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pH = −log[H+]

PV = nRT

KISJO UACE CHEMISTRY MOCK POOL

AND APPROACH TO SCENARIOS



$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

1ST EDITION

Author: Mr. Kisule Joseph

KISJO CONTENT KISJO UACE CHEMISTRY 1 MOCK POOL

INTRODUCTION

The journey to UACE success requires more than reading notes; it requires exposure to standard, challenging scenarios. This book, ***KISJO UACE MOCK POOL***, is a highly respected ***KISJO*** collection of Top Mock Examinations from Top Mock Bodies which will help thousands of scholars throughout the nation, not forgetting; St. Mary's SS Namaliga, St. Peters S.S Bombo Kalule, and Katikamu SDA SS.

It is designed according to UNEB format to help you master answering techniques, time management, and confidence. Use it daily, discuss with peers, and consult your teachers.

Learn with kisjo, rise beyond limits

DEDICATION

This book is dedicated to teachers and all Chemistry Scholars of Advanced Level - the future leaders, engineers, proffers, teachers, scholars, and innovators of Uganda. Your determination inspires this work. May you find in these pages the guidance to excel and achieve your academic dreams.

ACKNOWLEDGEMENTS

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ABOUT THE AUTHOR

Mr. Kisule Joseph is a passionate Ugandan educator committed to improving the performance of Advanced Level Chem students. With extensive experience in handling UACE Chemistry classes and setting standard assessments, he has compiled this book to make high-quality mock papers accessible to every student, regardless of school. His mission is simple: To see every A-Level student excel.

Table of Contents

STRUCTURE OF MOCK/UACE CHEMISTRY THEORY PAPER 1 (P525/1) 6
ELEMENTS OF CONSTRUCT, ASSESSMENT OBJECTIVE AND RELATED TOPICS.....6
Construct one (AO1) Basis of assessment.....8
SAMPLE NOTES ON ASSESSABLE AREOS FOR AO1.....9
Construct two (AO2) Basis of assessment.....10
Sample notes on the assessable areas for AO2 11
Homologous series (their properties, applications, dangers and mitigations).....12
Construct 3 (AO3) Basis of assessment.....15
Construct 4 (AO4) Basis of assessment.....16
Sample notes on AO4.....17
Sample notes on AO4.....17
1. UMTA.....17
Item 1 17
Item 2.....18
Item 3.....19
Item 4.....20
Item 5.....20
Item 6.....21
2. LUDISSEB mock.....21
Item 1 21
Item 2.....22
Item 6 23
3. PEA — COUHEIA Mock Examinations 23
SECTION A (Compulsory).....23
Item 1.....23
Item 2 23
Item 3 24
Item 4 24
Section B Part Il (Respond to any one item) 25
Item 5 25
Item 6 25
4. ASSHU Kigezi Regional Mock Examinations.....25
SECTION A - Respond to all items 25
Item One 25

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Item 2 26
SECTION B Part I (Respond to only one item) 26
Part II (Respond to only one item) 28
5. WAKATA 29
SECTION A - Respond to all items 29
Item 1 29
Item 2 29
SECTION B Part I (Respond to only one item) 30
Part II (Respond to only one item) 31
6. ASSHU- mock 31
SECTION A 31
Item One 31
Item 2 32
Item 3 32
Item 4 32
Item 5 33
Item 6 33
7. Pre-Mock Examinations 2026 34
SECTION A - Respond to both items 34
Item 1 34
Item 2 34
SECTION B Part I (Respond to only one item) 35
Part I l (Respond to only one item) 35
8. JJEB 36
Item 1 36
Item 2 36
SECTION B PART I (Attempt only one item) 36
Item 3 36
Item 4 37
Item 5 37
Item 6 37
9. Kabale Diocesan Mock Examinations 37
SECTION A - Respond to all items 37
Item One 37

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Item Two 38
SECTION B Part I (Respond to only one item) 39
Part II (Respond to only one item) 39
10 UMOB Mocks 41
11. **WAKISSHA** 51
12. KAMSSA 56
13. PREMOCK by ssematimba 61
14.USTAA 67
15.UNNASE 74
16 ACEITEKA 80
17.UTEC 85
18.UTES 90

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STRUCTURE OF MOCK/UACE CHEMISTRY THEORY PAPER 1 (P525/1)

- ✓ **Paper 1(Theory paper)**
- ✓ 2 sections A and B
- ✓ **Section A (2 compulsory items)**
- ✓ Item 1 from Assessment Objective 3 (AO3)
- ✓ Item 2 from Assessment Objective 4 (AO4)
- ✓ **Section B (2 Parts I and II)**
- ✓ Each part has 2 items (answer only one item from each part)
- ✓ Part I from Assessment Objective 1 (AO1)
- ✓ Part II from Assessment Objective 2 (AO2)
- ✓ **Duration is 2 hours and 45 minutes**

Paper 2 (practical paper): Chemistry P525/2
This consists of two compulsory items picked from any of the three constructs.
Item 1: from **physical chemistry experiments** (using the normal scientific skills like Aim, hypothesis, variables, procedure, risks & mitigations, data presentation and recording, data analysis, recommendations & conclusions)
Item 2: From **qualitative** analysis; either **organic** or **inorganic** chemistry.
Duration **3 hours** and **15 minutes**

ELEMENTS OF CONSTRUCT, ASSESSMENT OBJECTIVE AND RELATED TOPICS

Element of construct	Assessment Objective	Related topics
Construct one *For **inorganic chemistry** items, focus on:* ➢ Foundations of atomic structure. ➢ Bonding. ➢ Periodicity of elements.	**AO1 (Item 3 and 4)**- demonstrate understanding of atomic and molecular structures, periodic trends and patterns of chemical reactivity across the periodic table	1. Atomic & electronic structure and radioactivity 2. Bonding & structure 3. Periodicity 1 & II
Construct two *For **organic chemistry**, focus on:* ➢ Structure. ➢ Reactivity. ➢ Applications of organic molecules	**AO2 (item 5 and 6)-** Analyse the structure, reactivity and transformation pathways of organic compounds to predict chemical behaviour, explain natural processes and propose solutions in real-world and innovate chemical contexts	1. Organic chemistry I, II, & III
Construct three *For **physical chemistry** items, focus on:* ➢ Molecular interactions. ➢ System dynamics	**AO3 (Item 1)-** Apply fundamental physical chemical principles to analyse, model and predict the amounts of substances, energy changes and reaction rates in chemical systems under varying conditions	1. Thermochemistry 2. Reaction kinetics 3. Electro chemistry
Construct three For **physical chemistry** items, focus on: ➢ Chemical equilibria. ➢ Electro chemical systems.	**AO4 (Item 2)**- Apply principles of chemical and physical equilibria and electrochemistry to interpret, predict and evaluate the behaviour of chemical	1. Equilibria 1 & II 2. Electrochemistry 3. Moles and equations

➢ Stoichiometry.	systems in industrial and real-world contexts.	

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Construct one (AO1) Basis of assessment

Basis Of Assessment		Criteria of assessment	Code	Score
A	Well explained trend(s)/physical properties/factor (s)	Two well explained trends/physical properties/factors	2Te	02
		One well explained trends/physical properties/factors	1Te	01
		No well explained trends/physical properties/factors		00
B	Explained chemical properties/ reactions	Explained reaction + equation	Re + Eq	02
		Explained reaction only	Re	01
		No explained reaction		00
C	Explained application(s), explained danger(s) and explained mitigation(s)	Explained application + explained danger + explained mitigation	Ea+Ed+Em	03
		Explained application + explained danger	Ea+Ed	02
		Explained application/danger	Ea/Ed	01
		No explained application/danger		00

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SAMPLE NOTES ON ASSESSABLE AREAS FOR AO1

<table>
<tr><th>Basis of assessmen</th><th>Expected response</th></tr>
<tr><td>Well explained Trend(s)/ physical properties/ factor(s)</td><td>Example; Take data from sample item
<table><tr><th>Element</th><th>Na</th><th>Al</th><th>Si</th></tr><tr><td>Melting point</td><td>98</td><td>660</td><td>1410</td></tr></table>Trend; M.pt generally increases from Na to Si. Na, Mg, Al have giant metallic structures held by strong metallic bonds. From Na to Al, atomic radius reduces and electrons contributed per atom to metallic bond increases hence stronger bond requiring more energy to break.
Si has giant covalent structure with many Si atoms held by strong covalent bonds that require more energy to break.</td></tr>
<tr><td>Explained chemical properties/reactions

(Reason, conditions, type, products, equations)</td><td>When explaining a reaction, consider;
1. Reason for reaction 2. conditions, 3. type of reaction 4. products 5. Equation(s)
Note: Not a must to mention type in all.
Reaction with alkalis:
-Al being amphoteric reacts with dilute NaOH in single displacement & redox to form sodium aluminate (tetrahydroxoaluminate ions) and hydrogen gas. [Re]
2Al + 2OH- + 6H2O -> 2Al(OH)4- + 3H2 [Eq]
-Si being amphoteric & reducing agent; reacts with hot conc. NaOH in redox to form sodium silicate and hydrogen gas.
Si + 2OH- + H2O -> SiO3 2- + 2H2 [Re]</td></tr>
<tr><td>Explained application dangers and mitigation.</td><td>Silicon was centre of focus:
-Silicon is used to make processors in smartphones, laptops & other electronics/ used for making solar panels since its a semiconductor [Ea] however its causes water pollution since its non-biodegradable leading to waste accumulation in water. This pollutes water/ makes water unsafe for domestic use. [Ed] This can be mitigated by recycling all silicon wastes. [Em]
Case 2; if focus was on sodium;
-Sodium metal is used as a coolant in nuclear reactors however when exposed to water bodies/soil it reacts with water forming NaOH alkaline solution that increases water pH harming aquatic life</td></tr>
</table>

leading to the death and extinction of species. This can be mitigated by proper disposal of sodium wastes in gazetted containers.

Case 3; if the focus was on aluminium

-Aluminium because it conducts heat easily, light in weight and highly resistant to corrosion, is used in manufacture of utensils however it blocks oxygen intake in gills of fish leading to suffocation and death of these aquatics. This can be mitigated by recycling aluminium metals from the environment

A summary of application of elements and their compounds, danger and mitigation

Topic	Element/ comp.	Application	Danger	Mitigation
Atomic, electronic structure and radioactivity	**Radioactive nuclides**	-In archaeology; To determine the age of fossils using carbon-14 since its radioactive and its half-life is known, 5,700 years. -Food preservation; exposure to gamma radiations kill micro-organisms on food hence preserving it. -In Industry; Thickness of paper, plastics, metal foils is measured using radiations and also to detect leakages in oil and gas pipes -In medicine Gamma radiations from cobalt-60 is used to treat or kill cancer cells.	-The energy and radiations emitted can cause gene mutations by disorganising arrangement of genes in cells. -Causes cancer hence malfunctioning/death of body organs. This is due to uncontrolled/ uncoordinated cell division. -Excessive heat from the reactions leading to Explosion of nuclear reactor/plant.	use of lead sheets to absorb any form of radiations. - proper disposal of radioactive wastes/enforcing strict laws/peace talks/prevent or avoid exposure

Periodicity	Element	Application	Danger	Mitigation
	Sodium	-as a coolant in nuclear reactors -manufacture of sodium cyanide for gold extraction.	-When disposed into water/bodies, it reacts with water forming sodium hydroxide solution, an alkaline solution that raises water pH harming aquatics.	-Proper disposal of sodium wastes in well gazetted cans.
	Magnesium			
	Aluminium			
	Silicon			
	Phosphorous			
	Sulphur			
	chlorine			

As chemist, kisjo expects you to individually complete the table

Construct two (AO2) Basis of assessment

	Basis of assessment	Criteria of assessment	Code	Score
A	Well explained physical properties of compound(s) stated (relating to the suitability mentioned in scenario)	Two Well explained physical properties, one for each compound	**2Ep**	**02**
		One Well explained physical property of any one of the compounds stated.	**1 Ep**	**01**
		No explained physical property	**0Ep**	**00**
B	Mechanism(s) (Not direct)	All steps correct mechanism-1 + All steps correct mechanism-2 All M1 + All M2	**All M1+ All M2**	**08**
		2/3 of the required steps in mechanism-1 / 2/3 of required steps in mechanism-2	**2/3 M1 / 2/3 M2**	**05**
		No correct mechanism/ below 2/3 M2/ M1		**00**
C	Synthesis	All steps correct synthesis for all compounds given. All R1 + All R2	**All R1 + All R2**	**08**
		2/3 of the required steps in synthesis-1 / 2/3 of required steps in synthesis-2	**2/3 R1 / 2/3 R2**	**05**
		No correct synthesis / below 2/3 R2/ R1		**00**
D	Explained other Application of the compound, its explained danger and explained mitigation. (How many? The scenario will specify that)	Explained application + explained danger + explained mitigation	**Ea+Ed+Em**	**03**
		Explained application and danger	**Ea+Ed**	**02**
		Explained application/ danger	**Ea/ Ed**	**01**
		No Explained application		**00**

