REGISTRATION CENTRE NUMBER	CENTRE NAME	
CANDIDATE FULL NAMES		
CANDIDATE IDENTIFICATION NUMBER	SUBJECT CODE 0715	PAPER NUMBER 2

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GENERAL CERTIFICATE OF EDUCATION BOARD
ADVANCED LEVEL EXAMINATION

SUBJECT TITLE	SUBJECT CODE	PAPER NUMBER
CHEMISTRY	**0715**	**2**
	EXAMINATION DATE: **JUNE 2022**	

Three hours

Enter the information required in the boxes of the flap.

Answer ALL the SIX questions in this booklet.

The mark allocation is indicated for each question. Each question carries 20 marks.

Verify that this booklet contains six questions, 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 or there are blank pages so that the booklet should be changed.

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 for answers without brief statements showing how the answers have been obtained.

Calculators may be used.

Useful Data

One atmosphere (1 atm) = 1Pa = 1.01 x1 0^5 N m^{-2}

Relative atomic masses (RAM)

C = 12.0, S = 32.0, O = 16.0, H = 1.0 ; Na = 23

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Marked by: ..... *Signature:* ..... *Date:*	***SCORE***
Checked by: ..... *Signature:* ..... *Date:*	

Turn Over

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) Hydrogen peroxide decomposes according to the equation

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The reaction is first order with respect to hydrogen peroxide and is catalyzed by manganese (IV) oxide

(i) Sketch in the space below, the change in concentration (y-axis) of hydrogen peroxide with time (x-axis)

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(ii) Define

A: Order of reaction.....

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B: Catalyst.....

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(3 marks)

(b) State two postulates of collision theory.

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(2 marks)

(c) (i) What is the Born-Haber cycle?

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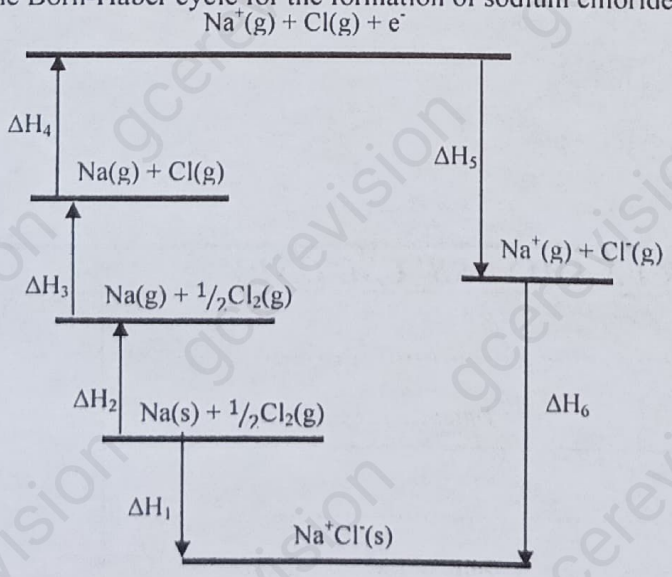
(ii) Below is the Born-Haber cycle for the formation of sodium chloride, NaCl.



Label the energy changes represented by ΔH_1, ΔH_4 and ΔH_6

ΔH_1.....

ΔH_4.....

ΔH_6.....

(iii) Explain, in terms of enthalpy changes, why some arrows are pointing upwards while some are pointing downwards.

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(5 marks)

(d) Given that the x-ray power pattern of KCl shows a cone at $\theta = 13.98$ and the distance between successive layers is 6.73×10^{-9} cm^3. Use the Bragg's equation to calculate the wavelength of the x-rays.

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(2 marks)

(e) Covalent bonds, ionic bonds and intermolecular forces are building forces in substances.

(i) Define

A: Covalent bond

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.....

B: Ionic bond

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.....

(ii) Identify the types of intermolecular forces in each of the following substances

Substance	**Intermolecular force**
Ice	
Propanone	
Kerosene	

(5 marks)

(f) For the reaction: $2NO(g) + 2H_2(g) \rightarrow N_2(g) + H_2O(l)$

The following data was obtained at the same temperature.

Experiment	Concentration (mol dm^{-3}) of		Initial rate mol dm^{-3} s^{-1}
	NO	H_2	
1	0.30	0.15	1.4×10^{-4}
2	0.60	0.15	5.6×10^{-4}
3	0.60	0.30	1.12×10^{-3}
4	0.30	0.30	2.8×10^{-4}

Deduce

(i) The order of the reaction with respect to NO and H_2.

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.....

.....

.....

(ii) The overall order of the reaction

.....

