

REGISTRATION CENTRE NUMBER

CENTRE NAME

CANDIDATE'S FULL NAMES

CANDIDATE'S IDENTIFICATION NUMBER

SUBJECT CODE
0715PAPER NUMBER
2**FOR OFFICIAL USE ONLY**
(Candidate Random CODE): ►**GENERAL CERTIFICATE OF EDUCATION BOARD**
General Certificate of Education Examination
ADVANCED LEVELSUBJECT TITLE
CHEMISTRYSUBJECT CODE
0715PAPER NUMBER
2EXAMINATION DATE: **JUNE 2024****Duration: 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.

Noiseless calculators may be used.

Useful Data: $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ or $0.082 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$ One atmosphere (1 atm) = 1 Pa = $1.01 \times 10^5 \text{ N m}^{-2}$

Relative atomic masses (RAM)

C = 12.0, O = 16.0, S = 32.0, H = 1.0; Cl = 35.5

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Marked by:

SCORE

Signature: Date:

Checked by:

Signature: Date:

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1.

- (a) The half-life of the radioactive isotope lead-210 is 19.7 years.

(i) What is half-life?

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(ii) How long will it take for a sample of the isotope to decay to 15% of its original value?

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(4 marks)

- (b) (i) Define order of reaction with respect to a reactant.

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(ii) Sketch a graph of rate against concentration of a zero, first and second order reaction on the same grid.

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(4 marks)

- (c) Define the following and give a suitable example of each.

(i) Homogeneous catalyst.

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(ii) Heterogeneous catalyst.

(a) (i)

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.....
(d) (i) Define an acid with respect to the Brønsted-Lowry concept. **(4 marks)**

(a) (ii)

(ii) Calculate the pH of 0.001 M solution of sulphuric acid

(a) (iii)

(a) (iv)

(a) (v)

(3 marks)

(e) Study the redox systems given and their corresponding standard electrode potentials, then answer the questions that follow. **(2 marks)**

REDOX SYSTEM	E° / volts
A $\text{Pb}^{2+} + 2\text{e} \rightarrow \text{Pb(s)}$	-0.13
B $\text{I}_2(\text{aq}) + 2\text{e} \rightarrow 2\text{I}^-(\text{aq})$	+0.54
C $\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e} \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51

(i) Identify the strongest oxidizing and reducing agents.

Strongest Oxidizing agent:

(a) (i)

Strongest Reducing agent:

(a) (ii)

(ii) Write the cell diagram of the cell that results when A and B are coupled and calculate the emf of the cell.

(a) (iii)

(iii) In which direction will electrons flow in the external circuit when cells A and B are connected?

(5 marks)

(Total = 20 marks)

2. (a) Define the following:

(i) Mole of a substance.

(ii) Give one example of a hetero atom element that can form more than one type of covalent bond.

(ii) Avogadro constant.

(2 marks)

(b) (i) 0.217 g of a volatile liquid produces 47.1 cm^3 of vapour at 60°C and 2.16 atm. Calculate the molar mass of the liquid. ($R = 0.082 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$)

(ii) State the method used in the determination of the molar mass of a volatile liquid.

(3 marks)

(c) Ionic bonds, covalent bonds and hydrogen bonds are all forces of attraction.

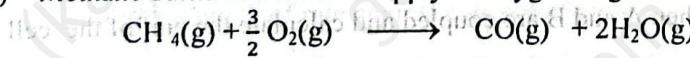
(i) Distinguish between an ionic bond and a covalent bond.

Ionic bond	Covalent bond
Attraction between oppositely charged ions	Attraction between atoms
Electrostatic force	Electrostatic force
Attraction between positive and negative charges	Attraction between nuclei and electrons

(ii) Give one condition necessary for the formation of hydrogen bonds.

(3 marks)

(d) Methane burns in a limited supply of oxygen to give carbon monoxide and water.



The standard enthalpy change of combustion of methane and carbon monoxide are -890 kJ mol^{-1} and -283 kJ mol^{-1} respectively.

