

REGISTRATION CENTRE NUMBER

CENTRE NAME

CANDIDATE'S FULL NAMES

CANDIDATE IDENTIFICATION NUMBER

SUBJECT CODE

0715

PAPER NUMBER

2

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 (Candidate Random CODE): ►

**GENERAL CERTIFICATE OF EDUCATION BOARD
 ADVANCED LEVEL EXAMINATION**

 SUBJECT TITLE
CHEMISTRY

 SUBJECT CODE
0715

 PAPER NUMBER
2

EXAMINATION DATE: JUNE 2023

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 DataOne atmosphere (1 atm) = $1\text{Pa} = 1.01 \times 10^5 \text{ N m}^{-2}$

Relative atomic masses (RAM)

C = 12.0, S = 32.0, O = 16.0, H = 1.0

Molar gas volume at stp = 22400 cm³**FOR EXAMINERS' USE ONLY**

Marked by:

SCORE

Signature:

Date:

Checked by:

Signature:

Date:

Turn Over

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. (a) Define

(i) a chemical bond.

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(ii) State and explain the shapes of the following molecules:



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(5 marks)

- (b) Sodium-23 decays through β -emission and has a half-life of 12 days.

(i) What is meant by half life?

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(ii) Write a balanced nuclear equation for the β -emission of sodium -23.

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(iii) Calculate the mass that remains when a 1.25 g sample of sodium undergoes decay for 60 days.

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(4 marks)

- (c) In an experiment to determine the molar mass of a volatile liquid, 1.715 g of a liquid was vapourized at 40°C and 2 atm releasing 488 cm³ of vapour.

(i) State the experimental method used in the determination of the molar mass of the liquid.

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(ii) Calculate the molar mass of the liquid. ($R = 0.082 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$).

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(3 marks)

- (d) Potassium chlorate (V), KClO_3 decomposes in the presence of manganese (IV) oxide catalyst to release oxygen.

(i) Write out a balanced equation for the decomposition of the chlorate.

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(ii) Calculate the volume of oxygen produced (measured at stp) for the decomposition of 0.73 g of KClO_3 .

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(3 marks)

- (e) An ideal mixture contains 0.85 moles of methanol and 0.42 moles of ethanol. If the vapour pressure of pure methanol and pure ethanol at 20 °C are 98 mmHg and 43.6 mmHg respectively.

Calculate:

(i) The mole fraction of each component in the mixture.

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(ii) The partial pressure of each component.

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(iii) The total pressure of the mixture.

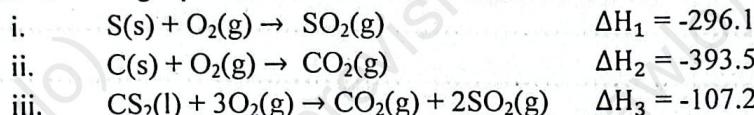
(5 marks)

(Total = 20 marks)

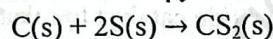
2. (a) Name two close packed structures, giving an example of each.

(4 marks)

(b) Given the following equations and enthalpy changes in kJ mol^{-1}

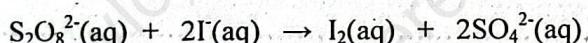


Calculate the enthalpy of formation of carbon disulphide, CS_2 .



(3 marks)

(c) Peroxodisulphate ions react with iodide ions according to the equation:



The following data was obtained for a series of mixtures

Experiment	Initial concentration / mol dm^{-3}		Initial rate of reaction in $\text{mol dm}^{-3} \text{ s}^{-1}$
	$[\text{S}_2\text{O}_8^{2-}(\text{aq})]$	$[\text{I}^-(\text{aq})]$	
1	0.038	0.030	7.0×10^{-6}
2	0.076	0.030	14.0×10^{-6}
3	0.076	0.060	28.0×10^{-6}

(i) What is the order of the reaction with respect to:

A: $\text{S}_2\text{O}_8^{2-}$ ions:

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B: Iodide ions:

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(ii) Write the rate expression for the reaction.

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(iii) Calculate the value of the rate constant stating the units.

(5 marks)

(d) Propanoic acid, ($\text{CH}_3\text{CH}_2\text{COOH}$) is a weak acid with an acid dissociation constant k_a of $1.22 \times 10^{-5} \text{ mol dm}^{-3}$.

(i) What is a weak acid?

