

REGISTRATION CENTRE NUMBER		CENTRE NAME		FOLD ← HERE
CANDIDATE'S FULL NAMES				
CANDIDATE IDENTIFICATION NUMBER	SUBJECT CODE 0715	PAPER NUMBER 2		
FOR OFFICIAL USE ONLY				
GENERAL CERTIFICATE OF EDUCATION BOARD ADVANCED LEVEL EXAMINATION				
SUBJECT TITLE CHEMISTRY	SUBJECT CODE 0715	PAPER NUMBER 2		
EXAMINATION DATE: JUNE 2025				

Duration: 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,

FOR EXAMINER'S USE ONLY

SCORE

Marked by

Signature Date

Checked by

Signature Date

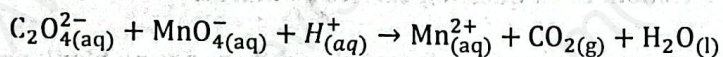
Turn Over

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) What is a redox reaction?

(1 mark)

- (b) 31.0 cm³ of an acidified KMnO₄ solution was required to completely oxidize 50 cm³ of 0.25 M solution of oxalic acid (H₂C₂O₄). The unbalanced ionic equation is:



- (i) Write down the half equation for

A: Oxidation:

B: Reduction:

- (ii) Write down the overall balanced equation

- (iii) Calculate the concentration of the KMnO₄ solution.

(5 marks)

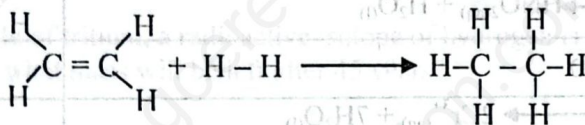
- (c) Bond energy can provide information about the energy changes that accompany a chemical reaction.

- (i) What do you understand by the term bond energy?

(ii) The table below shows some average bond enthalpies

Bond	Average bond enthalpy/kJmol ⁻¹
C – C	350
C = C	610
H – H	436
C – H	410

A: Use this information to calculate the enthalpy change for the process



B: The enthalpy change of this reaction was found by experiment to be -136 kJmol^{-1} . Explain why this value is different from that calculated above.

(4 marks)

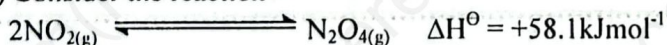
(d) The solid state of matter is characterized by the arrangement in fixed patterns of its constituent particles (atoms, ions, or molecules). Complete the table below by filling in either the crystal type or example.

Crystal type	Example
Body centred cubic	
Hexagonal close packed	
	Diamond

(3 marks)

(e) (i) State Le Chatelier's Principle.

(ii) Consider the reaction



How does an increase in temperature affect:

A. The equilibrium constant?

B. The equilibrium position?

(3 marks)

Turn Over

(f) Use the data below, where appropriate to answer the following questions:

Standard Electrode Potential		E°/V
A	$\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.27
B	$\text{NO}_3^{-}(\text{aq}) + 3\text{H}^{+}(\text{aq}) + 2\text{e}^{-} \longrightarrow \text{HNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.94
C	$\text{Cl}_2(\text{aq}) + 2\text{e}^{-} \longrightarrow 2\text{Cl}^{-}(\text{aq})$	+1.36
D	$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^{+}(\text{aq}) + 6\text{e}^{-} \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33
E	$\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{e}^{-} \longrightarrow 2\text{SO}_4^{2-}(\text{aq})$	+2.01

(i) From the table above, select the species which is the most powerful reducing agent.

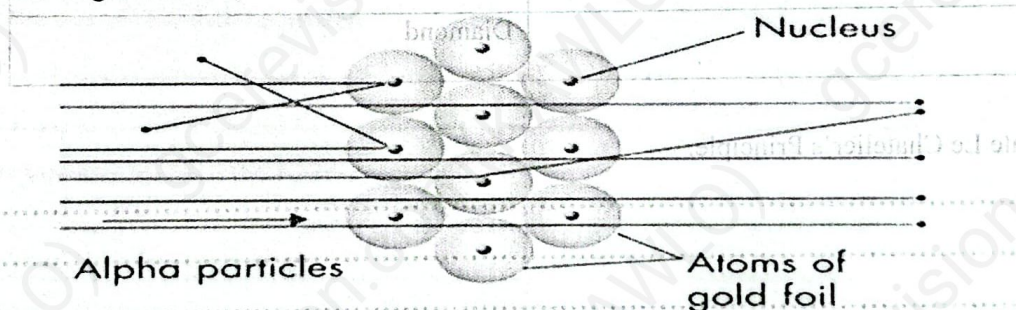
(ii) Calculate the oxidation state of Chromium in $\text{Cr}_2\text{O}_7^{2-}$.

