SOUTH WEST REGIONAL MOCK EXAMINATION
GENERAL EDUCATION

The Teachers' Resource Unit (TRU) in collaboration with the South West Chemistry Teachers' Association (SOWECTA)	Subject Code 0715	Paper Number 2
CANDIDATE NAME ..... CANDIDATE NUMBER ..... CENTRE NUMBER	Subject title Chemistry	
Advanced Level	DATE Saturday 22/03/2025: Afternoon	

Time Allowed: THREE HOURS

INSTRUCTIONS TO CANDIDATES:

Enter the information required in the boxes of the flap.

Answer ALL the SIX questions in this booklet.

No Mobile phones are allowed in the examination room.
The mark allocation is indicated for each question. Each question carries 20 marks.
Verify that this booklet contains SIX questions and 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 and there are no blank pages

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 to answers without brief statements showing how the answers have been obtained.
Calculators may be used.
Noiseless and non-programmable Calculators are allowed

Useful Data:

RAM: K=39, C=12.0, H=1.0, O=16.0, N=14, Cl = 35.5

Avogadro Constant, L = 6.02×10^{23}

SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1.) a) (i) Define

A) Relative Atomic Mass

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B) Limiting Reagent

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ii) Calculate the number of potassium ions present in 3.0 g of a solution of K_2CO_3.

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(5 marks)

b) i) What is a Born – Haber cycle?

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ii) Construct a Born – Haber cycle for the formation of sodium chloride (NaCl), given the following data:

$Na(s) \longrightarrow Na(g)$; $\Delta H^{\theta}_{AT}(Na) = +109\ kJ/mol$

$1/2Cl_2(g) \longrightarrow Cl(g)$; $\Delta H^{\theta}_{AT}(Cl) = +121.5\ kJ/mol$

$Na(g) \longrightarrow Na^+(g) + e^-$; $\Delta H^{\theta}_{IE}(Na) = +496\ kJ/mol$

$Cl(g) + e^- \longrightarrow Cl^-(g)$; $\Delta H^{\theta}_{EA}(Cl) = -349\ kJ/mol$

$Na^+(g) + Cl^-(g) \longrightarrow NaCl(s)$; $\Delta H^{\theta}_{LE}(NaCl) = -788.5\ kJ/mol$

$Na(s) + 1/2Cl_2(g) \longrightarrow NaCl(s)$; $\Delta H^{\theta}_{f} = -411\ kJ/mol$

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(4 marks)

c) (i) What is the coordination number of a hexagonal close packed crystal?

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ii) Which instrument is used to determine crystal structures?

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(2 marks)

d) (i) State the equilibrium law

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ii) For the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$; $\Delta H = +93$ kJ/mol

A) Write an expression for the equilibrium constant, Kc.

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B) What will be the effect on the equilibrium constant value when the temperature of the reaction is increased?

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(3 marks)

e) Calculate the pH of a 0.03 M solution of NaOH

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(3 marks)

f) Given the following half reactions

$MnO_4^-(aq) + 8H^+(aq) + 5e \rightarrow Mn^{2+}(aq) + 4H_2O(l)$ $E^\theta = +1.5$ V

$Sn^{2+}(aq) + 2e \rightarrow Sn(s)$ $E^\theta = -0.14$ V

i) Which species is oxidized?

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ii) Write a cell diagram showing the combination of the two half cells.

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iii) Calculate the emf of the cell

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(3 marks)

(Total = 20 marks)

2.) a) i) What is a nuclear reaction?

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ii) Write an equation for the beta decay of $^{234}_{90}Th$ to the isotope protactinium (Pa)

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(2 marks)

b) i) The mass spectrum of a vaporized sample of potassium, atomic number 19 shows peaks at 39, 40 and 41, with relative abundances of 93.22, 0.12 and 6.77 respectively.
Calculate the relative atomic mass of potassium

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ii) Give two reasons why particles must be ionized before analyzing in a mass spectrometer

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(4 marks)

c) i) Differentiate between metallic bonding and covalent bonding

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ii) Give the shape and the bond angle for each of the compounds NH_3 and BH_3.
A: NH_3
Shape;

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Bond angle;

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B: BH_3
Shape;

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Bond angle;

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iii) Explain why BF_3 reacts with NH_3

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d) i) Define
A: Rate Constant (5 marks)

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B: Activation Energy

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ii) For the decomposition of hydrogen peroxide; $2H_2O(aq) \rightarrow 2H_2O(l) + O_2(g)$
Give one method that can be used to follow up the rate of the reaction

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iii) Sketch a curve of rate against concentration for a first order and a second order reactions.

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(5 marks)

e) This question is on phase equilibrium.
i) State Raoult's Law.

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ii) Give an example of a mixture that will show positive deviation from Raoult's Law.

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iii) Sketch a well labelled diagram of the boiling point against composition for a mixture of heptane and hexane.

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(4 marks)
(Total = 20 marks)

SECTION B: INORGANIC CHEMISTRY

3.) a) (i) The elements of group VII (17) of the Periodic Table undergo disproportionation reactions.
(A) What is a Disproportionation reaction?

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(B) Write a balanced equation for the reaction of chlorine with a cold dilute solution of sodium hydroxide.

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ii) Sketch a graph of the acid strength for the hydrogen Halides (HF, HCl, HBr, HI)

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State and explain the shape of the graph.

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iii) Explain why HI cannot be prepared by reacting the potassium salt of iodine with conc H_2SO_4.

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iv) Name a suitable acid that can be used to produce HI.

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(7 marks)

b) This question concerns the elements in groups I and II of the Periodic Table.

i) Why are group I and II elements called s - block elements?