(i) Sketch the energy cycle diagram that combines all the above combustion reactions.

(ii) Calculate the enthalpy change for the combustion of methane in limited supply of oxygen.

(iii) State Hess's Law.

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(4 marks)

(e) X-ray diffraction is one of the indirect methods used in determining the structure of crystals.

(i) What is x-ray diffraction?

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.....
.....

(ii) In a potassium nitrite, (KNO_2) crystal, x-rays of wavelength 1.55×10^{-8} cm form a second-order cone at an angle of 8.92° . Calculate the spacing between the layers of ions in the crystal.

D	n	M	N	Evidence
.....

(iii) Write a balanced equation for the reaction between two aqueous solutions of sulphuric acid and sodium hydroxide.

(3 marks)

(f) A mixture comprising of 28 g of methanol and 36 g of ethanol obeys Raoult's law closely. At 30°C the vapour pressures of methanol and ethanol are 32 KPa and 20 KPa respectively. Calculate:

(i) Mole fraction of each component in the mixture.

Soilion and obizobz (3 marks)

(d) (a).....

(b) (i) Give the equilibrium stoichiometric equation for the complete combustion of ethanol.

(ii) Partial vapour pressure of each component in the mixture.

(i) For the elements lithium and potassium

.....

B: Second ionisation energy for Beryllium

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.....
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(4 marks)

(Total = 20 marks)

(e) (2 marks)

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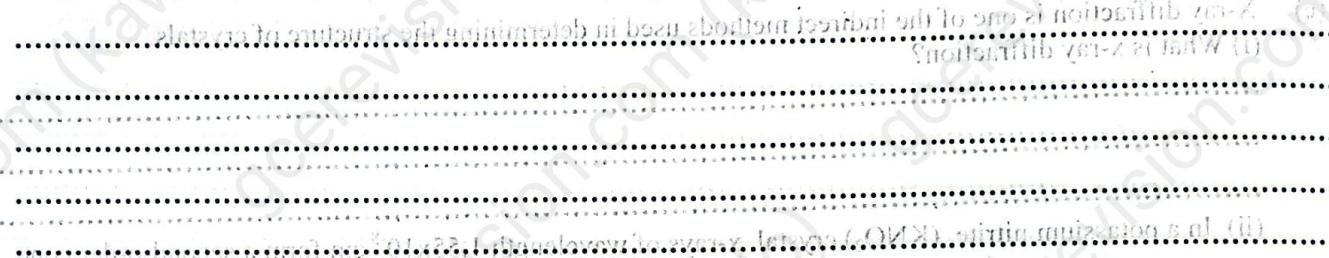
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SECTION B: INORGANIC CHEMISTRY

3. (a) This question concerns the elements across period 3 of the periodic table (Na – Ar).

(i) Sketch a graph for the variation of first ionisation energy against atomic number for the elements.

(a) (i)



(ii) Complete the table below by giving the chemical formulae of the stable oxides of the elements.

Element	Na	Mg	P	Cl
Oxide				

(iii) Write a balanced equation for the reaction of silicon tetrachloride with water.

(iv) Write two equations to show the amphoteric nature of aluminium oxide (Al_2O_3)

(v) What makes sulphur dioxide gas acidic?

(8 marks)

(b) (i) Give the outermost electronic configuration for the s-block elements (group I and group II)

(ii) For the elements lithium and beryllium, write equations representing:

A: First ionization energy for Lithium

B: Second ionization energy for Beryllium

(iii) Which of these two elements in b(ii) will have a higher second ionization energy? Explain.

(a) (iii) $I_2 = I_1 + \Delta I$

(5 marks)

- (c) The halogens are the elements in group VII of the periodic table (F, Cl, Br, I).
 (i) Complete the table by giving the colour of each element.

Element	F_2	Cl_2	Br_2	I_2
Colour				

- (ii) Account for the change in physical state (if any) for the elements

.....

(5 marks)

- (d) The hydrogen halides are HF, HCl, HBr and HI.

