Candidate's Name: .....

Signature: .....

Index Number | | | | | | | | |

Chemistry

P525/1

June/July

Uganda certificate of advanced education

Pre mock assessment 2026

Chemistry

P525/1

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of two sections a and b

Section A has two compulsory items while section b has two parts i and ii. Each of part i and 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 = 22.4dm³

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

SECTION A

Answer all items in this section

Item 1

Agro tech Mineral Ltd. Has developed a new inorganic fertilizer labelled X in Hydrated Form. Laboratory analysis shows that the solid contains 9.37% magnesium, 10.93% nitrogen and 42.18% water of crystallisation and rest being oxygen. Molar mass of X i s 256g. 5.0kg of the fertilizer was available for sale, the manager sought to know the amount in mass of the nutrient in X that would be deliver to maize. Keen to know abo ut environmental hazards, X was burnt in absence of air and decomposed with brown gas of nitrogen dioxide according to equation:

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

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

Due to available rocks containing magnesium in the area, the company manager furt her seeks to evaluate the industrial synthesis of the fertilizer X from magnesium oxid e:

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

The supplier reported that he would potentially supply 10.0kg of magnesium oxide pe r 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 mitigation s.

Task

As learner of Chemistry, help the company to know;

(a) The molecular formulas of the 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 fertilize r.

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

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

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

Item 2

A green energy investment project in Hoima plans to deploy small generator units in r ural trading centres. Engineers must choose between two possible fuels: methane ext racted from biogas digesters, and ethanol produced from molasses.

The project team requires a thermochemical assessment of which fuel delivers higher energy output, greater thermal efficiency, and lower environmental burden. To guide t he decision, the technical department provides the following standard thermochemic al data: Standard enthalpies of formation of methane, ethanol, carbon dioxide and liq uid water are −74.8, − 277.0, −393.5 and −285.8kJ mol^{-1} respectively.
Standard enthalpies of complete combustion of methane and ethanol are;

$$CH_3\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(l)$$

$$C_2H_5(l) + 3O_2(g) \rightarrow 2CO_2\,(g) + 3H_2O(l)\ respectively$$

Measured activation energies for combustion of methane and ethanol are; 252 kJ m ol^{-1} and 186 kJ mol^{-1} respectively.

The management has asked you, a learner of chemistry, to interpret the data and reco mmend the most suitable fuel.

Task

As a learner of chemistry, help the project manager;

(a) Calculate enthalpy of combustion of CH_4 and C_2H_5OH

(b) Sketch energy profile diagram for the combustion of CH_4 and C_2H_5OH on t he same axes, clearly indicating ΔH and Ea for each reaction and state cate gory of the reactions.

(c) Using the enthalpy data, calculate:

(i) The heat released per gram of CH_4 and per gram of C_2H_5OH.

(d) (ii) The volume of carbon dioxide produced per kJ of energy released for ea ch fuel at s.t.p.

(e) Using your diagrams and calculations, explain which fuel requires a lower activation barrier and discuss the implication on ignition and efficiency.

SECTION B

PART I ***(Attempt only one item)***

Item 3

A renewable energy company in Namanve industrial park is developing low cost rech argeable batteries for rural households. The engineers are comparing metal oxides as candidate anode or cathode materials. Thermal stability is crucial because battery pe rformance drops if the oxide decomposes at operational temperatures. They measure d decomposition temperatures of oxides (°C):

Group/period	Group II oxides				Period 3 oxides			
Atomic Number	12	20	38	56	11	13	14	15
Oxide	MgO	CaO	SrO	BaO	Na_2O	Al_2O_3	SiO_2	P_4O_{10}
Decomposition temper ature (^{0}c)	2800	2572	2531	1923	1132	2072	1713	340

The ideal battery oxide should have a decomposition temperature above 2500°C for l ong term efficiency. The company manager seeks to have a comprehensive report on the data; by analysing plots of decomposition temperature against the atomic numbe rs on the same axes, explaining trends in decomposition temperature, evaluating whic h oxide(s) is/are the most suitable for efficient, durable battery materials, and predicti ng the likely decomposition temperature of an oxide between CaO and SrO and justify its suitability for battery use. In order to best inform decisions for a proper electrolyte. You have been contacted you for help.