Sample notes on the assessable areas for AO2

Basis of assessment	Expected response
Well explained physical properties of compound(s) stated (relating to the suitability mentioned in scenario)	**Example;** Let's take an example of propanone from a sample scenario that is being used in fast-drying sprays. Propanone is used in Fast-drying sprays because its highly volatile and evaporate quickly. Ep
Mechanism(s)	Of course it cannot be direct like write a mechanism. But there will be some statements in the scenario to mean that. **For the example** -..'the chemist wanted to know how the reaction occurs.' -..is Interested in the step-by-step pathway -..explain sequence of elementary steps for the reaction -..guide the team with an illustration of the detailed course of the reaction -..Provide a molecular-level explanation for the reaction **Dear candidate, our principles in presenting these mechanisms still stand.** -hanging bonds/distorted -arrows that are not touching the species -correct chemical symbols of elements in species -correct structures of the intermediates -minor products -Proton shift in some reaction mechanisms -And many others as you have been guided by your teacher...
Synthesis	**Recommended; At least about 3-6 steps** (but this depends on the compound being synthesized as some will require at least an extra step/or even fewer, depending on the routes you have at hand); with equations or without using equations (descriptions). **Dear candidate, our principles in presenting this synthesis part still stand.** -Physical states of reagents -conditions -reagents for that reaction -correct structures of intermediates in some specific reactions -emphasis on trying to have shorter routes ..etc -And many others as you have been guided by your teacher...
Explained application, dangers and mitigation. (How many? The scenario will specify that)	Other Application(s) of that compound in daily life(well explained), its side effect(s) to environment or health depending on the scenario, and mitigation(s) explained.

Homologous series (their properties, applications, dangers and mitigations)

EXPLAINED PHYSICAL PROPERTIES, APPLICATIONS, DANGERS AND MITIGATIONS

Homologous	Explained physical prop	Other explained applications	Danger and mitigation explained.
Alkanes	Solvent for non-polar solutes Since its non-polar, it can not interact with polar water molecules	• Higher alkanes used as lubricants (due to higher boiling points as a result of higher molecular mass hence greater magnitude of van der Waals forces of attraction that require more energy to be broken) • Lower alkanes used as clean gas for lighter fuels since they are highly flammable with low boiling points allowing to ignite instantly.	• Incomplete combustion leads to carbon monoxide production that outcompetes oxygen for haemoglobin leading to respiratory disorders like lung cancer. • Complete combustion leads to carbon dioxide accumulation hence global warming. Mitigations; Use of non-carbon-based fuels like HEP/solar that are safer. • Forms a thin non-polar layer on water surface reducing oxygen and light supply to the aquatics hence their suffocation and death
Alkenes	Used in making of buoyant polymers such as life jackets, floating ropes because they are less dense than water and can form stable bonds in polymers.	• Used as solvent in water purification and solvent extraction to attract non-polar compounds since its non-polar, immiscible with water (less dense than water) and can easily vapourise off (volatile). • Used in fast drying coatings (e.g. in ink, paints) as fast evaporating solvents since they can easily vapourise at room temp. • Aerosol propellants as these gases can liquefy easily • Used to prepare ethane-1,2-diol that is used in radiators. • Ethene acts as plant hormone to ripen fruits artificially by signalling fruits to change colour, soften and develop good smell as it diffuses faster and has a low boiling point. • Lower alkanes used as clean gas for lighter fuels since they are highly flammable with low boiling points allowing to ignite instantly.	• Incomplete combustion leads to carbon monoxide production that outcompetes oxygen for haemoglobin leading to respiratory disorders like lung cancer. • Complete combustion leads to carbon dioxide accumulation hence global warming. Mitigations; Use of non-carbon-based fuels like HEP that are safer. • Forms a thin non-polar oil layer on water surface reducing oxygen and light supply to the aquatics hence their suffocation and death
Alkynes	Solvent for non-polar solutes Since its non-polar, it can not interact with polar water molecules	Oxy-acetylene welding flame since ethyne is highly flammable with a high heat of combustion (triple bonds in ethyne pack massive internal energy that is released on burning) • Ethyne as plant hormone to ripen fruits artificially as it diffuses faster and has a low boiling point.	• Incomplete combustion leads to carbon monoxide production that outcompetes oxygen for haemoglobin leading to respiratory disorders like lung cancer. • Complete combustion leads to carbon dioxide accumulation hence global warming. Mitigations; Use of non-carbon-based fuels like HEP that are safer. • Forms a thin non-polar layer on water surface reducing

Homologous se	Explained physical property	Other explained applications	Danger and mitigation explained.
Alkylhalides (Halogen compounds)	Some (e.g. methylbromide) fire because they are non-flammable and denser than air.	• As solvents in dry cleaning and de-greasing substances/ workwear since they are non-polar hence can dissolve dirt/grease removing it from a surface. • As a refrigerant (e.g. methylchloride) since they have low boiling points hence quickly absorb heat from a substance as they vapourise. • Manufacture of polymers like PVC from chloroethene since can undergo polymerisation • Used as intermediates in drug production such as chloramphenicol for typhoid, ethylchloride is used as anesthesia during operations because of its cooling effect when it evaporates from the patient's skin. • Methylbromide, a powerful fumigant for grain pests since it's toxic. • Paint removers since	oxygen and light supply to the aquatics hence their suffocation and death • Alkylhalides like DDT are inert and hydrophobic and bio-accumulate in body of living organisms. Mitigation; Bioremediation by injecting specialised anaerobic bacteria in water/soil to convert toxic alkylhalides to non-toxic compounds. • Combustions of waste alkylhalides leads to acidic emissions that lead to acid rains which crumble walls, buildings made of limestone and iron/lowering pH of soil reducing soil fertility/lowering water pH hence harming aquatics. • Soil pollution; Some alkylhalides persist in the environment. • Global warming since many gaseous halogenated waste products are greenhouse gases. • Air pollution; alkylhalides such as chloropicrin (tear gas) contribute to smog and toxic air which when inhaled can cause respiratory disorders.
Benzene and methylbenzene	Solvent for non-polar solutes such as fats, inks, oils, resins and waxes. Since its non-polar, it can not interact with polar water and also in solvent extraction since its immiscible/less dense than water and has low boiling point (highly volatile) to evaporate easily leaving the solute.	Highly volatile hence used in azeotropic distillation as the third component. • A precursor in making plastics like polystyrene • Methylbenzene for industrial cooling and heating loops and as a solvent in low-temp thermometers since its a stable liquid below and above its freezing and boiling points respectively. • Methylbenzene is used in fast-drying coatings as a formulation to remove nail polish, permanent markers. This is because its highly volatile hence evaporates quickly in the air. • As solvents for detergents (since it's non-polar) and pesticides (since it's toxic and non-polar)	On Health: • Highly volatile and carcinogenic when inhaled causing cancer and leukemia/reproductive issues (women get irregular menstrual periods/cardiac issues/severe poisoning • When in direct contact with it, skin irritations/eye damage Mitigation; wearing personal protective gears like closed shoes, lab coats, gloves and face masks to prevent direct contact and inhalation/should be used in closed chemical manufacturing systems. On Environment • Air pollution; its toxic hence contaminates air • Water pollution; highly toxic to aquatics • Soil pollution; it suppresses carbon dioxide absorption in plants inhibiting photosynthesis.
Alcohols and phenol	Universal industrial solvent for both polar and some non-polar solutes due to its dual solubility (having a polar hydroxyl head and non-polar hydrocarbon tail) • Ethanol; a beverage in wines, beers and spirits, (because it is soluble in	A colourless liquid with a spirit smell and highly volatile hence skin fumes. • Antiseptics and disinfectants (Sanitizers) since they penetrate water-soluble cell walls of bacteria and viruses disrupting the hydrogen bonds in proteins, causing protein denaturation. • Antifreeze and de-icing fluid in engines and also a thermometer due to extremely low freezing	HEALTH • It slows down brain activity, causing drowsiness, slurred speech and loss of coordination • Methanol causes nerve damage, permanent blindness and death Environmental • Methanol spills are toxic to animals For Phenol; On Health:

Homologous / To	Explained physical property	Other explained applications	Danger and mitigation explained.
Alcohols (cont.)	• water/polar, evaporates quickly for aromas in beverages, low melting point to stay as a liquid at freezing temp) • Fast-drying inks, aerosol sprays because its highly volatile. • Ethanol and methanol used as fuels (since they have high heat of combustion) • Used in skin cooling gels due to its high heat of vaporisation (heat required to convert a liquid to vapor).	For PHENOLS • Phenol is used in manufacture of phenol resins like Bakelite, a thermosetting plastic (since its highly reactive, benzene structure provides thermal and chemical resistance). • Manufacture of drugs (e.g. aspirin and paracetamol that are analgesics) • Phenol is used to make aspirin and antiseptics (e.g. Dettol).	For Phenol; On Health: • Chemical burns when exposed to skin. • Chronic toxicity e.g. liver damage On Environment: • High aquatic toxicity leading to death of these aquatics.
Carbonyl compounds	For Aldehydes: • Used as fragrances /perfumes and flavourings since they are highly volatile hence evaporate easily and has distinct odours • Solvents; Short chain aldehydes are polar (e.g. formalin solutions for tissue preservation)	For Ketones: • Fast-drying sprays because its highly volatile and evaporate quickly. • Dual polar/non-polar hence a solvent for nail polish and paint removal.	• Air pollution; Since they are highly volatile-smog formation. • Water pollution; Formaldehydes like formalin are toxic to aquatics.
Carboxylic acids and derivatives			
Amines			
Polymers			

In summary, for organic items think about the following

- Explained property of the compounds stated in the scenario
- Reaction Mechanism of the reactions mentioned in the scenario
- Synthesis of those (2) compounds mentioned in the scenario
- Explained (Application, dangers and mitigation) of the compound

Construct 3 (AO3) Basis of assessment

Basis of assessment	Criteria of assessment	Code	Score
A well explained Factors/ laws/ principles/ theories	At least two well explained Factors/ laws/ principles/ theories	2T + 2Te	04
	One well explained Factors/ laws/ principles/ theories	T + 2Te	03
	No well explained Factors/ laws/ principles/ theories		00
B Analysis + interpretation of data (Graphical, calculation, energy level diagram, Born Haber cycle) + conclusion	All Data Analysis + interpretation of data + conclusion	(Ca + Ci + Cd)	03
	All Data Analysis + interpretation of data	(Ca + Ci)	02
C Explained Application and recommendation of the concept	Well explained application of concept + recommendation	Ca + Cr	02
	Well explained application of concept / recommendation	Ca + Cr	01
	No Well explained application of concept / recommendation		00

Note; The scores displayed are not the fixed. This will depend on the scorer's guide of the day.

