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CANDIDATE IDENTIFICATION NUMBER	SUBJECT CODE **0715**	PAPER NUMBER **2**

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GENERAL CERTIFICATE OF EDUCATION (GCE) BOARD
ADVANCED LEVEL EXAMINATION

SUBJECT TITLE	SUBJECT CODE	PAPER NUMBER
CHEMISTRY	**0715**	**2**
	EXAMINATION DATE: **JUNE 2021**	

THREE HOURS

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

Relative atomic masses (RAM)
C = 12.0, O = 16.0, H = 1.0, Na=23.0,

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SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) Define the term "mole of a substance"

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(1 mark)

(b) 1.50 g of ethyl ethanoate was hydrolysed with 50.0 cm^3 of 0.5 M NaOH solution and the mixture was made up to 250 cm^3 with distilled water in a volumetric flask.

Calculate:

A: The number of moles of ethyl ethanoate in 1.50 g. (RMM: $CH_3CO_2C_2H_5 = 88$)

.....

.....

B: The number of moles of NaOH in 50 cm^3 of 0.5 M solution.

.....

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C: The percentage yield when 1.50 g of ethyl ethanoate reacts completely with sodium hydroxide to give 0.63 g of ethanol. (RAM: C = 12.0, H = 1.0, O =16.0, Na = 23.0)

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(5 marks)

c) The following is a path of the Uranium decay series

$^{238}_{92}Ur \xrightarrow{A} {}^{234}_{90}Th \xrightarrow{B} {}^{234}_{91}Pa \xrightarrow{C} X$

i) Identify the particles emitted in steps A and B

A: _____

B: _____

ii) If a beta particle is emitted in stage C, give the atomic number and mass number of the isotope X.

Atomic number: _____ Mass Number: _____

iii) If the activity of $^{234}_{90}Th$ is reduced to 25% in 48 days. What is the half - life of $^{234}_{90}Th$?

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(4 marks)

d) The mass spectrum of a vaporized sample of chromium shows the following data:

Mass of isotope	50	52	53	54
Relative abundance	0.04	0.84	0.1	0.02

Calculate the relative atomic mass of chromium

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(2 marks)

e) The following data were obtained from the reaction below:

$2NO(g) + 2H_2(g) \longrightarrow 2H_2O(l) + N_2(g)$

Experiment	Initial Concentration		Relative rate of reaction
	[NO] mol dm^{-3}	[H_2] mol dm^{-3}	
1	0.1	0.1	1
2	0.3	0.1	9
3	0.3	0.2	18

i) Determine the order with respect to NO

.....

.....

ii) Determine the order with respect to H_2

.....

.....

iii) Write the rate expression for the reaction

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iv) Calculate the value of the rate constant.

.....

.....

(4 marks)

f) A solution, A contains 0.10 mol dm^{-3} of CH_3COOH (ethanoic acid) and 0.20 mol dm^{-3} of CH_3COONa (Sodium ethanoate).

i) Give the general name for a solution such as A.

.....

ii) Give one use of the solution A

.....

iii) Calculate the pH value of solution A (Ka for $CH_3COOH = 1.8x10^{-5}$ mol dm^{-3})

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(4 marks)

(Total: 20 marks)

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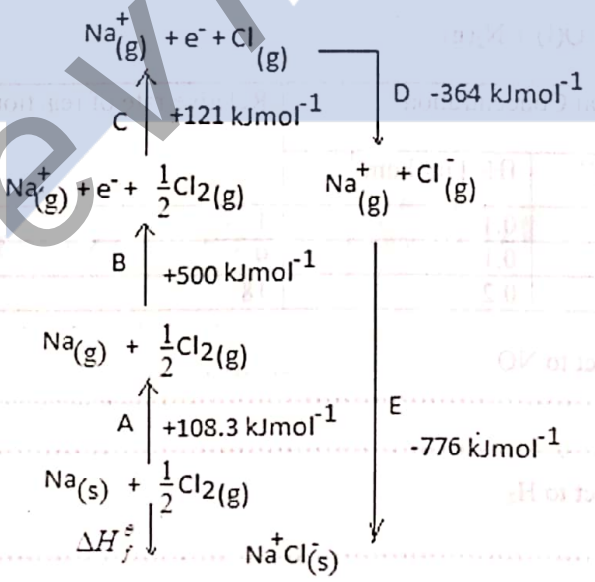
2. (a) The energy cycle below represents the enthalpy changes involved in the formation of solid sodium chloride.



i) Identify the enthalpy changes involved in steps A, B, C and D.

A.....

B.....

C.....

D.....

.....

ii) Calculate the enthalpy change of formation of $NaCl_{(s)}$

.....

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(5 marks)

(b) i) Define the following terms as applied to solid state chemistry.

A: Crystal lattice

.....

.....

B: Unit Cell

.....

.....

ii) Draw the unit cell of sodium chloride (NaCl)

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.....

(3 marks)

iii) i) Give one similarity and one difference between a chemical bond and an intermolecular force.

Similarity

.....

.....

Difference

.....

