Candidate's Name: ……..……..

Signature: ……..

STREAM:							

525/1
CHEMISTRY
Paper 1
October/November
2025
$2^1/_2$ hours

AOIs OF TERM III ASSESSMENT

Uganda Advanced Certificate of Education

S.5 CHEMISTRY

Paper 1

(***Set II***)

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

This paper has **two** *sections* **A** *and* **B.**

Section **A** *has two compulsory items while* **B** *has two parts* **Part I** *and* **Part II**

Each of part I and part II has two items, Answer only **one** *from each.*

Answers to Section **A** ***must*** *be written in the spaces provided and Section* **B** ***must*** *be written in the answer booklet(s) provided*

Answer four in all.

Where necessary use,

Molar gas volume at s.t.p = 22.4dm^3

FOR EXAMINER'S USE ONLY																				
ITEM	**1**					**2**						**3/4**				**5/6**				**T.**
CODE																				
SCORE																				

SECTION A

Answer **all** *questions in this section*

ITEM 1

A report from Kabong Chemical Works (U) Ltd revealed that the company is improving its sulphuric acid production process, an essential raw material used in fertilizers and lead acid batteries.

In one of the experiments, the company's chemists reacted *0.425 moles* of sulphur dioxide with *0.294 moles* of oxygen gas in a *1.60 dm³* sealed vessel. The gases were heated in the presence of a catalyst, and equilibrium was established according to the reversible reaction:

Equation 1: $2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3$

After analysis, it was discovered that *52%* of the oxygen gas had reacted this made the management curious how operating conditions influence both the position of equilibrium and rate of attainment of equilibrium in the process, and environmental effects of emissions.

Sulphur trioxide, is always converted to sulphuric acid, the plant's key product. For quality control, *25 cm³* of *0.05 M* sulphuric acid was diluted with *750 cm³* of pure water, and the resulting solution was tested for acidity. To confirm whether the product meets safety and concentration standards, the manager must know the *pH* of diluted acid sample.

The acid is used to produce lead(II) sulphate used in battery plates. The company's environmental unit reported that only *0.035g/dm³* of it dissolves water at 17 °C, and the manager sought to know its solubility product, so as to predict the effects of waste discharge on nearby water sources. Concerned about these findings, the Plant Manager has invited you.

Task

As a learner of Chemistry, help the company to know;

(a) The equilibrium constant for the gaseous reaction **(Kc)**.

(b) Explain effect on the position of equilibrium, the value of Kc, and the rate of attainment of equilibrium by:

i. adding more Sulphurdioxide gas.

ii. introducing a catalyst.

iii. increasing temperature.

iv. increasing pressure.

(c) Calculate the pH of the solution obtained.

(d) Determine the solubility product of lead(II) sulphate.

(e) Environmental impacts of the gaseous or aqueous equilibria and their mitigations.

Item 2

A recent report from Tororo Industrial Chemicals Ltd, one of Uganda's emerging producers of industrial reagents and laboratory kits, revealed that the company is developing a dual-purpose field chemical pack for technicians working in rural agricultural and health sectors. The pack is intended to include one safe *warming* substance for sterilising small instruments and generating heat in remote operations, and one *cooling* substance for preserving biological samples and stabilising temperature sensitive reactions.

The company's research department is currently *comparing* ethanol, a locally available biofuel derived from sugarcane waste, with *sodium chloride*, obtained from the salt works around Lake Katwe.

The thermochemical data obtained from a certain article about ethanol indicate that the standard heats of formation of ethanol, carbon dioxide and water are (−227.0) , (−393.5), (−285.5) kJ mol^{-1} respectively.

For sodium chloride, the enthalpy of sublimation of sodium, bond dissociation energy of chlorine, first ionisation energy of sodium, first electron affinity of chlorine, enthalpy of formation of sodium chloride, hydration enthalpy of $Na^{+}(aq)$ and hydration enthalpy of $Cl^{-}(aq)$,(+109), (+242), (+494), (−364), (−411), (−406), and (−363) kJ mol^{-1} respectively.

Preliminary tests by the plant's laboratory team indicated that combustion of ethanol and, dissolution of sodium chloride in water produces minimal temperature change. To ensure the most energy-efficient and environmentally safe field pack, the company manager has invited you.

Task

As a student of chemistry, help the researcher;

(a) Analyse the data to construct an energy cycle for the changes in the:

(i) Combustion of ethanol.

(ii) Formation of sodium chloride.

(b) Use the energy cycles constructed to calculate;
(i). Enthalpy of combustion of ethanol.

(ii). Lattice of sodium chloride and its enthalpy of solution.

(c) (i) Evaluate industrial usefulness of the two systems to advise the manager choose the best substance for warming, and cooling with reason.

(ii). State any other ideal industrial use of ethanol.

(d) Suggest the possible impacts and mitigations of the substances to the environment.