SAMPLE NOTES ON THE ASSESSABLE AREAS FOR ASSESSMENT OBJECTIVE 3 (AO3)

Basis of assessment	Expected response
well explained Factors/ laws/ principles/ theories	Example; Let's take an example of some data in a scenario requiring us to present a Born Haber cycle or energy level diagram. By constructing one to illustrate Hess law (for law/principle illustrated) Using it calculate the required energy term Explaining some factors (e.g affecting lattice)
Analysis + interpretation of data (Graphical, calculation, energy level diagram, Born Haber cycle) + conclusion	On assumption there's a graph involved Axes with correct units Plots Scale Shape Using this graph to determine what is required Making a final conclusion (On this note dear candidates, try to identify how to analyse any data provided-identify the topic it falls and the concept behind because these scenarios are high order not straight to the task)
Explained Application and recommendation of the concept	The reaction is exothermic this can be applied in hot packs _____(explain) and therefore I recommend the management to_____

Construct 4 (AO4) Basis of assessment

	Basis of assessment	Criteria of assessment	Code	Score
A	well explained Factors/ laws/ principles/ theories	At least two well explained Factors/ laws/ principles/ theories	2F + 2Fe	04
		One well explained Factors/ laws/ principles/ theories	2F + 2Fe	03
		No well explained Factors/ laws/ principles/ theories		00
B	Analysis + interpretation of data (Graphical, calculation, energy level diagram, Born, Harber cycle) + conclusion	All Data Analysis + interpretation of data + conclusion	(Ca + Ci + Cc)	03
		All Data Analysis + interpretation of data	(Ca + Ci)	02
C	Explained Application and recommendation of the concept (At least 2) Explained applications	Two Well explained application of concept + recommendation	Ca + Cr	02
		One Well explained application of concept / recommendation	Ca + Cr	01
		No Well explained application of concept / recommendation		00

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Sample notes on AO4

Basis of assessment	Expected response
well explained Factors/ laws/ principles/ theories	Example; Let's take an example of some data in a scenario requiring us to explain principles of steam distillation. By explaining the principle ✓Te (principle explained) + ✓T
Analysis + interpretation of data (Graphical, calculation, energy level diagram, Born Haber cycle) + conclusion	On assumption there's a calculation involved Calculating empirical formula: % of the element ✓Da ; getting moles of each element ✓Da ; getting mole ratio ✓Da Stating the formula for determining molar mass using steam distillation ✓T ; substituting variables ; ✓Da ; getting final molecular mass ✓Da -Using the obtained molecular mass to get molar mass of cpd ✓Di (on this note dear candidates, units are so important in calculations, so kindly always be on point.)
Explained Application and recommendation of the concept	The reaction is exothermic this can be applied in hot packs ____(explain) ✓Ep and therefore i recommend the management to____ ✓Er

1. UMTA

Instructions to Candidates

This paper consists of two sections A and B. Section A has two compulsory items. Section B has two parts, I and II; respond to only one item from each part. All responses should be written on the answer sheet(s) provided. Illustrate your responses with well-balanced equations where applicable.

Constants: Molar gas constant R = 8.31 JK-1mol^{-1}; Molar volume of a gas at s.t.p = 22.4 litres; Standard temperature= 273 K; Standard pressure = 101325 Nm^{-2}; Faraday's constant = 96500 C mol^{-1}.

SECTION A — Respond to all items in this section

Item 1

Portable electrochemical power units and oxidising disinfectants are essential in rural health centres for sterilising reusable medical instruments and providing emergency electrical power during immunisation outreaches.

To improve these services, the research team of a secondary school in Mityana developed a portable acidified dichromate (Vl) based disinfectant for sterilisation and a power unit constructed using the dichromate (Vl) 'chromium(lll) and chlorine/chloride half-cell.

During field trials, health workers observed that disinfectant stored in the outreach box during hot afternoon s became ineffective much sooner than samples kept in a refrigerator at the health centre. They

also found t hat a change in the energy associated with dissolving gaseous ions changes electrode potential value at each electrode, affecting the operation of the steriliser. Their supervisor provided the required electrochemical data while the students monitored the concentration of dichromate (Vl) ions remaining in the disinfectant and obtained the following data.

Time (minutes)	0	10	20	30	40	50	60
Conc ($moldm^{-3}$) of $Cr_2O_7^{2-}$	2.500	1.581	1.090	0.631	0.420	0.250	0.160

Electrochemical data

Half cell reaction	E^O (V)
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	+1.53
$Cl_2(g) + 2e \longrightarrow 2Cl^-(aq)$	+1.36

The project being developed was not understood by the health workers and they sought help from the research team, who selected you to help in: analysing and interpreting the concentration data on a suitable concentration-logarithm graph to estimate the storage efficacy by determining the half-life, considering a half-life of at least 0 minutes as making the disinfectant more efficient; interpreting disinfectant behaviour during trials; constructing the cell representation to evaluate the free energy change; and justifying optimal storage and electrode choices.

Task As the selected project team member, make a write-up of the presentation to the health workers to make them understand and use the project being developed by the research team.

Item 2

Thermal extraction using steam and pH regulating mixtures are commonly used in manufacturing industries to preserve product quality during processing and storage. Chemical engineers collaborated with an essential oils factory in Gulu to improve eucalyptus oil extraction for antiseptic formulations. During production, the team observed that increasing the heating temperature reduced both the yield and aroma of the oil, while fluctuations in the acidity of the blending tank caused variations in the quality and shelf life of the final antiseptic product. The factory proposed steam extraction of the oil, Q in eucalyptus, and introducing a suitable buffer solution of Q during blending. The students collected the following data for steam extraction of a mixture containing 3.43% of Q at 101.3 kPa:

Temperature (°C)	70	80	90	100	110
Vapour pressure Q (kpa)	1.4	2.4	3.9	6.1	9.2

May God Bless You

Vapour pressure of water (kpa)	19.0	47.0	72.0	104.0	132.0

In the laboratory, the team weighed 0.56 g sample of Q, known to contain carbon, hydrogen and nitrogen only, and subjected it to complete combustion, where 1.591 g of carbon dioxide and 0.379 g of water were collected and measured, while a significant amount of soot was also observed.

On further analysis they added 35.0 cm: of 0.10M hydrochloric acid to 45.0 cm: of 0.10M solution of Q to prepare the blending solution During one production run, a little sodium hydroxide accidentally poured into the mixture before packaging worried the workers; however, the laboratory technician guided that this should not worry them as the solution's pH will not be affected and informed them that the dissociation constant o f Q was 4.2×10^{-10} mol dm^{-3}.

Before approving the new production system, the factory management requested the engineers, who lack sufficient theoretical principles, to: justify the change in oil quality by predicting the outcome if direct heating or no buffer is used; analyse the steam distillation data on a suitable graph and use the data to deduce the structural formula of Q and the pH of the blending solution; justify the laboratory technician's guidance on t he stability of pH after accidental addition of sodium hydroxide; and understand the applications of the system in the factory.

Task:
Your brother, the main chemist in the company, is very busy and has asked you, a senior chemistry student, to write a detailed report to guide the engineers. Write the report.

SECTION B — Part I (Respond to any one item from this part)
Item 3

Certain chemical elements play a vital role as raw materials in the production of substances that enhance hygiene and sanitation in everyday life. A group of Senior Three students at a secondary school in Mbarara is participating in an innovation project to produce disinfectants and surface-cleaning agents using organic substances as solvents, for use within the school and for sale to the surrounding community. The best disinfectant or surface-cleaning agent is one with the most oxidising ingredient. To help them select a suitable active ingredient, the laboratory technician provided information about three elements and the data shown below

Element	Fluorine	Chlorine	Iodine
Action with water	Reacts vigorously	Reacts slowly	Slightly soluble
Boiling point (°C)	-188	-35	189
Standard electrode potential (v)	+2.87	+1.36	+0.54

The technician hinted that a suitable choice might emerge only after carefully weighing the given information against less obvious considerations such as environmental consequences and the differing ways each substance interacts with water and aqueous sodium hydroxide.

Task:

Help the learners address their challenge.

Item 4

The relevance of some metals as raw materials for making different laboratory tools depends on their ability to withstand and respond to varying thermal conditions, their densities, and how their chemical properties influence performance under practical laboratory conditions. An engineer at a metal fabrication company is helping two teams of senior five students at a secondary school in Iganga to select metals for laboratory equipment. One team studied selected transition metals for heating apparatus, while another examined some Group 2 elements for lightweight fittings recoverable with alkalis and analysed the action of the selected alkaline earth metals on water.

Group 2 element	Be	Mg	Ca	Ba
Atomic number	4	12	20	56
Density (g/cm^3)	1.85	1.74	1.55	3.54

Metal	Sc	Ti	V	Cr	Mn	Co	Ni	Cu
Melting point (^oC)	1541	1668	1907	1907	1247	1495	1455	1085
Atomic number	21	22	23	24	25	26	27	28

May God Bless You
A gift to serve

Task;

As the class coordinator of Senior six chemistry class, write a report that the engineer will use to guide the senior five class, clearly highlighting all the issues and evaluation of any environmental impacts arising from the process.

Part II (Respond to any one item from this part)

Item 5

The production of pharmaceuticals, disinfectants and other industrial chemicals relies heavily on aromatic compounds because they serve as versatile intermediates in the synthesis of a wide range of valuable products. A pharmaceutical manufacturing company in Kampala is expanding its production line to dyes, pharmaceutical intermediates and household cleaning products. During planning, research chemists recommended u sing benzene as the starting material for preparing an intermediate compound X through nitration, which would undergo further transformations to produce a target pharmaceutical intermediate. The company's environmental management team warned that compound X is considerably more toxic than benzene and any excess should be chemically converted back into benzene before storage or disposal. The research team also established that benzene could be converted into another aromatic compound Z by chlorination, which can react with an alkyl halide in the presence of a halogen carrier to produce an intermediate required for the manufacture of biodegradable household detergents.

Task As the senior chemistry student attached to the project, prepare a technical report that explains, using reaction schemes with arrows, how compounds X and Z are synthesised from benzene, how excess compound X can be converted back into benzene, how Z can be converted to the intermediate for

manufacture of the biodegradable household detergent, the applications of the compounds formed, and the environmental hazards associated with the various processes.

Item 6

A medium-sized specialty chemical company in Jinja plans to diversify its operations by manufacturing polymer-processing additives and industrial coating modifiers for use in the plastics and surface-engineering industries. The research and development team identified propanone hydrazone as a key raw material for the synthesis of polymer stabilising additives, while cyclohexene was selected as an important raw material for producing coating-performance modifiers. Propanone and cyclohexanol were selected as the immediate cheaper precursor compounds required for the respective production pathways. Since ethanol is readily available from local bioethanol producers, it was chosen as the principal feedstock from which both intermediates would first be synthesised before conversion into the desired products.

Task:

As a Senior Chemistry student, prepare a concise technical write-up that addresses the company's concerns: determine the suitability of the selected raw materials, critically assess the methods for converting ethanol into the required intermediates, and, using arrows, analyse the subsequent transformations leading to the target intermediates for industrial production.

2. LUDISSEB mock

SECTION A - Attempt all Items

Item 1

Volatile radioactive Iodine species can pose biological and environmental hazards. The S. 5 Chemistry class carried out research on the factors affecting the rate of Iodine production for the reaction:

$H_2O_2(aq) + 21^-(aq) + 2H^+(aq) \longrightarrow 2H_2O(l) + I_2(aq)$

They measured the rate of reaction by the time taken for the Iodine produced to react with a small fixed amount of Sodium thiosulphate added to the constant volume system and obtained the following data.

Experiment	$[I^-]$ (mol dm^{-3})	Time (s)
1	0.004	740
2	0.006	49.4
3	0.008	37.0
4	0.010	30.0
5	0.012	25.0

The students are interested in the order of reaction with respect to l- ions, factors affecting the rate of reaction, and feasibility of the reaction Additional data:

Half-cell reaction	E^o (V)
$H_2O_2(aq) + 2H^+(aq) + 2e \longrightarrow 2H_2O(I)$	+1.77
$1_2(aq) + 2e \longrightarrow 21^-(aq)$	+0.54

Task As a student of Chemistry; analyse and interpret the data provided to address the learners' concerns. (Assuming the reaction is first order with respect to H_2O_2 and also first order with respect to 1^-)

Item 2

Equilibrium reactions are widely employed in optimization of industrial processes. In a bid to improve agricultural yield, a new factory has been constructed in Uganda to produce fertilizer. However, locals have complained about the fumes released by the factory. It was discovered that the fumes were of gas Z, which contains 50.05% Sulphur and the rest Oxygen Gas Z burns in oxygen to form gas W according to the equation:

$2Z(g) + O_2(g) \longrightarrow 2W(g)$ $\Delta H = -190\ kJ\ mol^{-1}$

The process was carried out in the presence of Vanadium pentoxide at about 700 K and at a pressure of 120 kPa. Under these conditions, the partial pressures of Z and W at equilibrium are 33 kPa and 39 kPa respectively.

Task:

As a student of Chemistry analyse and interpret the data provided to address the production mana gets concerns about the molecular formula of Z, factors that can increase the equilibrium yield of W, and the value of equilibrium constant Kp and analyse the application of the process.

SECTION B - Part I (Attempt only one item)

Item 3

Knowledge of the chemistry of group (Il) elements is employed in the medical profession A group of S.5 Chemistry students, after a tour visit to a pharmaceutical industry, noticed that most medicines contain at least one group (Il) element. The tour guide told them periodic properties affect reactivity, and that during manufacture they incorporate reactions of elements with water, alkalis and dilute acids.

Element	Be	Mg	Ca	Sr	Ba
Atomic Radius (nm)	0.112	0.160	0.197	0.215	0.222
Ionisation Energy (kJ/mol)	890	738	590	550	503

Task As a learner of Chemistry, analyse and interpret the data to address the issues of the S.5 Chemistry Class — how periodic properties affect reactivity, reactions of elements, and any health implications.