In the space provided sketch a graph of boiling point against relative molecular mass for the halides

.....

Name	Relative size from left to right	Oxidation state	Boiling point
HF
HCl

Explain the shape of the graph.

.....

(3 marks)

(Total = 20marks)

4. (a) This question is on transition metal chemistry.

- (i) Differentiate between a d-block element and a transition metal.

.....

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	metals
.....

- (ii) $[CrCl_2(H_2O)_4]^+$ is a complex ion formed by a transition metal.

A: Name the complex and state the coordination number of the central metal ion.

Name:

Coordination number:

B: Give one condition which favours the formation of the complex.

.....

Turn Over

- (iii) The compound $\text{Co}(\text{NH}_3)_5\text{BrSO}_4$ exhibits isomerism. State the type of isomerism exhibited by the compound and give the structures of the isomers.

Type of isomerism:

Structure of isomers:

(extra credit)

(8 marks)

- (b) This question concerns the chemistry of nitrogen and sulphur.

- (i) Complete the table below by giving the formula and name of a compound in which sulphur exhibit the oxidation states -2 and +7.

Oxidation state	Formula of compound	Name
-2		
+7		

- (ii) How does the +7 oxidation state in sulphur come about?

- (iii) Give the main chemical equation, indicating the conditions for the manufacture of ammonia by the Haber process.

(extra credit)

- (iv) Give one industrial use of Nitric acid.

(5 marks)

- (c) The group IV elements are C, Si, Ge, Sn and Pb.

- (i) Complete the table below by giving the formula of the oxides of the elements in the +2 and +4 oxidation states.

Element	C	Si	Ge	Sn	Pb
+4 oxidation state					
+2 oxidation state					

- (ii) Give the formula of one oxide each which is

A: Neutral

B: Amphoteric

C: A greenhouse gas

- (iii) Which of these elements exhibit allotropy?

Give the allotropes of one of the elements.

-
-
-

(7 marks)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5. (a) An organic compound contains 40.4% carbon, 7.9% hydrogen and 15.7% nitrogen. The molecular mass of the compound is 89.

- (i) Calculate the empirical formula of the compound.
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-
-

-
-
-

(i) Give the structure of the hydrocarbon.

.....

.....

.....

(ii) Give the structure of the following compounds.

.....

.....

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

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

(8 marks)

Turn Over

(Section 4)
(Section 4, 5, 6, 7, 8, 9)

(b) The amino acid, amino ethanoic acid ($\text{NH}_2\text{CH}_2\text{COOH}$) has both acidic and basic properties. In neutral solution it forms a zwitterion.

(i) What is a zwitterion?

(column 3)
(column 0 & into 1)

(ii) Give the structure of the amino acid in acidic, basic and neutral medium.

Acidic:

Basic:

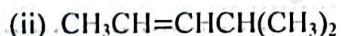
Neutral:

(iii) State the type of reaction taking place when two molecules of aminoethanoic acid combine.

Give the structure of the product.

(6 marks)

(c) Give the systematic names of the following compounds.

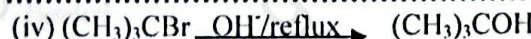


(2 marks)

(d) State the specific type of organic reaction mechanism taking place in the following conversions:

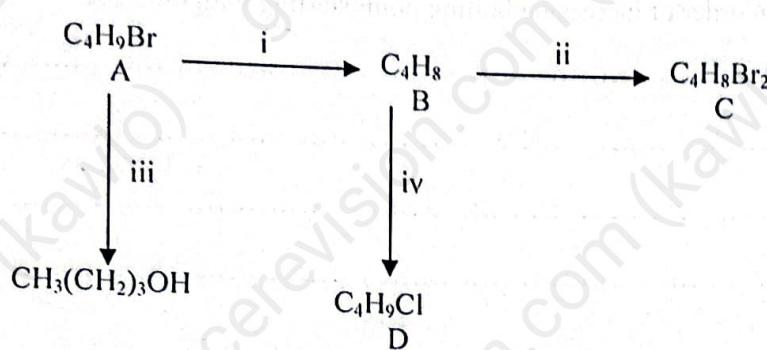


(column 3)



(4 marks)
(TOTAL = 20 marks)

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



- (i) Give the reagents and reaction conditions for the steps represented by i to iv.

