Candidate's Name: ……..……..

Signature: ……..

STREAM:							

525/1
CHEMISTRY
Paper 1
Otober/November
2025
$2\frac{1}{2}$ hours

MID OF TERM III ASSESSMENT

Uganda Advanced Certificate of Education

S.5 CHEMISTRY

Paper 1

(***Set I***)

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 **<u>one</u>** *from each.*

Answers to Section **A** ***<u>must</u>*** *be written in the spaces provided and Section* **B** ***<u>must</u>*** *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.T
CODE																					
SCORE																					

SECTION A

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

ITEM 1

AgroTech Minerals Ltd. has developed a new inorganic fertilizer labeled **X** in Hydrated Form. Laboratory analysis shows that the solid contains 9.37% magnesium, 10.93% nitrogen, and 42.18% water of crystallization and rest being oxygen. Molar mass of **X** is 256g. 5.0 kg of the fertilizer was available for sale, the manager sought to know the amount in mass of nitrate nutrient in **X** that would be delivered to maize. Keen to know about environmental hazards, **X** was burnt in absence of air and decomposed with brown gas of nitrogen dioxide according to equation:

Equation 1: $2\,Mg(NO_3)_2(s) \rightarrow 2\,MgO(s) + 4\,NO_2(g) + O_2(g)$

The company sought to know the volume at s.t.p of the brown gas produced from burning 1.0 kg of the fertilizer and assess the environmental impacts of the emissions and mitigations.

Due to available rocks containing magnesium in the area, the company manager further seeks to evaluate the industrial synthesis of the fertilizer **X** from magnesium oxide:

Equation 2: $MgO(s) + 2\,HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2O(l).$

The supplier reported that he would potentially supply 10.0 kg of magnesium oxide per day, and the manager intends to know how much fertilizer would be available in one month and also possible environmental impacts of using the fertilizer and mitigations.

Task

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

(a) The Molecular formula of compound **X**.

(b) Mass of nitrate nutrient in **X** that would be delivered to maize.

(c) (i) The volume at s.t.p of the brown gas produced from burning the fertilizer.

(ii) The environmental impacts of the brown gas emissions and mitigations.

(d) (i)Mass of the fertilizer produced in one month.

(ii) Possible environmental impacts of using the fertilizer and their mitigations

Item 2

An aluminium smelting company in Jinja uses a substance called aluminium fluoride as a flux to lower the melting point of cryolite during aluminium extraction. However, the production unit is facing high energy costs, and the environmental team reports challenges in dissolving waste AlF_3 residues before disposal. The research chemist is tasked to analyse the thermochemical feasibility of both forming and dissolving AlF_3 using available thermodynamic data to determine whether these processes are spontaneous or energy-intensive.

Across a certain article the following data was discovered by the researcher:

Type of enthalpy change	Magnitude (kJ mol^{-1})
Standard enthalpy of formation of $AlF_3(s)$	−1301
Enthalpy of atomization of aluminium	+314
Bond dissociation energy of flourine	+158
First, second, and third ionization energies of Al	+577, +1820, and +2740 respectively
First electron affinity of flourine	−348
Hydration enthalpies aluminium and fluoride ions	−4690 , −364 respectively

The researcher struggles to use this information to construct and interpret an energy cycle diagram, perform calculations, evaluate the feasibility of the key processes and properties that suit aluminium fluoride for use in the process. You have been contacted for help.

Tasks

As a student of chemistry, help the researcher;

(a) Analyse the data to construct an energy cycle diagram for the formation of solid substance.

(b) Know the lattice energy of substance.

(c) Know the enthalpy of solution substance

(d) Evaluate whether the dissolution of the substance in water is thermodynamically feasible and spontaneous under standard conditions.

(i) State the properties that make the substance suitable to serve the above purpose

(ii) Suggest the possible impacts and mitigations of the substance to the environment.