Item 4

Access to safe and clean drinking water is important in human life. A chemical plant is exploring the use of one of group 7 elements for water treatment. An industrial chemist has advised that knowledge of the reactivity of the elements and their reactions with water and alkalis should be considered and provided the following data:

Element	F	Cl	Br	I
Atomic radius (nm)	0.072	0.099	0.114	0.133

Task As a chemistry learner, your teacher has requested you to analyse and interpret the data for the company — reactivity, reactions with water and alkalis, and associated health implications.

Part Il (Attempt only one item)

Item 5

Use of perfumed deodorants is becoming of high demand in Uganda. A manufacturing company has decided to enter into business. The company chemist has advised that a perfume, methyl ethanoate can be obtained

from chloroethane. In a parallel chain synthetic route ethene can be used as a starting material for preparation of propanoic acid. In a mitigation side chain reaction, the chemist recommended reacting the unreacted chloroethane with benzene and unreacted ethene with bromine in organic solvent.

Task:

As a learner of chemistry analyse and interpret the data to address the company's concerns about suitability of products, synthetic pathways, mitigation reactions for unreacted raw materials, and the associated environmental impact.

Item 6

Use of polymers and solvents for grease is becoming of high demand in Uganda. A manufacturing company uses propene to manufacture polythene and propanol to prepare a solvent for grease. In a parallel chain reaction as a mitigation measure, the company reacts propene with bromine water and propanol with concentrated sulphuric acid at 1 80 ^{0} C.

Task As a student with knowledge of Chemistry, prepare a write-up to help the technical team of the company on suitability of raw materials, synthetic pathways, mitigation reactions, and an evaluation of environmental impacts of the application of its products.

3. PEA — COUHEIA Mock Examinations

SECTION A (Compulsory)

Item 1

A manufacturing company specializing in construction materials uses thermal stability as a key factor when choosing raw materials. An industrial chemist advised that aluminium oxide, $A1_2O_3$, could be a suitable raw material despite the fact that it is amphoteric and reacts with both acids and bases. An environmental chemist, after noticing a high level of concentration of aluminium ions in water discharged by the company, advised that before discharge, aluminium metal could be recovered from solution using metal Q and provided t he following data.

Thermochemical data: standard enthalpy of formation of A1203 -1 675 kJ/mol; standard enthalpy of atomization of Al +330 kJ/mol; 1 st, 2nd, 3rd ionization energies of Al +577, +1817, +2745 kJ/mol; standard enthalpy of atomization of O +249 kJ/mol; 1st electron affinity of O -141 kJ/mol; 2nd electron affinity of O +798 kd/mol.

Electrochemical data: Al^{3+}(aq)/Al(s) Eo -1 .66 V; Q2+(aq)/Q(s) Eo -0.76 V.

Task a) Analyse the observations made using the data provided. b) Assess how the use of metal Q can optimize the recovery of aluminium ions from the solution and make recommendations, if any.

Item 2

Chemical industries producing dyes and pharmaceuticals rely on solvents like naphthalene and precise knowledge of molecular characteristics of additives and impurities. The local water supply shows signs of contamination, with an unknown weak acid solute T affecting the freezing point of water in storage tanks. Data on solute T:

Concentration of T (g/dm^3)	0	30	60	90	120	150
Freezing point (°C)	0	-0.16	-0.32	-0.49	-0.65	-0.81

Cryoscopic constant for water = 1.86 ° c kg mol-I. T is a weak monobasic acid HT To make a disinfectant solution for equipment cleaning, the technician must prepare a sample solution whose pH change should be le

ss than 5.0, because bacteria don't thrive well in that range. The technician mixes sodium hydroxide with the purified acid HT to form its salt NaT, but is confused why the solution does not appear neutral.

Technical Data: Ka for HT = 1.8 x 1 0-5 mol dm-3; Kw = 1 .0 x 10-14 mop dm-6 at 25 ^{0}C. Batch 1: 50 cm3 of 0.05 M I-IT with 50 cm3 of 0.02M NaOH. Batch 2: 50 cm3 of 0.02M HT with 20 cm3 of 0.05M NaOH.
Task:
a) Assess the company's concerns on solute T used.
b) Evaluate the technician's disinfectant batch es and comment on their effectiveness and safety uses.

SECTION B Part I (Respond to any one item)
Item 3
An aerospace construction company is in the process of selection of materials based on their durability once put into use. A class of senior five students are exploring the materials that make aeroplane body and engines. The materials needed are aluminium and iron; selection depends on structural properties, interaction with environmental conditions, and health/environmental side effects. The engine propellers made of iron can be coated with magnesium but not the engine blocks, while the aeroplane body can be constructed with beryllium instead of aluminium due to similar properties.

Task:

a) Assess the properties of the materials and comment with reason which would best be selected f or aerospace construction.

b) Analyze the interactions of the materials with the environment.

c) Assess t he impacts of using these materials to the environment.

Item 4
A chemical plant near Lake Victoria is exploring Group 1 7 elements and their compounds to treat drinking water for a nearby community, focusing on atomic radii and boiling points to balance effectiveness and safety

Guiding questions: 1. Between chlorine and iodine, which one would be suitable for water treatment and why? 2. Why would dumping industrial wastes containing hydrofluoric acid into water be considered less harmful compared to hydroiodic acid? 3. Why is concentrated sodium hydroxide used to trap fumes containing c hlorine gas produced in the production process?

Element	F	Cl	Br	I
Atomic radius (nm)	0.072	0.099	0.114	0.133
Boiling point (°C)	-188	-34	+58	+185

The site safety quality officer responded that the gaseous fume should be treated using strong alkalis to pre vent its emission into the atmosphere, and that liquid industrial wastes containing the strong hydride can be treated with calcium oxide before disposal

Task:

a) Analyze the observations obtained during the study at the plant.

b) Justify the responses given by the tour guide.

c) Assess the impacts of using these products to the environment.

Section B Part Il (Respond to any one item)

Item 5

Use of perfumed deodorants is growing fast in Uganda. Abacus Pharmaceutical Company plans to start production. Chloroethane is obtained from compound X, a straight chain hydrocarbon with 2 carbon atoms, u sed to make compound Y, methyl ethanoate serving as fragrance. Compound X is used as feedstock to make organic compound W, an alcohol with 3 carbon atoms, which produces propanoic acid needed for deodorant action. For waste control, the analyst suggested reacting any leftover chloroethane with benzene, and a ny leftover of compound X with liquid bromine with a suitable organic solvent.

Task:

a) Examine the compounds to determine production of the most suitable active organic ingredient s.

b) Analyze the reaction mechanisms and processes for formation of organic products from any leftover chloroethane, with benzene, compound X and bromine.

c) Evaluate the practical applications of the various organic products intended to be produced, including any side effects.

Item 6

The use of polymers and solvents in grease production is growing rapidly in Uganda. A manufacturing comp any uses propene to make polystyrene and propanol as a solvent for grease. Their daily routine mitigation measures run two parallel reactions: 1. Propene with bromine water. 2. Ethanol with concentrated Sulphuric acid at 180 ^{0}C to form a hydrocarbon R. 3. Compound R serves as feedstock for making benzene a six-carb on hydrocarbon, and phenylethane, an aromatic hydrocarbon with 8 carbon atoms and molar mass of 104.

Task:

a) Examine the compounds to help the team determine the most suitable for making plastic materials and solvents.

b) Analyze the reaction mechanisms in the formation of propene and bromine water, ethanol to hydrocarbon R, benzene to phenylethane.

c) Evaluate the impact(s) of the product(s) intended to be produced.

4. ASSHU Kigezi Regional Mock Examinations

SECTION A - Respond to all items

Item One

A Conglomerate Industry located in Kampala manufactures industrial coolants, fertilizers, and storage batteries for solar energy systems used in rural electrification projects. The chemists investigate the effect of dissolved salts on freezing points, the energetics of dissolving ionic compounds, the rate of industrial reactions, and the performance of electrochemical cells. A highway department dissolves 117 grams of sodium chloride in 1 15 kg of water during transportation during a snowstorm in Canada. The Cryoscopic constant for water used is 1.86 $^{0}C\ mol^{-1}\ kg$. They also want hydration enthalpy of sodium chloride and the rate constant for the reaction leading to the formation of nitrogen(lV) oxide.

Thermochemical data for sodium chloride:

Process	Enthalpy change (kJ/mol)
Atomization of sodium	+108
Atomization of chlorine	+121
First ionization energy of sodium	+496

Electron affinity of chlorine	-349
Enthalpy of formation of sodium chloride	-411
Enthalpy of solution of sodium chloride	+4

The fertilizer branch investigates the kinetics of $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$.
Sample data obtained at const ant temperature:

Experiment	[NO] (mol/dm^3)	[O_2] (mol/dm^3)	Initial rate (moldm^{-3}s^{-1})
1	0.10	0.10	2.0×10^{-3}
2	0.20	0.10	8.0×10^{-3}
3	0.20	0.20	1.6×10^{-2}

The electrochemistry branch constructs a galvanic cell using Zinc and Copper electrodes: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ Eo=+O.34 V; $Zn^{2+}(aq) + 2e \rightarrow Zn(s)$ Eo=-O.76 V.

Task:

As a learner of chemistry help the chemists to:

a) Assess the industrial chemists' concerns.

b) Evaluate the amount of energy that will be produced from the cell formed, and also the impacts of using such cells to the local communities.

Item 2

Aroma Chem Industries produce perfumes, pharmaceutical solvents, soaps, and water-treatment chemicals for industries across Uganda. In the perfume section, Ethanol reacts with Ethanoic acid when catalyzed using concentrated sulphuric acid to produce an ester used in fragrances: $CH_3COOH(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3COOCH_2CH3(l) + H_2O(l)$. The production manager wonders about what mass of the ester will be formed at equilibrium when 90.1 g of ethanoic acid is added to 92.1 g of ethanol at 100 ^0C, given Kc = 4.00 at 100 ^0C, and the acid dissociation constant is 1.8×10^{-5}. The Quality-Control laboratory food scientist is testing prevention of spoilage in fruit juice based on microorganisms not growing well in acidic conditions, by dissolving 8.3 g of ethanoic acid and 16 g of sodium ethanoate in one litre of juice, and determining its ph. The water treatment section mixes 50 cm: of 0.02 mol dm^{-3} silver nitrate solution with 100 cm: of 0.01 mol dm^{-3} sodium chloride solution; Ksp of silver chloride = 1.8×10^{-10}.

Task:

As a chemistry learner and member of science club:

a) Assess the concerns of various department s in this industry

b) Evaluate the impact of additives used in juice to human life.

SECTION B Part I (Respond to only one item)

Item 3

A chemical Plant near Lake Victoria invited the chemistry class to a one-day workshop to evaluate different oxides of period 3 elements for use in industrial furnaces, ceramics, water treatment, glass manufacture and refractory linings, investigating melting points, structures, and oxidation states.

Element	Atomic No.	First ionization energy (kJ/mol)	Melting point of oxide (°C)
Sodium	11	496	1275
Magnesium	12	738	2800
Aluminium	13	578	2072
Silicon	14	786	1710
Phosphorus	15	1012	580
Sulphur	16	1000	-58
Chlorine	17	1251	-119

Task

a) Analyze the data given.

b) Discuss the reactions of the oxides of magnesium, aluminium and phosphorus with water, dilute hydrochloric acid, and sodium hydroxide.

c) Draw the structures, name the sha pes of oxides of Sulphur, state the oxidation state of Sulphur in these oxides, and explain the dangers of emission of these oxides to the environment.

Item 4

Uganda faces persistent challenges in rural electrification. A Ugandan Company is developing solar-powered micro-grids in Kigezi region and invited the class to help identify suitable materials for solar batteries and wiring — affordable, corrosion-resistant, and durable under Uganda's rural conditions, investigating elements similar to period 2 and 3.

Element	Atomic radius (pm)	1st IE (Kj/mol)	electronegativity	Bonding types
Li	145	520	1.0	Metallic
Mg	130	738	1.3	Metallic
Al	110	578	1.5	Metallic
Si	95	786	2.0	Covalent
p	85	1012	2.1	Covalent

Environmental scientists studying pollution and soil erosion in Lake Bunyonyi due to damaged lead batteries found a freshly deposited sediment layer with activity of 960 counts per minute while a deeper sediment layer showed 120 counts per minute, due to disintegration of lead-210; they want to know the age of the sediment layer. They also wish to study application of halogens in water treatment:

Element	Fluorine	Chlorine	Bromine	Iodine
Atomic Number	9	17	35	53
Boiling Point (°C)	-188	-34	59	184

Task:

a) Evaluate the suitability of the materials for solar batteries and wiring for Uganda's micro-grid sys terns basing on the data.

b) Analyze the halogen data and discuss the reactions of these elements with s odium hydroxide, relating the reactions with daily life applications where possible.

