Teacher's Copy.

0715/2/2023
CHEMISTRY A/L

SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION

THE TEACHERS' RESOURCE UNIT (TRU)

IN COLLABORATION WITH

THE REGIONAL INSPECTORATE OF PEDAGOGY FOR SCIENCE AND
THE SOUTHWEST CHEMISTRY TEACHERS' ASSOCIATIONS (SOWECTA)

TUESDAY: 21/03/2023-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:

One (1) atmosphere (1atm) = 1 Pa = 1.01 x 105 Nm^{-2}. Molar gas volume = 24,000 cm^3 at RTP

Molar gas constant R = 0.082 $atmdm^{-3}K^{-1}$ (Or R = 8.314 $JK^{-1}mol^{-1}$)

RAM: C=12.0, H=1.0, O=16.0, N=14, Cl = 35.5

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) i) Define Avogadro constant

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(ii) Calculate the number of chlorine atoms present in 0.74 g of chlorine-37 (Avogadro constant, L = 6.02×10^{23}).

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(2 marks)

b) (i) What do you understand by the term;

A: Empirical Formula:

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B: Molecular Formula:

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(ii) Analysis shows that 2.215 g of the chloride of an element (E) contains 1.065 g of chlorine. Determine the formula of the chloride given that the relative atomic mass of E is 115.

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(4 marks)

c) In the experiments for the discovery of subatomic particles, some observations were made. State the significance of each of the following observations:

(i) Cathode rays were able to cast a sharp shadow of an object placed in its path.

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(ii) The electric counter was able to deflect only when a block of paraffin wax was placed between the beryllium foil and the counter.

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(2 marks)

d) The mass spectrometer is an instrument used to determine the relative atomic mass of an element.

(i) Why must the interior of the instrument be evacuated before being used?

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(ii) Chlorine consists of two isotopes in nature namely Chlorine-35 and Chlorine-37. If the relative atomic mass of Chlorine is 35.5, determine the relative abundance of each isotope.

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(iii) 28.0% of an isotope of silver decays in one and a half year; determine the half-life of the isotope.

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(4 marks)

e) (i) In the determination of the first ionization energy of an element by the electron impact method, how do you know if ionization has occurred?

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(ii) In the determination of the ionization energy of an element by the emission spectra method; what does each line in the emission spectrum represent?

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(2 marks)

f) (i) Identify the different bond types present in lithium aluminum hydride ($LiAlH_4$).

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(ii) Draw the shape of the oxonium ion (H_3O^+) and propose a value for its bond angle.

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(iii) Water is the only liquid which freezes with an increase in volume. Explain

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(4 marks)

g) Given the equilibrium system; $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

State what would happen to the equilibrium position when:

(i) Pressure is increased at constant temperature.

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(ii) A catalyst is introduced into the system.

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(2 marks)

(TOTAL = 20 marks)

2. (a) (i) Determine the conjugate acid-base pairs in the equilibrium below:

$HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{2-}$

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(ii) 1 dm^3 of an aqueous solution contains 0.1 mole of methanoic acid and 0.1 mole of potassium methanoate. Calculate the pH of the solution. Ka(HCOOH) = 1.6×10^{-4} mol/dm^3.

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(3 marks)

(b) (i) State Hess's law.

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(ii) Using the data below, calculate the enthalpy change of combustion of ethanol.

Substance	C_2H_5OH	CO_2	H_2O
$\Delta H^\ominus_f$ kJ/mol	- 304	- 394	- 286

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(iii) The enthalpy of hydration of rubidium chloride is -655 kJ/mol and its enthalpy of solution is +19 kJ/mol. Calculate the lattice energy of rubidium chloride.

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(4 marks)

c) When x-rays with wavelength of 0.05nm are diffracted by a certain crystal, the angle of diffraction of the first order beam n = 1, is found to be 10.5^0, calculate:

(i) The distance between the layers of atoms in the crystal responsible for the diffraction.