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(ii) Calculate the pH of a 0.2 M $\text{CH}_3\text{CH}_2\text{COOH}$ solution

(3 marks)

(e) A mixture of sodium propanoate ($\text{CH}_3\text{CH}_2\text{COONa}$) and $\text{CH}_3\text{CH}_2\text{COOH}$ acid acts as a buffer solution.

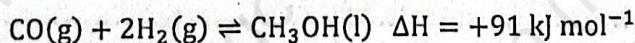
(i) What is a buffer solution?

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(ii) Write equations to show what happens when a small amount of hydrochloric acid solution is added to the buffer.

(2 marks)

(f) Consider the following reaction in equilibrium at 350°C :



(i) State the equilibrium law

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(ii) What is the effect on the equilibrium position if the temperature of the system is increased?

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Explain

(3 marks)

(Total = 20 marks)

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SECTION B: INORGANIC CHEMISTRY

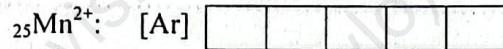
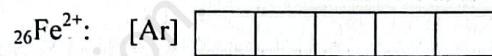
3. (a) Iron and manganese are transition metals.

(i) Define a transition metal.

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- (ii) Using the boxes below, write out the electronic configuration for Mn^{2+} and Fe^{2+} ion ($Mn = 25$, $Fe = 26$)

$3d$

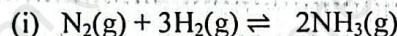


- (iii) Account for the fact that Fe^{2+} ions are readily oxidized to Fe^{3+} ions but Mn^{2+} ions are not readily oxidized to Mn^{3+} .

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(5 marks)

- (b) Give the transition metal or transition metal compound used as catalyst in the following conversions.



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(2 marks)

- (c) The group I and II elements are called s-block elements.

- (i) State and explain the general trend of the reaction of the elements down group I and II with water

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- (ii) Give the formula of an s-block oxide which is amphoteric.

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- (iii) Write out balanced chemical reactions of the amphoteric oxide in c(ii) with HCl and NaOH.

HCl.....

NaOH.....

- (iv) State and explain the trend in the solubility of the s-block sulphates down the groups.

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(7 marks)

(d) The Group IV (Groups 14) elements of the periodic table are carbon, silicon, germanium, tin and lead.

(i) Give the trend in the structure of the elements from carbon to lead.

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(ii) Identify the elements which exhibit allotropy

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Give the allotropes of one of the elements.

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(iii) These elements exhibit two oxidation states. Use the oxides of lead to illustrate this property.

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(6 marks)

(Total = 20 marks)

4. (a) The halogens are the elements of Group VII (Group 17) of the periodic table (F, Cl, Br, I, At)

(i) Write the outer general electronic configuration of halogens.

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(ii) Complete the table below by giving the physical state and colour of the elements.

	Fluorine	Chlorine	Bromine	Iodine
Physical state				
Colour				

(3 marks)

(b) Chlorine undergoes a disproportionation reaction when reacted with hot concentrated potassium hydroxide.

(i) What is a disproportionation reaction?

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(ii) Write down an equation for the disproportionation of chlorine in hot concentrated potassium hydroxide.

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(2 marks)

(c) Consider the following hydrogen halides: HF, HCl, HBr, and HI.

(i) Sketch a graph of boiling point for the hydrogen halides

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Explain the shape of the graph

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(3 marks)

(d) The elements across period 3 of the Periodic Table are Na to Ar.

(i) Complete the table below by giving the formulae of the chlorides formed by the elements.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Chloride								

(ii) Which of the chlorides in d(i) is

- A: a solid ionic chloride.....
 B: a solid covalent chloride
- C: a liquid chloride.....

(iii) Give the formula of one oxide of the elements which is

- A: Giant ionic.....
 B: Giant molecular.....
 C: simple molecular

(8 marks)

(e) Sulphur and its compounds are used in the industry and in agriculture.

Give one use of Sulphur and its compounds in the industry and in agriculture

- (i) Industry.....
 (ii) Agriculture.....

(2 marks)

(f) Give an example of a compound of nitrogen in the -3 and +5 oxidation states

- (i) -3.....
 (ii) +5.....

(2 marks)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5. (a) An organic compound X contains 54.9% carbon, 10.9% hydrogen and 13.9% nitrogen.
A molecular weight determination of the compound gave a value of 230.
(R.A.M: C = 12, N = 14, H = 1, O = 16)

(i) Calculate the empirical formula of the compound.

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(ii) Determine the molecular formula of the compound.