Part II (Respond to only one item)

Item 5

Albertine chemical facility produces fuels, solvents and organic feedstocks used in plastic disinfectant additives in food and other chemical syntheses. Organic Compound Q was isolated from a distillation unit; on complete combustion it burnt with a sooty flame and yielded 8.8 g of carbon dioxide and 1.8 g of water. When 0.100 g of Q was vaporized at 273 ^{0}C and 734 mmHg, it occupied a volume of 4.46 x 10^{-2} dm^3. Treatment of Q with acidified water and heat yielded Compound Z, which on oxidation in presence of acidified potassium dichromate (Vl) yielded a compound Y that gives no observable change with Fehling's solution.

Task:

As a learner of Chemistry:

(a) Analyze the data to identify Q, Y and Z (include equations/mechanisms where possible).

(b) Propose mechanisms for:

(i) reaction of Q with bromine water;

(ii) conversion of Q to phenyl ethyne used in plastics (include mechanisms for all steps). (c) Using appropriate reagents and conditions, show how:

(i) Q can be converted to any carboxylic acid;

(ii) Q can be converted to benzene;

(iii) Q can be converted to 3-phenylpropan-l-ol.

(d) Discuss the environmental impacts of producing the associated compounds.

Item 6

A Small Cosmetic Start-up is producing herbal skin care. The production process generates significant amounts of waste materials currently disposed into nearby drainage systems, causing blockages and foul smells, leading to complaints. Analysis of the sample oil revealed a mixture of compounds:

Compound	IUPAC Name
K	Propan-1-ol
L	Propanone
M	Methylbenzene
N	But-2-ene

Task:

(i) Analyze the composition of these waste materials, their functional groups and any physical properties.

(ii) Design synthetic routes to: convert N to ethanol (a disinfectant); convert K to L; convert M to benzoic acid; convert L to propyne; convert N to poly(but-2-ene) repeat unit.

(iii) Explore possible mechanisms for reactions of M with concentrated nitric acid and concentrated sulphuric acid; and L with 2,4-dinitrophenylhydrazine in acidic medium.

(iv) Discuss the impacts of Compound M to health and environment.

5. WAKATA

This paper consists of two sections A and B; six examination items. Section A has two compulsory items. Section B has two parts, I and Il; respond to only one item from each. Constants: C=I2, H=1, 0=16, Cl=35.5; 1 mole of gas at room temperature occupies 24 dm^3.

SECTION A - Respond to all items

Item 1

Calcium chloride ($CaC1_2$) is an important industrial chemical widely used in road construction to melt ice and snow because of its ability to absorb moisture and lower the freezing point of water. A road construction engineer wants to determine the lattice energy and enthalpy of solution of calcium chloride, understand the effect of temperature on its solubility in water, and determine whether the formation of calcium chloride in an electrochemical cell provides evidence that the reaction between calcium and chlorine is thermodynamically feasible.

$Ca^{2+}(aq) + 2e- \longrightarrow Ca(s)$, Eo = -2.87 V; $C1_2(g) + 2e- \longrightarrow 2Cl^-(aq)$, Eo = +1.36 V

Quantity	Process	Value
Atomization energy of calcium	$Ca(s) \longrightarrow Ca(g)$	+193 kJ/mol
First ionization energy of calcium	$Ca(g) \longrightarrow Ca^+(g)$	+590 kJ/mol
Second ionization energy of calcium	$ca^+(g) \longrightarrow Ca^{2+}(g)$	+1150 kJ/mol
Atomization energy of Cl	$^1/2\ C1_2(g) \longrightarrow Cl(g)$	+122 kJ/mol
First electron affinity of Cl	$Cl(g) \longrightarrow Cl^-(g)$	-349 kJ/mol
Enthalpy of formation of CaC12	-----	-795 kJ/mol
Hydration enthalpy of calcium ions	-----	-1650 kJ/mol
Hydration enthalpy of chloride ions	-----	-381 kJ/mol

Task:

As a chemistry student, help the construction engineer address her concerns.

Item 2

Food additives play an important role in modern food production and preservation. Some of these additives are naturally derived from fruits. A food manufacturing company is developing a new artificial pineapple flavour for use in frozen desserts. The flavouring compound is the ester ethyl butanoate which has a characteristic pineapple aroma. The company's chemists must first synthesise the ester through esterification and the n determine its purity using freezing-point measurements.

A chemist reacts butanoic acid with ethanol in the presence of concentrated sulphuric acid to produce ethyl butanoate. The pure ester has a freezing point of -93. O ^OC, whereas the synthesised sample freezes at -95. 5 ^0C. The Cryoscopic constant (Kf) for ethyl butanoate is 7.2°c kg mol-tv A sample containing 0.50 g of impurity is dissolved in 100 g of ethyl butanoate.

Task As a chemistry student, prepare a comprehensive report to assist the company in evaluating the suitability of the product.

SECTION B Part I (Respond to only one item)

Item 3

Differences in melting points allow engineers to select materials that can either withstand high temperature s or melt easily when required. Similarly, bond energies determine how readily substances react during chemical manufacturing processes. A company that manufactures electronic circuit boards uses components made from Group IV and Group Vll elements.

Group IV element	Melting point (°C)	Group VII element	Bond energy (kJ/mo l)
Carbon	3730	Fluorine	158
Silicon	1410	Chlorine	242
Germanium	937	Bromine	193
Tin	232	Iodine	151
Lead	327	–	–

The research team wants an analysis of the trends in the physical properties shown, the reactions of Group IV elements with air, and the reactions of Group Vll elements with water. The company manager is also interested in evaluating the applications and environmental risks.

Task As a chemistry student, prepare a comprehensive report addressing the above concerns.

Item 4

Many construction materials are based on the chemical behaviour of Group Il carbonates and Period 3 chlorides. Croup II carbonates are widely found in limestone, used in cement production, while Period 3 chlorides are important in water purification. A chemical company produces Period 3 chlorides for water treatment; it s furnace is heated by decomposition of Group Il carbonates. The manager wants to know how the carbonates neutralise acidic effluents containing hydrochloric acid.

Carbonate	$BeCO_3$	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
Decomposition temp (°C)	100	350	900	1290	1350

Chloride	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_5	S_2Cl_2	Cl_2
Melting point (°C)	808	714	192	-68	160	-76	-101

Task:

As a chemistry student, prepare a comprehensive report addressing the above concerns.

Part II (Respond to only one item)

Item 5

Alcohols are widely used as fuels and in consumer products, while alkyl halides are important in refrigeration systems and as industrial solvents. A chemical company is investigating suitable methods for producing phenol and 2-methylpropan-2-ol for use in the manufacture of resins and antiseptics. The company intends t o prepare phenol from bromobenzene and 2-methylpropan-2-ol from propan-2-ol. It also intends to study the elimination reaction of propan-2-ol using concentrated sulphuric acid and the reaction between phenol and propanoyl chloride, including the mechanisms involved.

Task:

As a chemistry student, help the team address the above challenges — including physical properties of bromobenzene and propan-2-ol, and environmental/ethical implications of producing and using these chemicals.

Item 6

Customers prefer products that not only remove nail polish effectively but also leave a pleasant fragrance. Carbonyl compounds are widely used as fragrance ingredients because of their characteristic aromas. A cosmetics company manufactures a scented nail-polish remover using propanone (acetone) and benzaldehyde. To ensure a steady supply of propanone, the company intends to prepare it from propan-l -01, while benzene is to be converted into benzaldehyde. Quality-control chemists also study the nucleophilic addition reaction of hydrogen cyanide with propanone and the condensation reaction of benzaldehyde with 2,4-dinitrophenyl hydrazine, including the mechanisms involved.

Task As a chemistry student, help the team address their concerns and evaluate whether the company's intended production processes are suitable.

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6. ASSHU- mock

Two sections A and B, six (examination items. Section A has two compulsory items. Section B has two parts, I and II; respond to only one item from each part. Respond to only four items in all.

SECTION A

Item One

An aluminium smelting company in Jinja used to use an aluminium compound as a flux to lower the melting point of cryolite during aluminium extraction. Options: A. Aluminium fluoride; B. Aluminium chloride. The pro duction unit faces high energy costs, and the environmental team reports challenges dissolving waste aluminium fluoride or aluminium chloride residues before disposal.

Data: Standard enthalpy of formation of AlF3 = -1301 kJ/mol; enthalpy of atomization of aluminium = +314 kJ/mol; bond dissociation energy of fluorine = +1 58 kJ/mol; bond dissociation energy of chlorine = +242 kJ/ mol; 1st, 2nd, 3rd ionization energies of aluminium = +577, +1820, +2740 kJ/mol; 1st electron affinity of fluorine = -348 kJ/mol; 1st electron affinity of chlorine = -264 kJ/mol; standard enthalpy of formation of AIC13 - 004.2 kJ/mol; hydration enthalpies of aluminium, fluoride and chloride ions = -4690, -364, -378 kJ/mol respectively.

Task:

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

b) Evaluate whether the dissolution of the substances in water is thermodynamically feasible under standard conditions.

c) State which of the substances is most appropriate basing on its properties.

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

Item 2

An agrochemical industry (U) Ltd produces ammonia used in fertilizers and industrial cleaning products. 2.00 moles of nitrogen gas and 6.00 moles of hydrogen were mixed in a 5.00 dm^3 reactor at 200 atm and 450 ^0C: $N_2(g) + 3H_2(g) — 2NH_3(g)$, AH = -92 kJ/mol. At equilibrium, the mixture contained 30% ammonia by volume. The ammonia produced was dissolved in 750 cm^3 of water; equal volumes of 250 cm^3 each of this ammonia solution and 2.0M ammonium chloride solution were mixed to prepare an ammonia-ammonium chloride buffer. Two separate 10.0 cm^3 portions of the buffer were tested with 10.0 cm^3 of 2.0M HCI and 2.0M Na OH respectively.

Task:

a) Analyse the data and determine the equilibrium constant Kp; assess how the equilibrium is affected by;

(i) increased temperature

(ii) increased pressure

(iii) a catalyst.

b) Calculate the pH of the ammonia solution (Kb = 1.8 x 10-5 mol dm^{-3}).

c) Analyse how the buffer works when small amounts of HCI or Na OH are added, and how buffers are applied in real life.

d) Analyse the change in pH when 10.0 cm^3 each o f 2.00M HCI and 2.00M NaOH is added to the buffer.

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SECTION B Part 1 (Respond to one item)

Item 3

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: water, phosphorus trichloride carbon tetrachloride tin (II) chloride, ammonia, tin (IV) chloride nitrate ion, and phosphorus pentachloride.

Task:

a) Predict the molecular shapes and structures, bond type and approximate bond angles for the above chemical species.

b) Basing on the above shapes and structures, analyse and classify the above chemical species according to physical states, solubility in water, and electrical conductivity.

c) Analyse the difference in:

(i) type of bonds between water and ammonia, phosphorus trichloride and phosphorus pentachloride;

(ii) electrical conductivity and melting points of tin (II) chloride and tin (IV) chloride.

Item 4

Roofing Rolling Mills Ltd located Namanve industrial park, manufactures electric cable components, heat-resistant furnace linings and chemical storage metallic tanks. The company received complaints: some metallic tanks storing sodium hydroxide solution were corroding rapidly; a furnace-lining material was found

to mel t at unexpectedly low temperatures; the waste management unit requested a metallic tank that can safely store acidic waste without corroding.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	15	16	17	18
Melting point (°C)	98	650	660	1414	44	115	-102	-189

Task:

a. Analyze the above data (melting points) and recommend the most suitable element for heat-resistant furnace linings, giving reasons.

b. Analyse the chemical reactivity of the elements with the commonly encountered substances stated by the company and recommend the most appropriate element for each of the company's needs while identifying any element(s) unsuitable for structural or industrial use.

Part Il (Respond to only one item)

Item 5

A hospital and research centre in Hoima city is investigating a new isolated organic compound Y for potential industrial application. 1.50 g of Y is burnt completely in dry oxygen, giving 2.870 g of carbon dioxide and 1.761 g of water. When vaporised, 0.1 g of Y occupied 78.8 cm^3 at 157°C and 740 mmHg.

Task:

Determine the molecular formula of Y; identify all possible structural isomers of Y and their IUPAC names, and determine which isomer can undergo chemical transformations to produce an alkene Z; stud y the reactions of the identified isomers with sulphuric acid to form alkene Z, and how alkene Z reacts with acidified water, including mechanism; develop feasible pathways to convert the isomer into ethane for further pharmaceutical applications; analyse how important the isomer Z is in daily life situations. Analyse the data and address the plans to the hospital team and propose suitable solutions.