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(ii) The angle of diffraction for the second order beam, n = 2.

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(3 marks)

d) Given the following half cells:

A: Fe^{3+} / Fe^{2+} ; $E^\ominus$ = +0.77V

B: Ag^+ / Ag ; $E^\ominus$ = +0.80V

C: Cl_2 / Cl^- ; $E^\ominus$ = +1.36V

D: Zn^{2+} / Zn ; $E^\ominus$ = - 0.76V

(i)Identify the strongest reducing agent from the redox half cells A to D.

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(ii) From the data given, predict whether or not, a solution of $FeCl_3$ can be stored in a Zn metal container.

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(3 marks)

e) For the reaction: $H_2(g) + I_2(g) \longrightarrow 2HI(g)$

The rate is quadrupled when the concentration of H_2 is doubled and that of I_2 kept constant. The rate is doubled when the concentration of I_2 is doubled and that of H_2 kept constant.

(i) Write the rate expression for this reaction.

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(ii) Determine the overall order of the reaction.

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(iii) Predict what will happen to the rate of the reaction if the concentration of H_2 is halved and that of I_2 kept constant?

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(iv) What do you understand by the term "molecularity of a reaction"?

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(4 marks)

f) (i) What is a non-ideal mixture?

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(ii) An ideal mixture is made up of 0.076 mol of compound A and 0.543 mol of compound B. Given that compound B, has a vapour pressure of 36.7 mmHg at 30 ^{0}C and the total vapour pressure of the mixture is 80 mmHg at 30 ^{0}C. Calculate the partial vapour pressure of compound A in the mixture.

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(3 marks)

(TOTAL = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3. a) (i) Define the term periodicity?

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(ii) Write the formulae of two oxides, one from period 2 and one from period 3 having giant molecular structures.

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(iii) Most covalent hydrides are acidic, name one covalent hydride in period 2 that is alkaline.

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(iv). Consider two closely adjacent iodine molecules, what is the difference between the atomic radius and the van der Waals radius of iodine?

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(5 marks)

b)(i) What do you understand by the term "electronegativity of an element"?

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(ii) How does electronegativity vary across the Periodic Table from left to right?

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(2 marks)

c) (i) Lithium and magnesium show diagonal relationship. What do you understand by the term "diagonal relationship"?

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(ii) Write two chemical equations to show the similarity between the hydroxides of lithium and magnesium.

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(iii) State one way in which Beryllium oxide differs from all the other oxides of the s-block elements?

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(iv). State and explain how the solubility of the sulphates of s-block elements varies down the group.

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(6 marks)

d) Some group IV elements show allotropy and catenation and also form different types of oxides.

(i) State one condition required for an element to catenate.

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(ii) Name one element that exhibits allotropy but does not catenate.

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(iii) Why is the +2 oxidation state more stable as the group IV is descended?

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(iv). Write the chemical formulae of two oxides in group IV that are;
A: Amphoteric.....B: Acidic.....

(5 marks)

e) (i) Nitric acid prepared in the laboratory often has a yellowish colour as opposed to nitric acid produced industrially. Explain.

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(ii) Nitrogen dioxide is described as a mixed acidic oxide. Write an equation for the reaction of nitrogen dioxide with water at room temperature.

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(2 marks)

(TOTAL = 20 marks)

4. a)(i) Name the noble gas which is isoelectronic to the Scandium ion.

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(ii) Why are iron(III) compounds generally more stable than iron(II) compounds?

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(iii) Why is an aqueous solution of iron(III) chloride often neutralized before being used?

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(iv). Both Fe^{2+} and Cr^{3+} solutions form green precipitates with aqueous NaOH. How can you distinguish between aqueous solutions of Fe^{2+} and Cr^{3+} using NaOH?

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b) Consider the following complex compound: $[CrCl_2(H_2O)_4]Cl \cdot 2H_2O$

(i) Name the complex compound.

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(ii) Write an ionisation equation for the complex compound.

