) Give the product for each of the reactions below.

(i) C_6H_6 $\xrightarrow[\text{Reflux; }55-60\ ^{\circ}C]{\text{Conc. }H_2SO_4/\text{conc. }HNO_3}$

(ii) $CH_3CH_2CH_2Br$ $\xrightarrow[\text{Reflux}]{\text{NaOH/alcohol}}$
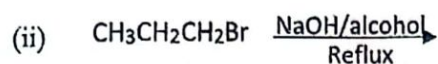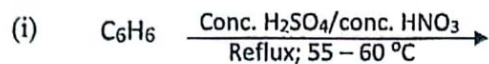
(iii) Write down the reaction mechanism for the reaction in a(i) above

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(5 marks)

b) Study the reaction scheme below, then answer the questions which follow

B: CH_3CH_2CN

$D \xleftarrow{CH_3COCl} C_3H_9N \xleftarrow{i} C_4H_9ONH_2$
    A   C

B $\downarrow$ ii
A $\downarrow$ NaNO₂/HCl

$E \xrightarrow{iii} CH_3CH_2COOH$
              F
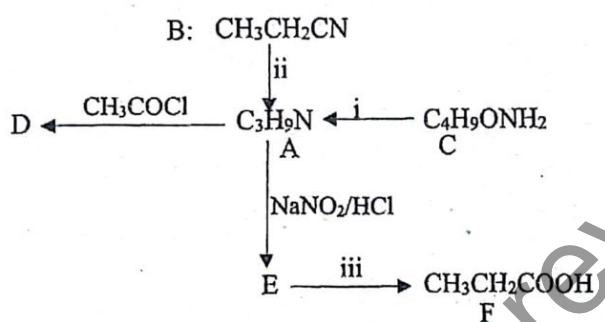
(i) Give the structures of compounds A and C

A : ....

C : ....

(ii) Give the reagents and reaction conditions for processes i, ii and iii

   i : ....

   ii : ....

   iii : ....

(iii) Identify compounds D and E by giving their formulae

D : ....

E : ....

(iv) Identify the functional group present in compound C and give a chemical test to identify the group

....

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(12 marks)

c) Given the amino acid, H_2NCH_2COOH,

(i) Name one method that could be used to separate the amino acid from its mixture with other components

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(ii) Give the formula of the amino acid in a neutral medium

....

....

(iii)   How is the zwitterion of the amino acid formed?

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(3 marks)
(TOTAL = 20 marks)

END