Item 6

Crude oil cracking produces unsaturated hydrocarbons such as Ethene, propene, butene and methylbenzene, used respectively to manufacture polythene plastics, polypropylene plastics, synthetic rubbers/specialty chemicals, and industrial solvents/chemicals. Ethene can be converted to ethanoic acid which reacts with an alcohol synthesized from butene to make an ester used in perfumes. Propene can be alternatively synthesized from propanone used as a nail polish remover. Methylbenzene is used to make 2-nitromethylbenzene which is used to manufacture dyes.

Task:
a) Analyse the reaction processes involved in synthesis of polyethene, propanone and ethanoic ac id.
b) Analyse the reaction mechanisms involved in the formation of 2-nitromethylbenzene and the ester.
c) Evaluate the practical applications of the various plastics and their environmental effects with their mitigations.

7. Pre-Mock Examinations 2026

Two sections, A and B, six (examination items. Section A has two compulsory items. Section B has two-part s, I and II; respond to only one item from each part. Respond to four items in all.

SECTION A - Respond to both items

Item 1

The increasing cost of conventional fuels has encouraged many institutions in Uganda to explore alternative sources of energy. A boarding school installed a biogas digester that uses animal waste and food remains t o produce methane for cooking. Observations: (i) temperature of the digester contents increased during decomposition; (ii) gas production was initially high after fresh waste was added but gradually decreased with time; (iii) food cooked faster when methane supply to the burner was increased

Data set 1: $C_6H_{12}O_6(s)$ ~~$\rightarrow$~~ $3CH_4(g) + 3CO_2(g)$. Enthalpies of formation: $C_6H_{12}O_6(s)$ -1273 kJ/mol; $CH_4(g)$ -75 kJ/mol; $CO_2(g)$ -394 kJ/mol.

Data set 2: $CH_4(g) + 2O_2(g)$ ~~$\rightarrow$~~ $CO_2(g) + 2H_2O(g)$.

Experiment	[CH4] (mol/dm³)	[O2] (mol/dm³)	Initial rate (mol dm⁻³ s⁻¹)
A	0.10	0.10	2.0×10^{-4}
B	0.20	0.10	4.0×10^{-4}
C	0.20	0.20	1.6×10^{-3}

Task:

a) Analyse the observations made during the production and use of the biogas, using the information provided.

b) Assess the conditions and practices that the school should adopt to maximise the production and efficient use of methane as a fuel.

Item 2

A fruit-processing company produces bottled passion-fruit juice. The company uses benzoic acid and sodium benzoate to control the acidity of the juice, and sugar to improve taste. Customers complained that one batch tasted unusually sour and froze more readily than another under similar refrigeration.

Substance	Sample P	Sample Q
Benzoic acid (g)	1.22	1.22
Sodium benzoate (g)	0.288	0.288
Sugar (g)	8.0	24.0

pKa of benzoic acid = 4.20. Recommended pH range for the juice: 3.5-40. Mr = C_6H_5COOH 122; C_6H_5COO Na 144.

Task:

a) Assess the customers' concerns about the acidity and freezing behaviour of the two juice samples.

b) Evaluate the benefits and possible consequences of the additives used in the juice, and recommend appropriate practices for their use.

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SECTION B Part I (Respond to only one item)

Item 3

A ceramic and glass manufacturing company uses compounds of silicon and other Period 3 elements in its production processes. Observations: silicon(IV) oxide used as major raw material in heat-resistant products; magnesium oxide used to neutralise acidic industrial wastes; aluminium oxide could not be used effectively t o treat strongly alkaline waste; gaseous oxides of sulphur and phosphorus produced during processes could contaminate rainwater and nearby water sources. The company also uses chlorine-containing substances during water treatment.

Task:

a) Analyse the observations in terms of structure, bonding and chemical properties.

b) Explain, using equations, reactions relevant to treatment of the industrial wastes and water.

c) Evaluate the environmental importance and possible dangers, and suggest mitigation measures.

Item 4

A company plans to construct a pedestrian bridge across a river, considering aluminium and iron as main structural materials. Notes: bridge exposed continuously to air and moisture; iron components could be protected by attaching blocks of magnesium; aluminium remains resistant to further corrosion despite being reactive; a worker suggested replacing aluminium with beryllium as they occur in related periodic positions.

Task:

a) Analyse the physical properties of aluminium and iron in relation to structure and suitability for bridge construction.

b) Explain the chemical behaviour of the metals in the stated environment, including corrosion control methods.

c) Assess the suggestion to use beryllium and evaluate environmental/health impacts.

Part I l (Respond to only one item)

Item 5

Plastic waste from packaging materials has accumulated around markets and drainage channels in an urb an area. Polymer X repeating unit: [-CH_2-CH_2-]n. Polymer Y repeating unit: [-$CH(C_6H_5)$-CH_2-] Investigations: monomer of X can be prepared from ethanol; ethanol can be manufactured from ethanoic acid through suitable transformations; monomer of Y is obtained from an aromatic compound; an aromatic ketone us ed in another industrial process can be prepared from benzene using an acyl chloride derived from ethanoic acid.

Task:

a) Analyse the structural features/properties of X and Y contributing to their environmental accumulation.

b) Analyse reaction pathways for: formation of the monomers of X and Y; polymerisation of the monomers; conversion of ethanoic acid into the stated intermediates; formation of the aromatic ketone (include reagents, conditions, equations, mechanisms).

c) Evaluate applications and environmental/health impacts of X and Y, and recommend waste-management practices.

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Item 6

A pharmaceutical company extracts active ingredients from plant materials using organic solvents, and manufactures compounds for use as solvents/intermediates. Compound A: straight-chain hydrocarbon, 6 carbons, Mr 86. Compound B: aromatic hydrocarbon, 7 carbons, Mr 92. Compound C: alcohol, 2 carbons, Mr 46. The company manufactures nitrobenzene, ethyl ethanoate, propanone, and phenylethanone.

Task:

a) Identify compounds A, B and C, and examine their structures/physical properties for suitability a s extraction solvent.

b) Analyse reaction pathways/mechanisms for preparation of nitrobenzene, ethyl ethanoate, propanone and phenylethanone from suitable starting materials (include reagents, conditions, equations, mechanisms).

c) Evaluate practical applications and health/environmental impacts, and recommend safe handling measures.

8. JJEB

Item 1

Electrochemical cells generate energy from spontaneous redox reactions. A group of S.5 students under their science club selected the strongest oxidizing/reducing agents between copper and zinc, constructed an electrochemical cell, and applied quantitative chemical principles. Their teacher provided:

First ionization energy of Zn 906 kJ/mol; Second ionization energy of Zn 1733.3 kJ/mol; Hydration energy of $Zn^{2+}(aq)$ 2046 kJ/mol; First ionization energy of Cu 754 kJ/mol; Second ionization energy of Cu 1 958 kJ/mol; Hydration energy of $Cu^{2+}(aq)$ 2100 kJ/mol.

Half cell: $Zn(s)|Zn^{2+}(aq)$ Eo = +0.76 V; $Cu(s)|Cu^{2+}(aq)$ Eo = -0.34V.

Task:

As a chemistry student analyse and interpret the data to address the S.5 issues.

Item 2

A manufacturing company in Uganda uses compound X as a primary intermediate for making a dye which gives blue jeans their iconic colour. Analysis: X is immiscible with water, contains 77.3% C, 7.58% H and the r est nitrogen; a mixture of X (boiling point 180 ^{0} C) and water (boiling point 100 ^{0}C), when steam distilled at 760 mmHg and 98 ^{0} 0 gave a distillate containing 85% by mass water. Saturated vapour pressure of water at 98 ^{0} C is 734.9 mmHg.

Task:

As a student of chemistry, analyse and interpret the available data to address management concerns — molar mass of X, molecular formula of X, and associated applications of steam distillation.

SECTION B PART I (Attempt only one item)

Item 3

The chemistry of period 3 elements is vital to modern technology, biology and industry. A manufacturing plant dealing in modern technology equipment is interested in how periodic properties of elements affect reactivity, reactions of elements and health implications. Data provided:

Element	Na	Mg	Al	Si	P	S	Cl
Electron affinity (Kj/mol)	-20	+67	-30	-135	-60	-200	-364
Ionization energy (kj/mol)	492	743	579	791	1060	1003	1254

Task:

As a student of Chemistry, prepare a write-up to address the management's concerns.

Item 4

The chemistry of Group 17 elements is important for water sanitation, health and industrial manufacturing.

Data:

Element	F_2	Cl_2	Br_2	I_2
Atomic radius (nm)	0.072	0.09	0.114	0.138
Boiling point (°C)	-188	-35	59	184

A manufacturing company dealing in antiseptics is interested in how periodic trends affect reactivity, reactions of the elements, and health implications, if any.

Task:

As a Chemistry student, analyse and interpret the available data to address the company's issues.

PART I l (Attempt only one item)

Item 5

Use of nail polish removers and polymers is increasing in Uganda. A chemical plant makes polythene and ethyl acetate, a nail polish remover, from propene and methane respectively. As mitigation, excess raw propene is reacted with bromine water while excess methane is reacted with chlorine gas in UV light.

Task:

As a student of chemistry, make a write-up to address the plant management concerns — suitability of products for applications, analysis of mitigation reactions with equations, evaluation of synthetic pathways and possible health implications of products.

Item 6

A school science club wants to produce benzaldehyde hydrazone from ethane and propanone (solvent) from propan-1-ol. One student raised the issue of managing excess propan-l-ol and the product propanone. The chairperson proposed reacting propanone with 24-dinitrophenylhydrazine and propan-1-ol with hot concentrated sulphuric acid as a mitigation measure.

Task:

As a student of chemistry, analyse and interpret the data to address the club's issues — suitability o f propan-1-ol for its application, analysis of mitigation reactions with equations, and evaluation of synthetic pathways with associated health implications.

9. Kabale Diocesan Mock Examinations

Two sections A and B. Section A has two compulsory items while B has two parts, I and II, each with two items; answer only one item for each part. Respond to four items in all. Molar volume of gas at s.t.p is 22.4 dm^3; standard temperature 273 K; standard pressure 101325 Nm^{-2}.

SECTION A - Respond to all items

Item One

At Lake Bunyampaka in the Albertine Rift Valley System, university students made an exciting discovery: a rich deposit of a mineral suspected to contain Boron. During analysis, the sample was found to contain 20%

Boron-10, 50% Boron-11, 15% Boron-12, and 15% Boron-13, used to determine an accurate relative atomic mass (RAM) of Boron. It was also discovered that the hydride of Boron, diborane (B_2H_6), a valuable gaseous fuel, could be used in semi-conductor fabrication since it produces more energy per unit mass than many conventional fuels when burnt: $B_2H_6(g) + 3O_2(g)$ $B_2O_3(s) + 3H_2O(l)$. The hydride burns producing boron oxide that clogs engines, is highly toxic and difficult to store, and reacts with water and acids. Standard enthalpy of combustion of diborane = +36 kJ/mol; boron oxide = -1273 kJ/mol; water = -286 kJ/mol.

The team also wants to use diborane as a boron source for doping silicon wafers, heating 13.7 g of diborane until complete decomposition $B_2H_6(g) \longrightarrow 2B(s) + 3H_2(g)$. Rate of decomposition studied at constant temperature:

Experiment	$[B_2H_6]$ (mol/dm^3)	Initial rate (mol dm^{-3}s^{-1})
1	0.10	2.0×10^{-3}
2	0.20	4.0×10^{-3}
3	0.30	6.0×10^{-3}

Task:

a) Prepare a write-up you would use to help this team of university researchers upon invitation — describing the process of obtaining the relative atomic mass of Boron, and explaining why it's not a whole number, plus the enthalpy of combustion of diborane, how much boron can be produced during thermal decomposition, and the rate constant for thermal decomposition.

b) Explain why the rate of decomposition of diborane must be controlled in an industrial system. Suggest any two methods that can be used to reduce the rate of decomposition during storage.

Item Two

Quantuo Uganda, a fish transporting company, tests different concentrations of sodium chloride in solvent X to achieve the lowest possible cooling temperature for fish transport in Kampala. Sample data'

Concentration (mol/kg)	0.50	1.00	1.50	2.00	3.00
Freezing point (°C)	-1.90	-3.65	-5.40	-7.10	-10.20

In another department, a team is formulating a new medicine containing calcium hydroxide as an antiacid and calcium supplement. Challenges: calcium hydroxide not dissolving sufficiently in water, inconsistent dosing, visible sedimentation in the bottles. Solubility product, Ksp, of calcium hydroxide at 25 ^0C = 5.5×10^{-6} mol^2 dm^{-6}. Management wants a scientific explanation of why calcium hydroxide is sparingly soluble and how its solubility can be manipulated, and the pH of its saturated solution.