SECTION B

Part I

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

Item 3

A manufacturing company in Mukono produces parts for high-temperature furnaces and electrical systems. The durability of each component depends on the melting point of the material, higher melting points ensure better heat resistance and mechanical strength. To guide selection, the research team compared melting points of selected Group II and Period 3 elements.. Following data was available

Group/period	**Group II**					**Period 3**							
Element	Be	Mg	Ca	Sr	Ba	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	4	12	20	38	56	11	12	13	14	15	16	17	18
Melting point (°C)	1280	650	850	770	720	97.8	650	660.3	1414	44.2	115.2	−101.5	−189.4

The engineering department seeks a scientific analysis to select materials for different temperature ranges. The company is also considering an unknown element X, positioned between aluminium and silicon in the periodic table. *Plotting graphs* of melting point against atomic number for Group II and Period 3 (separately), *describing and explaining* trends and irregularities in melting points across Period 3 and down Group II, *evaluating, with reasons*, which elements are most suitable for furnace linings and electrical connectors and *predicting* the likely melting point range and industrial suitability of the unknown element X.

Task

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

Item 4

A chemical company in Tororo manufactures halide compounds used in disinfectants. The first electron affinity (EA) of an element indicates how readily it gains an electron to form stable anions. Elements with more negative EA values are more reactive and suitable for halide formation, while those with low or positive EA are less effective.

The company is analysing Group VII and Period 3 elements to identify the most suitable for halide production and is also considering an unknown element X between aluminium and silicon.

Group/period	**Group VII**				**Period 3**							
Element	F	Cl	Br	I	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	9	17	35	53	11	12	13	14	15	16	17	18
First EA (kJ/mol)	−354	−370	−348	−320	−21	+67	−44	−135	−72	−200	−364	0

The manager seeks to analysis the data to make informed decisions by *plotting* first electron affinity vs. atomic number for Group VII and Period 3 elements separately. Describe and explain *trends* and all *irregularities* in electron affinity across Period 3 and down Group VII. Evaluate which elements are(is) most suitable for industrial halide production, giving reasons. Predict the likely electron affinity of element X and comment on its potential suitability for forming halides.

Task

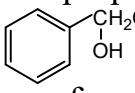
As a chemistry student, make a write up you will use to help the company.

Part II

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

ITEM 5

A chemical manufacturing firm in Uganda produces a variety of organic-based materials used in plastics, solvents, fuels, and disinfectants. The firm has identified an inorganic compound containing 62.5% calcium and 37.5% carbon as a starting material. When this compound was reacted with water, it released a colourless flammable gas that burned with a sooty flame, which has numerous industrial applications in Uganda, including the production of alkenes, alkyl halides, and aromatic compounds.

The firm sought to convert it into valuable organic materials such as propanol, chloroethane, benzene, which can be further converted to 1-phenylethan-1-ol 

, ethylbenzene, and nitrobenzene. Key mechanisms involved include dehydration of propanol to propene, electrophilic substitution reactions on benzene ring.

The company seeks a comprehensive evaluation: *determine* the empirical formula of inorganic compound, confirm the identity of the gas evolved, *predict* the functional groups of resulting organic compounds, and illustrate stated *mechanisms*. Additionally, assess *synthetic* pathways in the formation of stated compounds, and evaluate *health* and *environmental* impacts of producing both aliphatic and aromatic compounds in an industry. You have contacted for assistance on this.

Task

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

ITEM 6

A chemical research laboratory in Uganda is investigating a gaseous hydrocarbon X obtained from a petrochemical facility. Elemental analysis shows that X contains 11.11% hydrogen by mass, and its vapour density is 27, suggesting a molecular mass of 54 g. Hydrogenation of X with 1 mole of hydrogen and 1 mole of X over a nickel catalyst at 150°C produced a carbon–carbon double bond. When X is treated with concentrated sulphuric acid and water, it forms Y, which is further oxidized using hot acidified potassium dichromate to yield a compound Z. Z can also be tested with Tollens' reagent to confirm its functional group. Multi-step synthesis from but-1-ene, propene, and ethene are explored to generate X and its derivatives, which are important for producing alcohols, carbonyl compounds, and polymer intermediates in Uganda's chemical industry, while safety considerations such as flammability and waste management are observed.

An analyst, wishes to know *molecular formula* X, all structural *isomers* of X with IUPAC names, identify of X from its hydrogenation reaction, *identify* of Y from hydration of X, and identify of Z from oxidation of Y, *write equations* for hydration of X, dibromination followed by alcohol formation and mechanisms, oxidation of Y to Z, and reaction of Z with Tollens' reagent, *propose multi-step synthesis* of X from but-1-ene, propene, and ethene, and discuss the industrial applications, *environmental impact*, and mitigatigations of X, Y, and Z. you have been cotacted for your help.

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

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