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ii) Explain the following;

(A) The boiling points of group II elements are generally higher than those of group I elements in the same period

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(B) The carbonates of group I elements are more stable than those of group II elements

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iii) What is a diagonal relationship

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iv) Give a pair of s – block elements that show a diagonal relationship

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v) Write equations to show the effect of heat on the carbonates of sodium (Na_2CO_3) and calcium ($CaCO_3$).

Na_2CO_3

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$CaCO_3$

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(7 marks)

c) The elements of group IV (14) in the Periodic Table are C, Si, Ge, Sn and Pb.

i) Give the outer electronic configuration of these elements.

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ii) These elements exhibit two oxidization states.

Give the two oxidization states

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State and explain the relative stability of these oxidation states.

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iii) The elements form oxides in the two oxidation states. Give the formula of one acidic and one neutral oxide of any of the elements.

Acidic oxide:

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Neutral oxide:

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(6 marks)

(Total = 20 marks)

4.) a) This question concerns the Transition metals.

i) State any two characteristics of transition metals.

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ii) What do you understand by "chelating ligand"?

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iii) Why do transition metals form complexes?

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iv) Give an example of a bidented ligand.

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v) Calculate the Oxidation Number of the metal ion in the complex $[Fe(CN)_3\ NO]^{2-}$

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vi) Name the complex ion with formula $[CoCl(NH_3)_5]^{2+}$

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(7 marks)

b) This question concerns the element of period 3 of the Period Table (Na – Ar)

i) What is atomic radius?

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State and explain the trend in atomic radius across the period from Na to Ar.

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ii) Give an example of a pair of isoelectronic ions

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(4 marks)

c) i) Complete the table below by writing the formulae of the hydrides of the elements.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Hydride								

ii) Write a balanced equation for the reaction of the hydride of magnesium with water

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iii) Which of the elements in period 3 form oxides with giant ionic structure

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(5 marks)

d) In the industrial manufacture of nitric acid, a gas is produced which causes acid rain.

i) State one effect of acid rain on the environment

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ii) What is allotropy

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iii) Give the main allotropes of Sulphur

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(4 marks)

(Total = 20 marks)

SECTION C: ORGANIC CHEMISTRY

5.) a) An organic compound X on analysis was found to contain 38.4 % carbon, 4.8% hydrogen and 56.8% chlorine.

i) Calculate the Empirical formula of compound X.

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ii) The molecular mass of compound X is 125. Calculated the molecular formula of compound X.

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iii) Compound X exhibits geometric isomerism.

Write out the structures of the isomers of compound X

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iv) How would you identify the presence of chlorine in compound?

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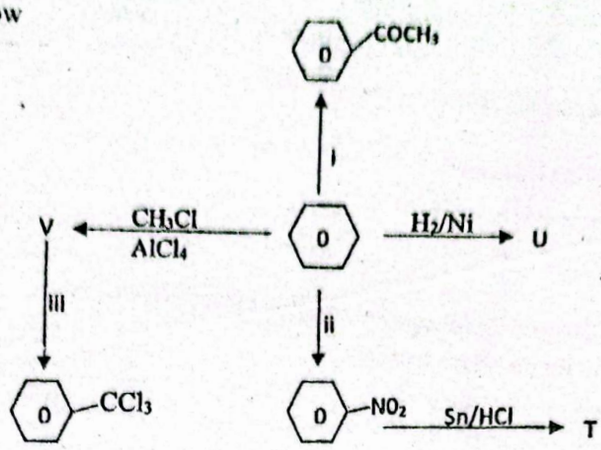
(10 marks)

b) Given the sketch below



i) Give the name and structural formula of compound T, U and V

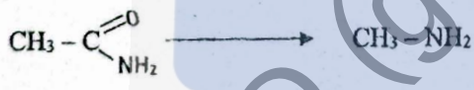
COMPOUND	STRUCTURE	NAME
T		
U		
V		

ii) Give the reagents and reaction conditions for the processes

Process	Reagents	Reaction Conditions
i		
ii		
iii		

(6 marks)

c) i) State the reagent and reaction condition for the conversion below



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ii) What is the name of the above process?

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(2 marks)

d) i) What is hybridization?

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ii) What type of hybridization is exhibited by the carbon atoms in benzene (C_6H_6)?

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(2 marks)

(Total = 20 marks)

6 a) i) Define a "Racemic Mixture"

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Give a method that can be used to separate a racemic mixture

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ii) What is a "Nucleophilic Substitution Reaction"

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(4 marks)

b) The reaction of the compound $(CH_3)_3CBr$ with aqueous NaOH produces an alcohol

i) Write out the reaction mechanism for the above reaction

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ii) Complete the table below

Spectroscopic Technique	Information Obtained from Technique
Ultraviolet spectroscopy	
	Identifies atoms with odd number of protons

(5 marks)

c) Given the compounds A and B

A: C_6H_5OH B: $C_6H_5CH_2OH$

i) Give a chemical test to identify compound A

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ii) Compound B can be prepared from phenylmethanal.

Write the equation for the production of compound B from phenylmethanal

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(3 marks)

d) Methanoic acid is a carboxylic acid but does not exhibit typical properties of a carboxylic acid.

Give one reaction of methanoic acid that confirms the above statement

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(1 mark)

e) Give the reagents, reaction conditions and observations that can be used to distinguish the following pairs of compounds.

i) CH_3CH_2CHO and CH_3COCH_3

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ii) $CH_3CH_2NH_2$ and CH_3CONH_2

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(6 marks)

f) State one reason why carbon catenates extensively.

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(1 mark)

(Total = 20 marks)

END