Task:

As a chemistry learner:

a) Describe how the freezing point of solvent X will be determined. b) Prepa re a technical report for the product development team at the meeting.

SECTION B Part I (Respond to only one item)

Item Three

A chemical manufacturing company in Jinja is establishing a new facility to produce ionic compounds used i n refractory lining in furnaces, antiacids, flame retardant, cement and mortar production, medicinal X-ray imaging, and fireworks. Challenges encountered: 1. Reactivity of different metals with water varies significantly. 2. Melting points of these elements exhibit differences, leading to different suitability for applications. 3. Beryllium displays atypical chemical behavior compared to other group 2 elements, instead showing similarities to Aluminium. 4. A beryllium chloride compound (Q), containing 1 1.25% beryllium, has an unknown structure requiring characterization; molecular mass of Q is 160. 5. A radium-226 source used in an industrial gauge had initial count rate of 1200 counts/minute; half-life 1600 years.

Task:

As a chemistry learner:

a) Prepare a scientific report addressing:

(i) the trend in reactivity of group 2 elements in water;

(ii) variations in melting points;

(iii) anomalous behaviour of beryllium;

(iv) the structural formula of compound Q.

b) Help the engineers determine the count rates of radium-226 remaining after exactly 3200 years.

Item 4

Environmental chemists are investigating a chemical contamination incident in a local river following an industrial discharge. Laboratory analysis of the water reveals the presence of sodium chloride, aluminium chloride, silicon(IV) chloride, phosphorus(V) chloride and Di sulphur dichloride. To assess environmental impact, the chemists add water to samples of each chloride under controlled laboratory conditions to observe their chemical behaviour

Task:

As a chemistry learner:

a) Address the concerns of the environmental investigation team and propose suitable explanations and observations made during the assessment.

b) State how each of the anhydrous chlorides can be prepared in the school laboratory.

Part II (Respond to only one item)

Item Five

An environmental agency is investigating air pollution near an industrial zone suspected of a hydrocarbon re lease and open combustion. A 20.0 cm^3 sample of hydrocarbon Z was reacted with 200.0 cm^3 of oxygen. After cooling to room temperature, the total gas volume was 160.0 cm^3, and passing residual gases through aqueous sodium hydroxide reduced the volume to 20.0 cm^3. Hydrocarbon Z burns with a sooty flame. When treated with hot alkaline potassium manganate (Vll), then acidified with dilute hydrochloric acid, it produces compound T, which reacts with magnesium to liberate hydrogen.

Task:

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As a chemistry learner, prepare a presentation covering the chemical equation for combustion of Z the molecular formula, IUPAC names and structures of Z and T, a method to synthesize Z from ethanol, environmental hazards with mitigation measures, and conversion of Z into a more valuable product such as nitrobenzene to manufacture explosives and dyes.

Item Six

A hospital and research centre in Kigezi region is investigating a newly isolated organic compound Y for potential industrial applications. 1.50 g of Y burnt completely in dry oxygen gave 2.870 g of carbon dioxide and 1.1761 g of water. When vaporized, 0.1 g of Y occupied 78.8 cm^3 at 157 ^{O}C and a pressure of 740 mmHg.

Task

As a chemistry learner, address the plans of the hospital team and propose suitable solutions:

a) Determine the molecular formula of Y.

b) Identify all possible structural isomers of Y and their IUPAC names, and determine which isomer can undergo transformations to produce an alkene Z.

c) Study the reaction of the identified isomer with sulphuric acid to form alkene Z, and how alkene Z reacts with acidified water including mechanisms.

d) Develop feasible pathways to convert the isomer into ethane for further pharmaceutical applications.

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10 UMOB Mocks

P525/ 1

Chemistry

Paper

JULY/AUGUST

2¾ hours

UGANDA UNION MOCK EXAMINATION BOARD

Uganda Advanced Certificate Of Education

CHEMISTRY

Paper 1(THEORY)

Time; 2hours 45 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 item from each.

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

For Scorer's Use Only

Item no	Basic code	Weighed score	Score's initial
1			
2			
3			

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SECTION A

Answer all items from this section

ITEM 1

The Agro-chemical industries utilise thermochemical data in the manufacture of fertilizers to better agricultural outputs. The Agro-chemical plant in Uganda produces calcium-based fertilizers and uses electrochemical processes for hydrogen generation. To preserve vital soil microorganisms during application, the fertilizer's thermal stability and energy changes must be tightly regulated. To achieve this, the plant chemist utilises thermochemical data for calcium oxide, as follows:

Type of enthalpy change	**Magnitude (kJ mol^{-1})**
Standard enthalpy of formation of CaO	–635
Enthalpy of atomisation of Ca	+193
Bond dissociation energy of O_2	+498
First ionisation energy of Ca	+589.8
Second ionisation energy of Ca	+1145.5
First electron affinity of O	–140.9
Second electron affinity of O	+770

Recently, the production plant experienced a formulation error in thermal management of the fertilizer stabilisation process, threatening supply lines. Their industrial engineer needs to calculate the lattice energy of calcium oxide using the provided thermochemical data (Born–Haber cycle) to understand the energy changes involved in fertilizer stabilisation. If the calculated lattice energy does not match expected values, the engineer must determine the correct enthalpy adjustments needed.

Additionally, the plant uses electrolysis of dilute sulphuric acid to generate hydrogen gas for hydrogenation processes in fertilizer production. In a recent trial, a current of 89.6 mA was passed through an electrolytic cell containing dilute sulphuric acid between platinum electrodes for 1 hour. The engineer

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needs to calculate the total volume of gas liberated at 15°C and 100 kPa to assess the efficiency of gas production for downstream use.

The engineer must fix the thermal mismatch and verify electrolysis gas output. Your school has been selected to participate in an upcoming science fair organised by the management of the industry, and you are tasked with writing and presenting a report based on this scenario.

Task

Write a report you will present upon your school being chosen.

ITEM 2

Cement production in Uganda at a plant in Hima involves heating limestone ($CaCO_3$) to produce quicklime (CaO), which then reacts with other substances like sulphuric acid to form a sparingly soluble salt A (calcium sulphate), which is a highly versatile compound used across multiple industries. However, the production unit manager wants to find out the pH of a buffer system used in the cement slurry to control microbial growth, understand the effect of temperature on the solubility of A in water, how the solubility of A is affected when added to 0.01 M sodium sulphate, and the mass of A precipitated.

He researched and found the following ionic equilibria data which he could not use well:

- Ka of ethanoic acid = 2.0×10^{-5} mol dm^{-3}
- Solubility product (Ksp) of calcium sulphate = 2.4×10^{-5} mol^2dm^{-6}

He prepared a buffer by mixing 800 cm^3 of 0.10 M ethanoic acid with 200 cm^3 of 0.20 M sodium ethanoate to control pH in the slurry, but microbial death occurred due to incorrect acidity. The engineer needs to establish if the pH of this mixture falls within a safe range (4.50 – 4.90). If it does not, he must determine the concentration of the salt required to adjust the pH exactly to 4.70 while maintaining the acid concentration of the initial mixture. Additionally, he needs to calculate:

- The solubility of calcium sulphate in pure water.
- The effect of 0.01 M sodium sulphate on the solubility of calcium sulphate (common ion effect).

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- The mass of calcium sulphate precipitated when a given volume of saturated solution is mixed with the sulphate solution. He was referred to you for help.

Task

As a student of chemistry, help the manager address his concerns by preparing a report

SECTION B

Part I

Attempt one item in this section

ITEM 3

Physical properties of Group II metals influence their reactivity, usefulness and their environmental impact.

A Senior Five chemistry class is conducting a research project on the use of Group II compounds in improving water quality and their environmental impacts. To identify compounds that may be useful in water treatment, the learners investigated how Group II metals react with air, water, and dilute sulphuric acid under controlled conditions. To help understand the observed differences in reactivity, an expert gave them and advised them to analyze data on the atomic radii of the Group II elements. From the data, they observed that beryllium behaves differently from the other members of the group and shows similarities to aluminium, a typical Group III element.

They need assistance on how to: analyze the trend in atomic radii of the elements, explain the anomalous behavior of beryllium; predict and write equations for their reactions with air, water, and dilute sulphuric acid; and evaluate the suitability and environmental impacts of the compounds formed in water treatment.

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Element	Atomic radius (nm)
Beryllium	0.112
Magnesium	0.160
Calcium	0.197
Strontium	0.215
Barium	0.222

Task

As a chemistry learner, help the s5 learners to address their concern

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ITEM 4

A jewelry producing company wants to increase on the production of accessories due to high demand for them on market. The company wants to produce accessories which are water resistant, chemical resistant and will last longer and withstand Uganda's tropical environment.

The company's chemical engineer says the rate of the production of the accessories will depend on the reactivity of the raw materials and their melting points. The reactivity of the material is tested basing on reaction with water, alkalis and oxygen and durability basing on melting point. He is considering a group (IV) element to be used as a raw material in the production while taking precautions on their impacts on the environment. He has obtained some data on their melting points of group (IV) elements as shown below.

Element	Carbon	Silicon	Germanium	Tin
Melting point(^{0}C)	3550	1410	937	232

However, the chemical engineer cannot fully interpret and analyze the data and the conditions to increase the production process of the accessories and has contacted you for help.

Task

Using your chemistry knowledge of Group (IV) elements, write a report you would give to help the chemical engineer including the recommendation for the most suitable element.

Part II
Attempt one item in this section

ITEM 5

A chemical manufacturing company in Uganda is evaluating organic compound **X** for use as a perfume ingredient and as a raw material in paint-

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solvent production. The company aims to identify the compound, relate its physical properties to its structure, and assess environmental and ethical factors affecting its suitability for these applications.

Preliminary Laboratory data shows that compound **X** burnt with a non-sooty flame and on hydrolysis, it formed two organic compounds: **Y** ($C_4H_{10}O$) and **Z** ($C_2H_4O_2$). Both **Y** and **Z** react with sodium metal, but only **Z** reacts with sodium carbonate. **Y** shows no reaction with acidified potassium dichromate (VI) but dehydrates to **W** when heated with concentrated phosphoric acid. Before they can make decisions, they need guidance on how conversion of **Z** to an appropriate ketone which may be used in paint making occurs and explain dehydration reaction of **Y to W.**

The company was also advised to study how the ketone reacts with 2,4-dinitrophenylhydrazine and how it can be converted into an alkene, to help find better ways of treating ketone-containing wastewater from paint production.

The company was looking for a suitable person to do all this and were referred to you for help.

TASK

As a student of chemistry, help the company to address their aims and concerns.

ITEM 6

In Pharmaceutical manufacturing, the extraction of active ingredients from raw materials in plants is a critical step that determines yield and purity. The industry relies on the following compounds to achieve efficient phase separation.

A – A compound with molecular formula C_7H_8

B – A compound with molecular formula C_6H_{14}

C – A compound with molecular formula C_2H_6O

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However, the synthesis of compounds like nitrobenzene, ethyl ethanoate, propanone and phenylethanone possess risks regarding safety, environmental sustainability and process optimisation.

Tasks

a) Explain the physical properties of solvent C.

b) Ethyl ethanoate can be formed from compound C with Ethanoic acid and concentrated sulphuric acid, show how this happens? Show how the reaction between propanone and phenylhydrazine in acidic medium to form an important product with moderate antibacterial activity occurs.

c) Show how C_7H_8 can be transformed into phenylethanone and also design a synthetic route to show formation of propanone from Ethanol.

d) Evaluate the applications of the organic compounds in the environment

END

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11. WAKISSHA

SECTION A - Respond to both items from this section.

Item 1 - Green Chemistry: Fuel Cell vs Internal Combustion Engine (ICE)

A research laboratory explored a new green chemistry pathway to make a fuel cell using hydrogen peroxide as an alternative to internal combustion engines (ICE) which use octane (petrol). The team believes that the fuel cell is more efficient, produces inert byproducts in contrast to ICE which generate atmospheric pollutants and require constant oxygen supply.

To study the feasibility of the fuel cell reaction, the researchers mixed solutions of the suggested cathode and anode reactants in a beaker at room temperature.
No bubbles were observed and no products formed.
One team member explained that the reaction has high activation energy (Ea) but it is feasible.

The team wanted to determine the amount of energy generated by the fuel cell and the ICE in kJmol-1. Information in Table 1 and 2 about the electrode potentials and formation enthalpies of octane, carbon dioxide, water and oxygen respectively has been provided to guide the team.