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(iii) State the oxidation state and coordination number of chromium in the complex compound.
A: oxidation state .....B: coordination number: .....

(iv). State the shape of the complex ion formed from the complex compound.

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(9 marks)

c) (i) Write balanced ionic equations for the following disproportionation reactions of chlorine gas with:
A: cold dilute aqueous potassium hydroxide.

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B: hot concentrated aqueous potassium hydroxide.

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C: Why are these reactions described as disproportionation reactions?

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(ii) Hydrogen chloride may be prepared by the action of concentrated sulphuric acid on sodium chloride but a corresponding method is not suitable for hydrogen bromide.
A: Account for the difference.

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B: Name a suitable acid used for the preparation of hydrogen bromide in the laboratory.

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(iii) Consider the following oxoacids: $HClO$ and $HClO_3$.

A: Which of them is a stronger acid and why?

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B: Which of them is a stronger oxidizing agent and why?

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(8 marks)

d) Concentrated sulphuric acid is a strong oxidizing and dehydrating agent.

(i) Name the catalyst that is used in the manufacture of sulphuric acid.

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(ii) In the laboratory preparation of chlorine gas using $MnO_{2(s)}$, concentrated $HCl_{(aq)}$ and concentrated sulphuric acid, what is the role of the concentrated sulphuric acid?

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(2 marks)

e) Sulpur dioxide reacts with hydrogen sulphide in a redox reaction. Write a balanced equation for the reaction.

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(1 mark)

(TOTAL = 20 marks)

SECTION C : ORGANIC CHEMISTRY

5. (a) Briefly describe how the presence of the following elements can be determined in an organic compound after the sodium fusion test:

(i) Iodine

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(ii) Nitrogen

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(4 marks)

b) (i) The enthalpies of hydrogenation of cyclohexene and real benzene are -120 kJ/moi and -208kJ/mol respectively.

A : Explain why the enthalpy of hydrogenation of real benzene is not three times that of cyclohexene.

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B : Calculate the resonance or delocalisation energy of benzene.

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ii) In NOT more than two steps, write equations to show how benzoic acid can be obtained from benzene.

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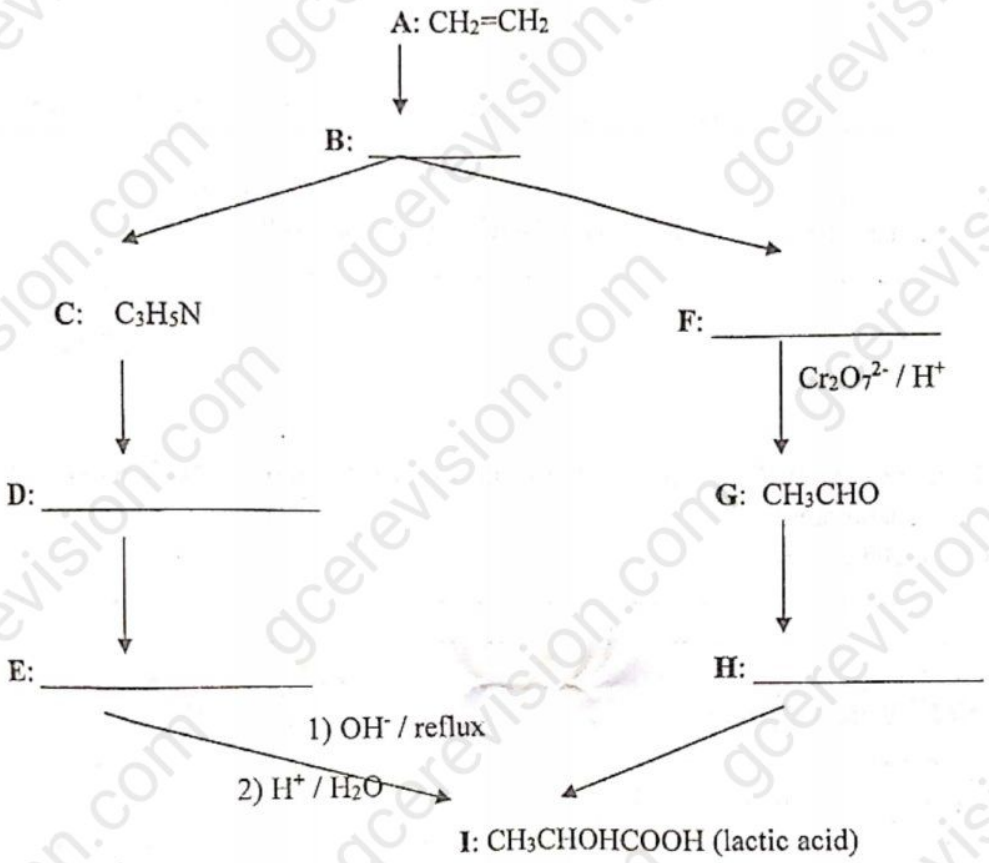
(5 mar