	Reagents(s)	Reaction conditions
i		
ii		
iii		
iv		

- (ii) Give the structures of compounds A to D

A:
 B:
 C:
 D:

What rule governs the formation of compound D from B?

(9 marks)

- (b) The compound $\text{C}_4\text{H}_{10}\text{O}$ exhibits isomerism.

- (i) What is isomerism?

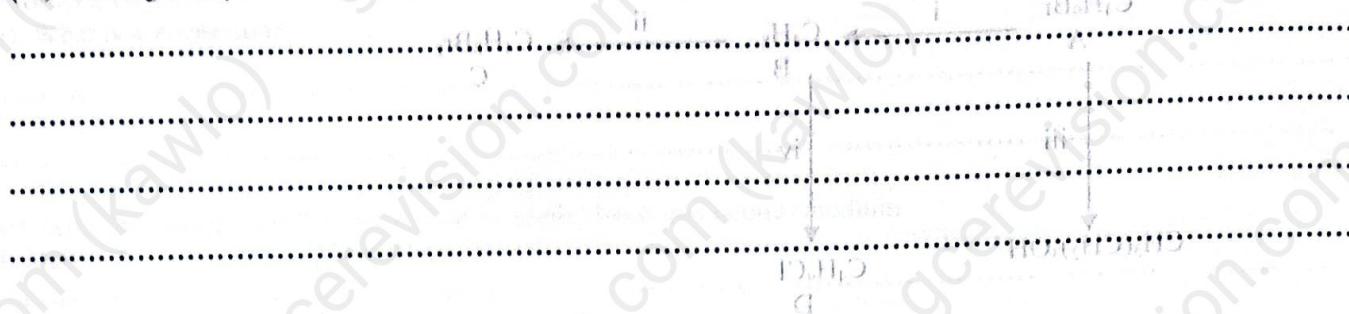
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- (ii) Give all the position isomers of the compound.

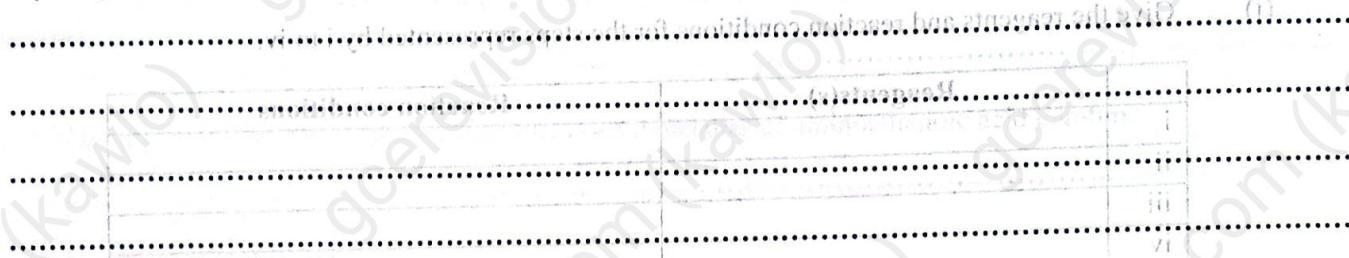
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(iii) Arrange the position isomers in order of increasing boiling point starting with the least.



Explain your trend.



(iv) State another kind of isomerism exhibited by the compound.

(i) Give the structures of compounds A and B.

(8 marks)

(c) Give a chemical test that can be used to distinguish between butan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$ and 2-methylpropan-2-ol, $\text{CH}_3\text{C}(\text{CH}_3)(\text{OH})\text{CH}_3$.

(a) Name the following compound.

(3 marks)

(Total = 20 marks)