(iii) Write a cell diagram for the reaction when A and D are coupled and calculate the emf of the cell.

(4 marks)

(Total = 20 marks)

2. (a) In the "scattering of alpha particles experiment", the results obtained by Geiger and Marsden can be summarized by the diagram below;



(i) Give the mass number of an alpha particle?

(ii) Explain why a few of the alpha particles were deflected at large angles?

(iii) Explain why most of the alpha particles went through undeflected?

(3 marks)

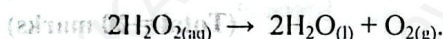
(b) The half-life of tritium, a radioactive isotope of hydrogen is 12.25 years. Beginning with a 2.5 g sample of tritium, what mass will be left after 45 years?

(2 marks)

(c) The Collision Theory of Reaction Kinetics was developed from the kinetic theory of gases.

(i) State two postulates of the Collision Theory.

(ii) Hydrogen peroxide decomposes according to the equation:



State and explain one method by which the rate of the reaction can be measured

(iii) Given that the rate law for the reaction is $\text{Rate} = K[\text{H}_2\text{O}_2]^2$. What does K represent

(5 marks)

(d) Complete the table below by filling in the missing information

Bond type	Species involved	Example of compound with the type of bond
Ionic bond		
Covalent		
Dative covalent bond		

(3 marks)

(e) Suggest an explanation for the trigonal pyramidal shape of NH_3 .

(2 marks)

Turn Over

(f) Two pure liquids A and B, have vapour pressures of $1.5 \times 10^4 \text{ Nm}^{-2}$ and $3.5 \times 10^4 \text{ Nm}^{-2}$ respectively at 20°C . If a mixture of the two liquids is prepared by adding 2.5 moles of A and 1.5 moles of B at the same temperature, calculate:

(i) The partial vapour pressure of A and B in the mixture:

(ii) The total vapour pressure of the mixture.

(3 marks)

(g) A solution made up of 0.15 mol/dm^3 propanoic acid ($K_a = 1.35 \times 10^{-5} \text{ mol/dm}^3$) and 0.35 mol/dm^3 sodium propanoate, constitutes a buffer solution.

(i) What is a buffer solution?

(ii) Calculate the pH of the solution.

(2 marks)

(Total = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3. (a) The elements of period three of the periodic table are; sodium, magnesium, Aluminium, silicon, Phosphorus, Sulphur, chlorine and Argon.

(i) Sketch a graph to show the variation of Atomic Radius against atomic number for the elements.

Atomic Number	Atomic Radius (pm)
11	186
12	132
13	120
14	111
15	106
16	103
17	99
18	97

(ii) Explain the shape of the graph in (i) above.

- (iii) Complete the table below by either giving the structural form or the formula of an oxide.

Structural form	Formula of oxide
Ionic	
	SiO ₂
	Cl ₂ O

(7 marks)

- (b) The complex ions of the elements of the first transition series undergo isomerism.

(i) Define the following;

A) Complex ion:

B) Isomerism:

- (ii) Draw structures to show Geometric isomerism in the complex $\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2$.

Isomer 1

Isomer 2

- (iii) Using the spdf notation, write the electronic configuration of the following ions;

$_{21}\text{Sc}^{3+}$:

$_{25}\text{Mn}^{2+}$:

- (iv) Which of the ions in (iii) above is not coloured? Explain.

(8 marks)

- (c) The Contact Process for the production of sulphuric acid involves three stages; the *production of sulphur dioxide*, *sulphur trioxide* and *sulphuric acid*. Write balanced equations for the processes involved in each stage.

Stage1:

Stage2:

Stage3:

(3 marks)

Turn Over

(d) Nitrogen exhibits oxidation states of -3 to +5 in its compounds. Complete the table below;

Oxidation state of nitrogen	Formula of compound
-3	
	NH ₂ OH
+2	
+5	

(2 marks)

(Total = 20 marks)

4. (a) i. State and explain the trend in the hydration energies of the group II sulphates down the group

(ii) Write an equation for the reaction of Barium with water

(iii) Would the reaction in a (ii) occur more vigorously or less vigorously than the reaction of Calcium with water?

Explain

(iv) At a given high temperature, which of the two carbonates, Barium carbonate or Calcium carbonate, would decompose more easily?

(6 marks)

(b) The Group IV (14) elements: Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb), have melting points 3730°C, 1410°C, 937°C, 232°C and 327°C respectively.

(i) Give the trend in the structure of the elements

(ii) Explain the variation in the melting points

(iii) Account for the fact that carbon tetrachloride is insoluble in water.