c) Study the synthetic pathway below and answer the questions that follow.



(i) Write the systematic name of lactic acid.

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(ii) If B has a relative molecular mass of 64.5 and it consists of carbon, hydrogen and chlorine onl determine the structure of B.

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(iii) Identify C by its structure and systematic name.

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(iv). State the reagents and reaction conditions for preparing compound C from B.

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(v) Give the structural formula of:

D: .....E: .....

F: .....H: .....

(vi). The lactic acid prepared in the laboratory has an asymmetric carbon but it is not optically active. Explain.

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(10 marks)

d)(i) What spectroscopic technique(s) can be used to identify functional groups in an organic compound ?

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ii) Write the structure of alanine $H_2NCH(CH_3)COOH$ in a neutral medium.

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(2 marks)

(TOTAL = 20 marks)

6. a) Using suitable reagents and reaction conditions, show how you can distinguish between the following compounds in the laboratory.

(i) But-1-yne and But-2-yne.

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(ii) Propan-1-ol and propan-2-ol.

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(4 marks)

b) (i) Using chemical equations, show how you can produce the following amines from propanamide. ($CH_3CH_2CONH_2$)

A: $CH_3CH_2CH_2NH_2$

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B : $CH_3CH_2NH_2$

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(ii) How is the reaction in (i)B above called ?

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(3 marks)

c) Write the structure of the MAJOR product of the following reactions :

(i) Refluxing of aqueous NaOH with $CH_3CH_2CHBrCH_3$

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(ii) Refluxing of alcoholic NaOH with $CH_3CH_2CHBrCH_3$

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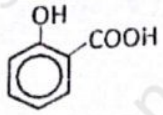
(2 marks)

d) Given the compound;



How would you test for the presence of the following functional groups in the compound?

(i) – OH group:

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(ii) – COOH group:

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(4 marks)

e) The carbon atoms in the following compounds exhibit different hybridizations.

A: $CH_2=CH_2$ B: CH_3CH_3 C: $CH\equiv CH$.

i) Using the letters **A, B, C**, select the compound in which the carbon atoms exhibits only:

sp^3 hybridisation

.....

sp hybridisation

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ii) Write down the structures of two isomers with the molecular formula C_4H_8 that would not decolorise bromine water at room temperature.

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(4 marks)

f) CH_3COCH_3 reacts with 2,4-dinitrophenylhydrazine to give an orange precipitate.

i) What name is given to this type of reaction?

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ii) Write the equation for the reaction between 2, 4-dinitrophenylhydrazine and propanone.

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(3 marks)

g) When HBr(g) is bubbled through propene, 90% of the products obtained is 2-bromopropane while only 10% is 1-bromopropane.

i) Why is 2-bromopropane obtained with a higher yield?

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ii) State the specific type of isomerism that relates the two products from the above reaction.

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iii) Write the mechanism for the reaction that produces 2-bromopropane.

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(3 marks)

(TOTAL = 20 marks)

END