(3 marks)
(Total = 20 marks)

2(a) A standard solution of a 0.18 mol dm^{-3} sulphuric acid was prepared, 21.6 cm^3 of the solution neutralized 25.0 cm^3 of a sodium hydroxide solution. On evaporation and weighing, 0.30 g of the salt Na_2SO_4, was obtained.

(i) What is a standard solution?

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(ii) Calculate the molarity of sodium hydroxide solution

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.....

(iii) Determine the mass of Na_2SO_4 expected.

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(iv) Calculate the percentage yield of the reaction

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(5 marks)

(b) The reaction $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ is in equilibrium at 503 K. The concentrations of the species at equilibrium in mol dm^{-3} are: $[NO] = 0.03$, $[NO_2] = 8.9$, $[O_2] = 0.07$

(i) State the equilibrium law

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(ii) Write the expression for the equilibrium constant

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(iii) Calculate the value for the equilibrium constant (Kc) stating its units..

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(4 marks)

(c) Given the following standard electrode potentials for the following half cells:

$Pb^{2+} + 2é \rightarrow \quad Pb(s) \quad E^{\theta} = -0.13\ V$
$Zn^{2+} + 2é \rightarrow \quad Zn(s) \quad E^{\theta} = -0.76\ V$

(i) Write the overall equation for the cell reaction.

.....

(ii) Draw the cell diagram for the combination of the two half cells.

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(2 marks)

(d) Calculate the pH of a 0.25 M solution of calcium hydroxide, $Ca(OH)_2$

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(2 marks)

(e) Ethanol (boiling point 78 °C) and propanone (boiling point 56 °C) form a completely miscible solution that deviates positively from Raoult's law.

(i) State Raoult's law

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.....

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(ii) Why does the mixture deviate positively from Raoult's law?

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(iii) Draw a well labeled graph of vapour pressure against composition for the mixture

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(4 marks)

(f) The relative abundance of each naturally-occurring lead isotope is given as follows:

Isotope	% abundance
^{204}Pb	2
^{206}Pb	25
^{207}Pb	21
^{208}Pb	52

(i) What are isotopes?

.....

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.....

.....

(ii) Calculate the relative abundance of lead.

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(3 marks)

(Total = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3 (a) Consider the following elements of Group VII (Group 17) of the periodic table: F, Cl, Br, I.

(i) Sketch a graph of bond energy against atomic number for the elements.

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Explain the shape of the graph.

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(ii) Write balanced chemical equations for the laboratory preparation of HCl and HBr.

HCl.....

HBr.....

Explain the reason for the similarity or difference in the method of preparation

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(8 marks)

(b) In the manufacture of sulphuric acid, H_2SO_4, the sulphur trioxide, SO_3, formed is dissolved in already existing concentrated sulphuric acid.

(i) Write an equation for the reaction at this stage.

.....

(ii) Give reasons why water is not added to the sulphur trioxide to produce sulphuric acid

.....

.....

(2 marks)

Turn Over

(c) Complete the table below by giving the formula and name of compounds of sulphur with the following oxidation states.

Oxidation state	Formula	Name of compound
-2		
+4		

(2 marks)

(d) (i) Give the formula of one nitrogenous fertilizer.

.....

(ii) What is the danger of applying more fertilizer to the soil than necessary?

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(2 marks)

(e) The elements of group I and II of the periodic table are called s – block elements.

(i) Write down the outermost electronic configuration of the elements of group I.

.....

(ii) State and explain the trend down the group for the reactions of the Group II (Group 2) elements with water.

Trend: .....

Explanation.....

.....

.....

(iii) Write balanced chemical equations to show the reactions of the following elements with water.

A. Sodium: .....

B. Magnesium: .....

(iv) Arrange the hydroxides of Group II elements (Group 2) in increasing order of solubility beginning with the least soluble.

(6 marks)

(Total = 20marks)

4. (a) The element Li, Be, B and C are successive elements in period (II) of the periodic table with first ionization energies 520, 903, 800 and 1085 kJ mol^{-1} respectively.

(i) What is first ionization energy?

.....

.....

.....

(ii) Explain why;

A: beryllium has a higher first IE than lithium.

.....

.....

.....

B: the first ionization energy of boron is less than that of beryllium?

.....

.....

.....

(iii) Complete the table below by giving the formula of the hydrides formed by the elements.

Element	Li	Be	B	C	N	O	F	Ne
Hydride								

(iv) Which two elements in a(iii) above form neutral hydrides

(8 marks)

(b) The group IV elements of the periodic table are C, Si, Ge, Sn and Pb.