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(iii) Suggest the structural formula for compound X given that it gives butylamine when warmed with bromine and concentrated potassium hydroxide.

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(5 marks)

(iv) How can you test for the presence of nitrogen in the compound X?

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(3 marks)

- (b) An organic compound with molecular formula $C_4H_9O_2N$ has both the amino and carboxylic acid functional groups and is optically active.

(i) What is a functional group?

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Turn Over

(ii) Give the condition for a compound to be optically active

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(iii) Give the optical isomers of the compound.

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(4 marks)

(c) 1,2-dimethylbromoethane ($\text{CH}_3)_3\text{CBr}$ reacts with aqueous NaOH under reflux.

(i) Give the equation for the reaction.

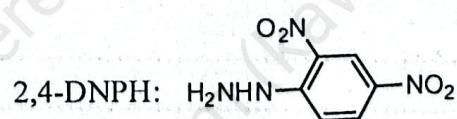
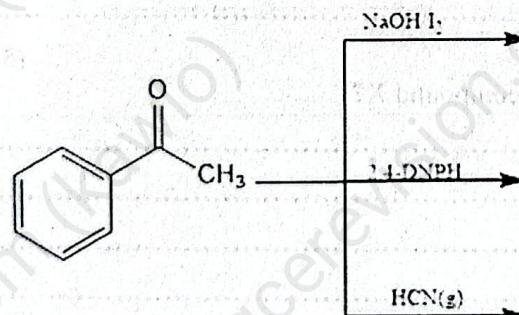
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(ii) What type of mechanism is illustrated by the reaction? Write out the mechanism.

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(5 marks)

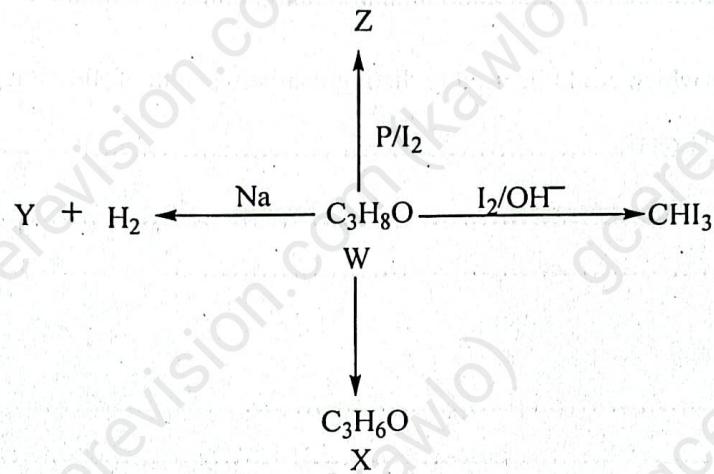
(d) Give the product(s) of the following reactions of Phenylethanone



(3 marks)

(Total: 20 marks)

6. (a) The following diagram shows the relationship between the molecular formula of some compounds



- (i) Give the name and write the structural formulae for the isomers of W.

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- (ii) Which of these isomers in a(i) correspond to the compound W?

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Give a reason

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- (iii) Identify the compounds X, Y and Z

X.....

Y.....

Z.....

- (iv) Give the reagent and conditions for the conversion of W to X

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- (v) Give the name and colour of CHI₃.

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(10 marks)

- (b) (i) What is hybridization?

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Turn Over

(ii) Give one example of an sp hybridized molecule.

(2 marks)

(c) Suggest a chemical test which could be used to distinguish between the following pairs of compounds.

(i) CH_3CH_3 and CH_2CH_2

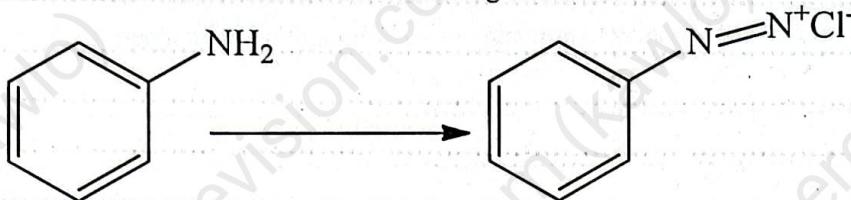
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(ii) $\text{CH}_3\text{CH}_2\text{CHO}$ and
 CH_3COCH_3

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(6 marks)

(d) State the reagent and reaction conditions for the following conversion



(2 marks)

(Total = 20 marks)

GO BACK AND CHECK YOUR WORK