.....

ii) List and locate all the types of bonds in solid $(NH_4)_3PO_4$

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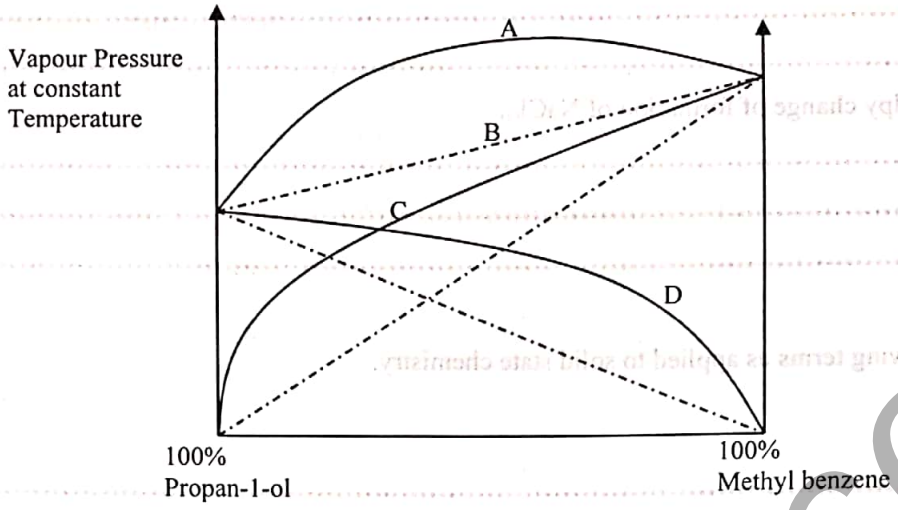
(5 marks)

iii) The diagram of vapour pressure against composition for mixtures of propan-1-ol and methylbenzene at constant temperature is given below:



What do the curves A to D represent?

A .....

B .....

C .....

D .....

e) Give two properties of a mixture which deviates negatively from Raoult's Law

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(4 marks)

f) Given the following redox potentials.

$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$ $E^o = +0.54V$

$S_4O_6^{-2}(aq) + 2e^- \rightleftharpoons 2S_2O_3^{2-}(aq)$ $E^o = +0.10V$

i) Select the species which is the strongest.

A: reducing agent.....

B: oxidising agent .....

ii) Write the cell diagram when the two half cells are coupled and calculate the e.m.f of the cell.

Cell diagram:.....

Cell e.m.f.....

(3 marks)

(Total: 20 marks)

SECTION B: INORGANIC CHEMISTRY

3. a) Li, Be, B, C, N, O, F and Ne are the elements of the Period 2 of the Periodic Table.

i) Sketch a graph of melting points against atomic number for the elements.

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ii) Explain the shape of the graph.

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(4 marks)

b) From the elements of the period lithium to neon, write the formula of:

i) An oxide which is amphoteric

.....

ii) A hydride which is a liquid

.....

(2 marks)

c) The elements of Group IV(Group 14) of the Periodic Table are carbon, silicon, germanium, tin and lead.

i) Classify the elements as metals, metalloids and non-metals.

Element	Classification
C	
Si	
Ge	
Sn	
Pb	

ii) Give a chemical equation for the reaction of germanium tetrachloride with water.

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iii) Explain why carbon tetrachloride will NOT react similarly with water as germanium tetrachloride.

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(4 marks)

d) Some of the Group IV elements show "inert pair effect"

i) What is the "inert pair effect"

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.....

.....

ii) Why is PbO more stable than PbO_2?

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.....

(2 marks)

e) This question is on the Group VII elements (Halogens).

i) Complete the following table:

	Colour at room temperature	Physical state
Chlorine		
Iodine		

ii) All the halogens show variable oxidation states except fluorine. Explain.

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.....

.....

iii) The following equation is used in iodometric titration

$$IO^-_3(aq) + I^-(aq) + H^+(aq) \rightarrow I_2(aq) + H_2O(1)$$

A: From the reacting species identify the oxidant and reductant.

Oxidant.....

Reductant.....

B: Give the balanced equation

.....

iv) Using suitable chemical reagents and stating your observations, clearly explain how you would distinguish between aqueous solutions of potassium chloride and potassium bromide?

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(8 marks)

TOTAL = (20 marks)

4. a) The Groups I and II elements are known as the s-block elements.

i) State and explain how atomic radius varies down the Group I elements.

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.....

ii) List the Group II elements in order of increasing atomic number.

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iii) Why is potassium carbonate readily soluble in water whereas calcium carbonate is insoluble?

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iv) Write chemical equations to show the product(s) formed when potassium and barium are heated in excess oxygen.

A: Potassium (K)

.....

B: Barium (Ba)

.....

(7 marks)

b) i) Give the symbols of the elements of the first transition series in order of increasing atomic number.

.....

ii) What accounts for the ability of transition metals to:

A: Show variable oxidation states.

.....

.....

B: Form coloured compounds

.....

.....

(3 marks)

c) Cobalt (Z = 27) forms a complex of formula $[Co(NH_3)_4Cl_2]$ Br.

i) Determine the oxidation state of cobalt in the complex

.....

ii) Using the electrons-in-boxes notation, write the electronic configuration of the cobalt ion in the complex

.....