Task

As a learner of chemistry, make a write up to help the company manager.

Item 4

A renewable energy company in Tororo is testing materials for a low cost rechargeabl e battery system to be distributed in rural households. The study compares the suitab ility of four substances: graphite, sodium chloride (NaCl), magnesium oxide (MgO), a nd distilled water a used in preparing battery electrolytes.

Engineers note that graphite is good for electrodes, NaCl only good for electrolytes, M gO is good for higher temperature environments and water stabilizes ions but may co rrode metallic parts. The design team requests a scientific evaluation to analyse the b onding and structure of all four substances. Relate these features to conductivity, ther mal stability and reactivity, include VSEPR diagram for water to explain hydrogen bon ding and its significance as a solvent. And justify which materials are most suitable f or incorporation into a durable, efficient, and affordable rural battery system.

Task

As a learner of chemistry, write a presentation you will use upon invitation.

PART II

(Attempt only one item)

Item 5

A small chemical plant near a rural community recently discharged an unknown hydr ocarbon into a drainage channel used by households and livestock. Environmental of ficers collected the sample, labeled G, and performed preliminary tests. The molecula r formula of G is C_4H_6, and when treated with silver nitrate solution in ammonia, a whi te precipitate was formed. Further tests with bromine water and acidified potassium manganate (VII) indicate that G contains unsaturation. The environmental chemistry team is tasked with identifying G and investigating its chemical properties. They also need to predict its likely reactions in both laboratory and environmental conditions, ex plore possible synthetic routes from simple alkenes such as but-1-ene, ethanol and a metal residue calcium carbide, and assess potential environmental and health impact s. The team is particularly interested in the mechanism of how G reacts with water in the presence of sulphuric acid and mercury(II) sulfate, with hydrogen bromide to yield 1-bromo compound, bromine liquid and potassium manganate(VII) using equations. Safe handling and mitigation strategies are also to be considered. Before any decisio n is made the team must know: structure, functional group and possible isomerism of compound. Apply correct IUPAC names to G and all related products formed in labora tory reactions. Predict major products at each reaction stage based on organic reactiv ity and mechanism for key reactions. Explain stepwise reaction pathways leading to f ormation of G, classifying type of reaction at each stage, and evaluate the environme ntal and health impacts associated with G and its derivatives while proposing mitigat ion strategies.

Task

As a learner of chemistry, make a write up to help the team inform their decision m aking.

Item 6

A chemical manufacturing plant producing specialty flame-retardant polymers has re cently synthesized a brominated organic compound Y, intended as a starting material for high value polymers and pharmaceutical intermediates. For quality control, 1.363 g of Y was completely combusted, giving 1.10 g of carbon dioxide and 0.45 g of wate r. In a separate experiment, 0.35g of Y was vaporized, occupying 39.5 cm^3 at 20°C an d 750 mmHg. When Y was heated with alcoholic potassium hydroxide, the resulting v apor decolorized bromine liquid and formed a white precipitate with ammoniacal silv er nitrate. Correct identification of the compound is critical, as it will be used in the sy nthesis of; propene gas for polymers, chloropentane for pharmaceuticals, hexanal for preserving fresh apples, and polythene for food storage. $\left[\begin{matrix}H\\-C\\H\end{matrix}-\begin{matrix}H\\C-\\H\end{matrix}\right]_n$

Understanding the how to determine the molecular formula of Y. Identify the functional group present and draw all possible structural isomers of Y. Predict the types of reactions that Y can undergo and illustrate the mechanisms for at least two reactions (e.g., nucleophilic substitution and elimination). Outline synthetic pathways from Y to stated useful compounds, indicating reagents and conditions at each step. Finally, evaluate the environmental and health impacts of handling Y and its derivatives, and propose appropriate mitigation will help the plant optimize profit maximization. You have been invited for assistance.

Task

As a learner of chemistry, make a write up to help the management.

THE END

ALWAYS AIM FOR EXCELLENT