(7 marks)

(c) (i) Complete the table below

halogen	physical state	colour
Fluorine		
Chlorine		
Bromine		
Iodine		

(ii) Write a balanced equation to show what happens when chlorine gas is bubbled into an aqueous solution of potassium bromide (KBr)

(iii) What are the observable changes?

(iv) An aqueous solution containing an unknown halide ion, was acidified with nitric acid; aqueous silver nitrate was then added. A cream precipitate was obtained which dissolves in concentrated aqueous ammonia. Identify the halide ion

(7 marks)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5. (a) The mass spectrum of a compound A has parent ion peak at $m/e = 168$. Elemental analysis shows that it contains 42.9% Carbon; 2.4% hydrogen and 16.7% nitrogen by mass. The remainder is oxygen

(i) Calculate the empirical formula of the compound A

(ii) Determine the molecular formula of the compound A

Turn Over

- (iii) Briefly describe how you can test for the presence of Nitrogen in compound A.

(7 marks)

- (b) Write down the systematic name of each compound below.

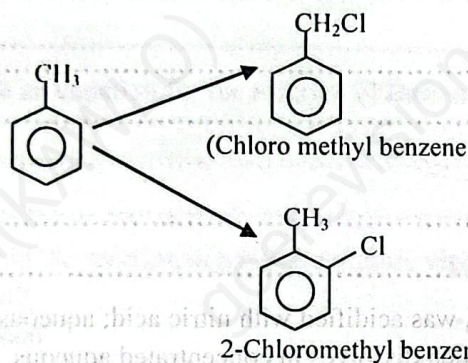
(i) $(\text{CH}_3)_3\text{COH}$

(ii) $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3$

(iii) $\text{CH}_3(\text{CH}_2)_2\text{CHCH}_2$

(3 marks)

- (c) Under different reaction conditions, methylbenzene reacts with chlorine by different reaction mechanisms. One product of each reaction is shown below



- (i) For the reaction leading to the formation of Chloromethyl benzene;

(A) Give the reaction condition

(B) Name the type of reaction mechanism involved

- (ii) For the reaction leading to the formation of 2-chloromethyl benzene.

A: Give the reaction condition

B: Name the type of reaction mechanism involved

(4 marks)

- (d) Aldehydes and ketones undergo nucleophilic addition reactions with HCN .

(i) What do you understand by a nucleophilic addition reaction?

(ii) Using ethanal, (CH_3CHO) write the mechanism for the reaction with HCN .

.....

(iii) Name the functional group present in aldehydes and ketones

.....

(c) (i) What is a functional group?

(4 marks)

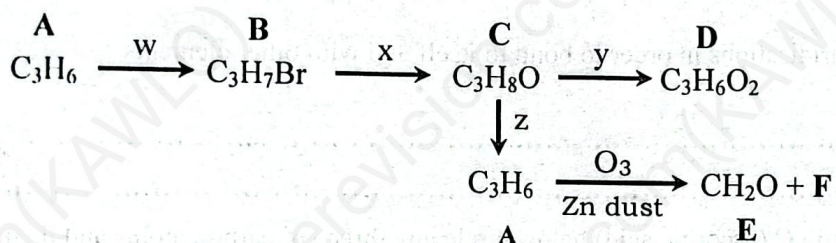
.....

(ii) Name the functional group present in aldehyde and ketones.....

(2 marks)

(Total = 20 marks)

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



(i) Write down the structural formulae of compounds A, B, C, D and F.

A. B.
 C. D.
 F.

(ii) Suggest the reagent(s) and reaction condition(s) for the reactions w, x, y and z.

	Reagent(s)	Reaction condition(s)
w		
x		
y		
z		

(9 marks)

(b) How can you distinguish by a chemical test the following pairs of compounds?

(i) $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ and $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3$

.....

Turn Over

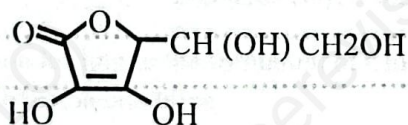
(ii) C_2H_5COOH and C_6H_5-OH

(iii) $CH_3CH_2NH_2$ and $(CH_3)_3N$

(c) Carbon undergoes sp^3 , sp^2 and sp hybridisations in order to bond to itself and with other elements.

(i) What is hybridisation?

(ii) On the structure of vitamin C (ascorbic acid) below circle any three sp^3 carbon atoms and then place an asterisk on all the sp^2 hybridised carbon atoms.



(d) Suggest the spectroscopic methods that could be used to identify the following:

(i) Positions of hydrogen atom.

(ii) Presence of double bonds.

(2 marks)
(Total = 20 marks)