.....

iii) Draw the stereoisomers of $[Co(NH_3)_4Cl_2]^+$

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(4 marks)

d) The Contact process involves converting sulphur into its oxides, purifying and converting to sulphuric acid.

i) Give equations for the formation of the oxides.

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.....

ii) Why is the gas mixture purified?

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.....

iii) State one industrial use of sulphuric acid.

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(4 marks)

e) Complete the table below by giving the formula and name of a compound in which nitrogen exhibits the oxidation states +3 and +5.

Oxidation state	Formula of compound	Name
+3		
+5		

(2 marks)

TOTAL = (20 marks)

SECTION C: ORGANIC CHEMISTRY

5. a) An organic compound W, on analysis was found to have a relative molecular mass of 58 and an empirical formula C_3H_6O.

i) Define Relative molecular mass.

.....

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ii) What information can be obtained from the mass spectrum of the compound?

.....

.....

Determine

A: The molecular formula of W

.....

.....

B: Suggest two possible structures of W

.....

.....

(7 marks)

b) i) A liquid X with less than 4 carbon atoms was subjected to the following tests in the laboratory. Complete the table below by giving the corresponding inferences.

Test	Reagent	Observation	Inferences
A	PCl_5	No white fumes	
B	Bromine water	No reaction	
C	2,4- dinitrophenyl hydrazine	Orange precipitate	
D	Ammoniacal silver nitrate (Tollen's Reagent)	No reaction	

ii) Suggest an identity for compound X.

.....

.....

(5 marks)

c) Give the systematic name for each of the following compounds.

i) $CH_3CH(CH_3)CH_2NH_2$

.....

ii) $CH_3CH_2CH_2COCl$

.....

(2 marks)

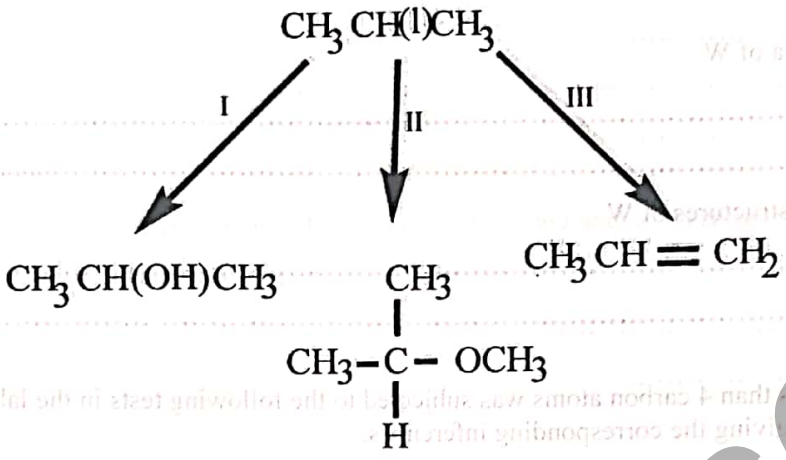
d) State the reagents and reaction conditions for the conversions in the table below.

	Reaction	Reagent	Reaction condition
i	$C_6H_6 \rightarrow C_6H_6NO_2$		
ii	$CH_3CH_2OH \rightarrow CH_2{=}CH_2 + H_2O$		
iii	$CH_3CH_2Cl \rightarrow CH_3CH_2CN + KCl$		

(6 marks)

(Total: 20 marks)

6. (a) Three different reactions of 2-iodopropane are shown below:



For each of the reactions I, II and III, give suitable reagents and conditions.

Reaction I:.....

Reaction II:.....

Reaction III:.....

(3 marks)

b) Benzene undergoes electrophilic substitution reaction.

i) What is an electrophilic substitution reaction?

.....

ii) Give an example of an electrophilic reagent.

.....

iii) Explain why benzene reacts with electrophilic reagents

.....

.....

(3 marks)

c) Ethene is obtained on a large scale from the process of cracking in the petroleum industry.

i) What is cracking?

.....

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ii) Write the equation of a reaction in which ethene is obtained by cracking.

.....

.....

iii) Write the equation for the reaction of ethene with the following reagents:

A: Aqueous bromine.....

B: Concentrated sulphuric acid.....

(4 marks)

d) 2-aminopropanoic acid (Alanine) is an example of an amino acid.

i) Describe a chemical test to confirm the presence of any one of the functional groups present in 2-amino propanoic acid.

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.....

ii) Write an equation for the synthesis of 2-aminopropanoic acid from propanoic acid stating the reagents and reaction conditions.

.....

.....

(4 marks)

e) Give the structure and name of the main organic product of the following reactions:

i) $CH_3CONH_2 + Br_2 + 4\ KOH \rightarrow$

Structure and name of product:

.....

.....

.....

ii) $C_6H_5NO_2 + HCl/Sn \rightarrow$

Structure and name of product:

.....

.....

.....

iii) $CH_3COOH + LiAlH_4$

Structure and name of product:

.....

.....

.....

(6 marks)
(Total: 20 marks)