SECTION B

Part I

Attempt **One** *item in this section*

Item 3

A chemical manufacturing company in Uganda, Kyoga Chemicals Ltd, produces industrial chemicals and water treatment agents. The company has been advised that substances suitable for use in water treatment plants and in construction industries, for stabilizing concrete and producing heat resistant materials must have the strongest ionic characters. The engineering department is analyzing the melting points of chlorides of Group II and Period 3 elements to select materials suitable for operations. The data is shown below:

Group/period	**Group II chlorides**					**Period 3 chlorides**							
Element	$BeCl_2$	$MgCl_2$	$CaCl_2$	$SrCl_2$	$BaCl_2$	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	PCl_5	S_2Cl_2	SCl_2
Atomic No	4	12	20	38	56	11	12	13	14	15	16	17	18
Melting pt/°C	405	714	782	875	962	405	714	782	875	962	405	714	782

The engineering department seeks a scientific analysis to select materials for different intended purpose. The company is also considering an unknown element X, positioned between aluminium chloride and silicon chloride in the periodic table. *Plotting graphs* of melting point against atomic number for Group II and Period 3 chlorides (separately), *describing and explaining* trends and irregularities in melting points across Period 3 and down Group II chlorides, *evaluating, with reasons*, which chlorides are most suitable for water treatment and stabilizing concrete, casting molds, and producing heat resistant materials and *predicting* the likely melting point range and industrial suitability of the element X chloride.

Task

As a chemistry student, make a write up you will use to help the company.

Item 4

Kilembe Chemical Works Ltd, in Kasese, is investigating how bonding and molecular structure affect the properties and industrial uses of several compounds used in fertilizer formulation, water purification, and manufacturing of plastics and ceramics.

The *compounds* under study include *water*, *phosphorus trichloride*, *carbon tetrachloride*, *tin(II) chloride*, *ammonia*, *tin(IV) chloride*, *nitrate ion*, and *phosphorus pentachloride*.

It was reported that some compounds such as carbon tetrachloride and phosphorus trichloride are liquids at room temperature and insoluble in water, ammonia and water are highly soluble and have strong intermolecular attractions. tin(II) chloride conducts *electricity* in molten form, while tin(IV) chloride does not.

The manager seeks to know *molecular shape*, *bond type*, and *bond angle* for each substance, use bond type and molecular structure in the compounds *account for their differences* in melting point, solubility, and electrical conductivity. why water and ammonia form hydrogen bonds, and how this affects their boiling points and solubility compared to phosphorus trichloride and phosphorus pentachloride. Compare the bonding and structure of tin(II) chloride and tin(IV) chloride explain their difference in electrical conductivity and melting points.to guide the design of safe storage systems and efficient cooling and purification processes. Evaluate the environmental impacts of using nitrate ions in fertilizers

Task

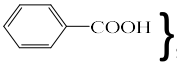
As a chemistry student, make a write up you will use to help the company.

Part II

Attempt **One** *item in this section*

ITEM 5

Nile Chemical Industries Ltd, a chemical manufacturing firm located in Jinja, produces a range of organic-based materials used in plastics, fuels, solvents, and disinfectants. In one of its experiments, 20.0 cm^3 of a gaseous hydrocarbon W was exploded with 150 cm^3 of excess oxygen. After complete combustion, the residual gas measured 110 cm^3, and when concentrated potassium hydroxide solution was added, the volume further decreased to 30 cm^3

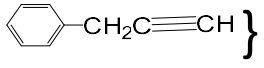
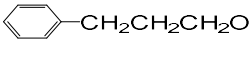
The company noted that ozonolysis of W produced only one compound and that W readily decolourised bromine water. These findings prompted the research team to seek a deeper understanding of W and its possible industrial applications in the synthesis of propan-1-ol, benzoic acid, {  }, 1,2-dibromopentane and 1-chlorobutane.

The company seeks a comprehensive evaluation: to determine the *formulae* of W, draw and name all possible *isomers*, *identify* W with reason(s), and illustrate the mechanism for the reaction between W and bromine water. Additionally, confirm the identity of the gas absorbed by potassium hydroxide solution, *predict* the functional groups of resulting organic compounds, describe *synthetic* pathways to related products, and assess the *environmental* impacts of producing above compounds in industry. You have been contacted for assistance.

Task

As a student of Chemistry, prepare a presentation you will use upon invitation.

ITEM 6

Albertine Oil Fractionation Ltd, an industrial chemical company in the Albertine region, produces fuels, solvents, and organic feedstocks for plastics and chemical synthesis. During a research study, an organic compound P was isolated from a distillation fraction. Complete combustion of a sample of P yielded 8.8 g carbondioxide and 1.8 g water, while 0.100 g of P, vapourised at 273°C and 734 mmHg, occupied 4.46×10^{-2} dm^3. Ozonolysis of P followed by hydrolysis produced a single ketone Q, and P was observed to react readily with bromine and concentrated sulphuric acid. The company is exploring industrial applications of these compounds for synthesis of prop-2-yn-1-ylbenzene {  } a component in manufacture of new drugs, benzene { }solvent, and {  }chemical feedstocks.

The manager seeks to know the formulae of P, all possible structural *isomers*, *identity* of P with reasons, illustrate *mechanisms* for reactions of P with *bromine* and *concentrated sulphuric acid*, deduce the structure and functional group of ketone Q, outline *synthetic* pathways from Albertine oil fractions P to synthesis industrial compounds stated, and evaluate the environmental impacts of producing compounds in industry and their mitigations. You have been invited to help the manager.

Task

As a student of Chemistry, prepare a presentation you will use to help the firm.

THE PERIODIC TABLE

1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.4 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Te 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Ti 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															
			139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 68	173 Yb 70	175 Lu 71
			227 Ac 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

END