(i) Complete the table below by giving the formulae of the oxides of the elements in the +4 oxidation state.

Element	C	Si	Ge	Sn	Pb
Oxide					

(ii) Give the formula of one oxide in b(i) which is:

Amphoteric.....

A green house gas.....

(iii) The elements form tetrachlorides of general formula XCl_4. Write the reaction of the tetrachloride of germanium with water.....

(5 marks)

(c) Transition metals characteristically form complex ions and show variable oxidation state in their compounds

(i) What is a transition metal?

.....

.....

(ii) Give one reason in each case to explain why transition metals.

A: form complexes

.....

.....

B: Show variable oxidation states

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(3 marks)

(d) The complex compound $Co(NH_3)_5BrSO_4$ exhibits isomerism

(i) What type of isomerism does the compound exhibit? .....

(ii) Give the structural formulae of the isomers

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(3 marks)

(e) Give the shape of the complex $[Cu(H_2\ddot{N}CH_2CH_2\ddot{N}H_2)_2]^{2+}$

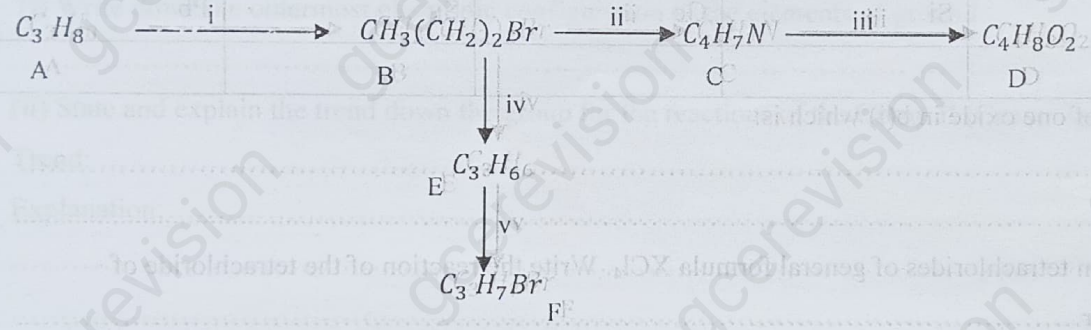
.....

(1 mark)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5 (a) Study the reaction scheme below and answer the questions which follow.



(i) Give the reagents and conditions for steps i, ii, iii, iv and v

Steps	Reagent and conditions
i	
ii	
iii	
iv	
v	

(ii) Give the structures of compounds D, E and F

D.....

.....

E.....

.....

F.....

.....

(iii) Outline the mechanism for the reaction of compound E with Br_2/CCl_4.

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(12 marks)

(b) Suggest chemical tests which could be carried out to distinguish between the following pairs of compounds.

(i) CH_3CH_2CHO and C_6H_5CHO

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.....

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(ii) $CH_3CH_2C{\equiv}CH$ and $CH_3C{\equiv}CCH_3$

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(6 marks)

(c) Organic chemistry is the chemistry of mostly carbon-containing compounds. State 2 unique properties of carbon.

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(2 marks)
(Total: 20 marks)

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6. (a) An organic compound, Y, on analysis was found to contain 35.0% carbon, 6.6% hydrogen and 58.4% bromine. Molecular weight determination of the compound gave a value of 136.9. (R.A.M: C = 12, H = 1, Br = 79.9)

(i) Calculate the empirical formula of the compound.

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(ii) Determine the molecular formula of the compound Y.

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(iii) How can you test for the presence of Bromine in the compound?

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(6 marks)

(b) The organic compound Z with molecular formula $C_4H_8O_2$ exhibits isomerism

(i) What is isomerism

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(ii) Give the structures and names of all the isomers of the compound Z.

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(iii) What kind of isomerism could be exhibited by the compound Z?

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(7 marks)

(c) The compound $CH_3CH(CH_3)CONH_2$ has a functional group, -CONH

(i) What is a functional group?

.....

.....

.....

(ii) Give the systematic name of the compound.....

(iii) Which spectroscopic method can be used to determine the presence of the double bond in the molecule?

.....

(3 marks)

(d) The compound $CH_3CH(NH_2)COOH$ is an amino acid containing an asymmetric carbon atom.

(i) Put an asterisk (*) on the asymmetric carbon

(ii) Give the structure of the compound in the following medium

Acidic:

.....

.....

Basic:

.....

.....

Neutral:

.....

.....

(4 marks)

(Total = 20 marks)

GO BACK AND CHECK YOUR WORK