Table 1 - Half-cell Reactions

Half cell reaction	Electrode potential E° (volts)
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	+1.77
$O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O_2(aq)$	+0.68

Table 2 - Enthalpy of formation

Substance	ΔfH° (kJmol-1)
C_8H_{18} (octane)	-250.0
H_2O	-286.0
CO_2	-394.0
O_2	0.0

Octane burns in ICE according to the equation:
$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)$
F = 96500 Cmol-1

You have been requested to join the research team by the science club of your school.

Task:

As a knowledgeable learner of chemistry, help the research team;
(a) understand the energy generated by ICE and the proposed fuel cell.
(b) assess the ways through which laboratory reaction feasibility can be achieved to overcome the high activation energy challenge.

Item 2 - Highway Engineering: Freezing Point Depression

A highway engineer is charged with the responsibility of maintaining a road in a mountainous region where temperatures frequently drop to -8.0°C. The engineer is considering whether to use granular sodium chloride or calcium chloride to prevent water on the road from freezing. The more effective salt is the one for which a smaller mass is required to lower the freezing point of 1.0kg of water to -8.0°C.

To resolve this, technicians on the engineer's team dissolved different masses of pure glucose ($C_6H_{12}O_6$) in a fixed 360 g of water from that area and measured the freezing point of the resultant solutions to determine the freezing point of water and its cryoscopic constant. The results were summarized in Table 3 below.

Table 3 - Freezing Point Data

Mass of glucose in 360g water (g)	1.80	3.60	9.00	18.00
Freezing point of solution (°C)	-0.052	-0.103	-0.258	-0.517

(R.F.M of glucose = 180, R.F.M of water = 18)
Despite the effectiveness of the salt chosen, state-level environmental agencies are concerned about the use of the salt near local waterways.

Given the following additional data:
Molar mass of NaCl = 58.4 g/mol
Molar mass of $CaCl_2$ = 110.8 g/mol

Task:

(a) Analyse the data to help the engineer make a choice.
(b) Address the concerns of the state-level environmental agencies.

SECTION B - Item 3: Halogen Acids

SECTION B - Part I - Respond to one item from this section.

Item 3 - Industrial Halogen Acids: HF, HCl and HI

An industrial manufacturing plant utilizes three different halogen acids; HF, HCl and HI in separate specialized chambers to produce different commercial products.

Chamber A
The halogen acid is used to frost glass and the chamber has plastic (Teflon) piping instead of the standard glass-lined vessels used in B and C.

Chamber B
Metalworkers use highly concentrated halogen acid which is stable, cheap and enough for mass industrial use to remove rust from the surface of manufactured steel sheets before they are galvanized.

Chamber C
Chemists use the halogen acid as strong reducing agent and catalyst to make specific pharmaceutical precursors.

During safety inspection, engineers made the following observations:

- The cylinder of halogen acid used in chamber A liquefies easily under minimum pressure at room temperature while the cylinders for chambers B and C required deep refrigeration and high pressure.
- A red-hot wire plunged into the halogen acid of chamber C produced dense purple vapour.

Halogen acid in chamber A dissolves in water to produce an aqueous solution that sluggishly reacts with Magnesium while aqueous solutions of B and C aggressively corrode Magnesium with rapid effervescence. Additional data was presented in Table 4.

Table 4 - Properties of Halogen Acids

Halogen acid	Boiling point (°C)	Bond energy (kJmol-1)
HF	+19.9	568
HCl	-85.1	431
HI	-35.8	299

Task:

(a) Analyse the data and observations to explain the choice of halogen acids in their respective chambers.
(b) Assess the health and environmental impacts of the industrial manufacturing plant.

Item 4 - Group II Hydroxides: Soil pH, Antacids, Fire Retardants

The hydroxides of group II elements are widely used in everyday life, e.g. soil pH restoration, antacid medicines, fire retardants and manufacture of soap greases in high temperature conditions by the alkaline hydrolysis of fatty acids.
After studying group II elements of the Periodic Table, a group of A-level students carried out a research activity to investigate the properties of the hydroxides and obtained the data in table 5 below.

Table 5 - Group II Hydroxides

Compound	Decomposition Temp (°C)	Solubility (mol/100g water)
Be(OH)2	138	insoluble
Mg(OH)2	330	2.0 x 10^-5
Ca(OH)2	450	1.5 x 10^-3
Sr(OH)2	540	3.4 x 10^-3
Ba(OH)2	780	1.52 x 10^-2

However, the students were unable to interpret the data because they did not understand the variation in decomposition temperatures, solubility and the interaction of the hydroxides with sulphuric acid and sodium hydroxide.
You have been approached for guidance about the choice of hydroxide(s) and their health and environmental impacts.

Task:

Make a write up of your presentation to the group of the A-level students.

Item 5 - Bukoola Agrochemicals: Fumigant EDB

Bukoola Agrochemicals Uganda synthesizes a fumigant for citrus fruits and post-harvest grain preservation. The active ingredient is 1,2-dibromoethane (EDB) which is dissolved in propan-2-ol as a co-solvent. The industrial chemists explained that 1,2-dibromoethane is a more effective active ingredient than 1,2-dichloroethane due to its volatility.

During a workshop organized by NARO, farmers were discouraged from using EDB due to its significant health and environmental impacts which affected its demand.

To mitigate environmental effects, the industry has been advised to chemically transform EDB into 2-methylphenol (a disinfectant) while propan-2-ol converted to 2-methylpropan-2-ol which is a better solvent.

An industrial chemistry intern suggested that EDB can easily react with sodium hydroxide to form ethane-1,2-diol, a coolant in petrol engines, and propan-2-ol reacts with ethanoic acid to form a common fragrance.

Task for Item 5:

Help the industry's production team to;
(a) understand how the mitigation of environmental effects and suggestions of the industrial chemistry intern can be achieved.
(b) assess the potential health and environmental hazards associated with fumigant as guided by NARO.

Item 6 - Science Club Enterprise: Solvents & Fragrances

The Science Club of your school plans to establish a small chemical manufacturing enterprise which intends to produce and market a range of products including: a cleaning solvent (nail polish remover), a fragrance additive for perfumes, soaps and lotions, a preservative for dairy products and an antiskinning agent as a paint additive.

Before production begins, the club must select suitable compounds as raw materials and production methods considering their safety, health and environmental impacts. The laboratory technician guided the club members that the available materials are propanone and ethanal whose properties were summarized in Table 6 below:

Table 6 - Raw Materials

Raw material / compound	Properties
Propanone (CH_3COCH_3)	flammable with sweet fruity odour, boils at 56°C and resistant to oxidation
Ethanal (CH_3CHO)	boils at 20.2°C, highly flammable and readily oxidised

The club membership includes students from all classes who may lack the necessary knowledge. They would like to understand;
(a) why the available compounds have different boiling points and one of them is a better solvent.
(b) how ethanal can be converted to phenylethanone which is a fragrance additive to soaps and lotions and how propanone is synthesized from ethanol which is more readily available in the laboratory.
(c) how propanone reacts to form propanone oxime that acts as an antiskinning agent in paints and ethanal reacts with acidified potassium cyanide to form an intermediate during the synthesis of 2-hydroxypropanoic acid which is a preservative in dairy products.
(d) safety, health and environmental assessment impacts of the entire process.

Task:

Make a write-up you will present to your teacher addressing the challenges of the science club members.

END OF PAPER
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12. KAMSSA

KISJO CHEMISTRY | KAMSSA 2026 P525/1 - PAGE 1/6 - CLEAR RETYPED

Mr. Kisule Joseph aka KisJo - Chemistry Educator

P525/1 CHEMISTRY - July-Aug 2026 - KAMSSA JOINT MOCK

Kyazanga, Masaka | Search on Google: KisJo Chemistry | Content Accessible on Google

KAMSSA JOINT MOCK EXAMINATIONS - UACE - CHEMISTRY Paper 1 (Theory) - 2h45min

Instructions to candidates:
- This examination paper consists of two sections; A and B.
- It has six examination items.
- Section A has two compulsory items.
- Section B has two parts; I and II. Respond to only one item from each part.
- Respond to four items in all.
- Any additional item(s) responded to will not be scored.
- All responses must be written in the answer booklet(s) provided.
- Begin each item on a fresh page.

ITEM 1 - Local Production of NaOH from Lake Katwe Salt

The Government of Uganda encourages local industries to increase production of essential industrial chemicals using locally available raw materials to reduce dependence on imports.
A small industrial plant near Kampala produces sodium hydroxide (NaOH) from locally mined rock salt (NaCl) from Lake Katwe. The NaCl is melted and electrolysed to produce sodium, which is then reacted with steam to form NaOH.

Recently, plant management observed production process largely depends on fuel and electricity, making process expensive. They also noted steel pipelines used to transport waste water are corroding more frequently, increasing maintenance costs and interruptions.
The management became concerned and recommended solutions including coupling iron with metals;
however, they are cautioned that higher Emf from the metal couple with iron is not always preferred as it causes hydrogen embrittlement and paint blistering.

TABLE 1 - Coupling metals

Metal | Standard electrode potential (V)
Fe2+/Fe | -0.44
Zn2+/Zn | -0.76
Al3+/Al | -1.66

TABLE 2 - Atomic and molecular energetic data (kJ/mol)

Quantity (reaction) | Value
Atomisation of sodium: Na(s) -> Na(g) | +108
Bond dissociation of chlorine: Cl2(g) -> 2Cl(g) | +243
First ionisation energy of sodium: Na(g) -> Na+(g)+e- | +496
Electron affinity of chlorine: Cl(g)+e- -> Cl-(g) | -349
Standard enthalpy of formation: NaCl(s) | -411

Task:
a) Analyse factors responsible for increased fuel and energy cost in production process.
b) Using Table 1, assist management in choosing suitable metal for coupling and analyse proposed method.

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ITEM 2 - Industrial Chemistry & Agriculture - Ammonia & Fertilizer

In industrial chemistry and agriculture, correct control of concentration, temperature, pressure, and pH is essential for efficient production and safe use of chemicals.
A factory in Abim manufactures ammonia using the Haber process for use as raw material in ammonium nitrate fertilizer production.
$N_2 + 3H_2 \iff 2NH_3$ (-92 kJ/mol)

Plant has been experiencing two major operational challenges:
(a) constant bursting of reactor vessels, and
(b) incredibly slow production process.

Production manager's log shows they are currently operating at temperature of 200°C and pressure of 400 atmospheres. At this temperature, theoretical equilibrium constant is $K_p = 4.30 \times 10^{-1}\ atm^{-2}$. Structural engineer notes reactor steel is only rated to withstand maximum partial pressure of any single gas up to 300 atm before cracking.

Furthermore, local commercial farmer buying ammonium nitrate fertilizer noticed corn leaves turning yellow.
Farmer took sample of soil solution near root zones and found concentration of unreacted ammonium ion NH_4^+ in ground moisture was 0.05M. Farmer wants to understand if NH_4^+ causing yellowing
and how to save crops.

From literature, acid dissociation constant for ammonium ion at ground temperature is $K_a = 5.6 \times 10^{-10}$. Corn grows optimally only when soil solution pH is kept strictly between 5.5 and 7.0.

Task:
a) Assess factory's operational challenges in relation to Haber process conditions provided.
b) Assess effect of fertiliser on agricultural productivity.

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SECTION B Part I - Respond to one item

ITEM 3 - Deep-sea Mining & Radioactive Isotopes - Erongo, Namibia

Deep-sea mining and energy research company operating in Erongo Region of Namibia recovered unusually heavy radioactive mineral during exploration. Lab analysis using mass spectrometry revealed sample contains two previously isolated radioactive isotopes with unique nuclear properties.

Further investigations identified:
- Isotope X: An isotope with atomic number 53 and unusually high neutron-to-proton ratio (N/Z ≈ 1.63).
- Isotope Y: An actinide isotope with atomic number 94 and mass number 244.

The company is considering refining Isotope Y into compact atomic battery packs for powering
deep-sea monitoring sensors. However, scientists expressed concern that accidental leakage or
improper disposal of radioactive material could pose risks to marine ecosystems and human health.

During laboratory meeting, company manager sought clarification on:
a) Most likely mode of radioactive decay that Isotope X will undergo to move towards band of nuclear stability.
b) Expected mode of radioactive decay of Isotope Y, and why isotopes of elements with atomic numbers >82
cannot maintain permanent nuclear stability.
c) Freshly isolated sample of 120mg of Isotope Y has decay constant of 0.0231 year^-1. Manager wishes
to determine mass that will remain after 90 years of continuous deep-sea deployment.
d) Despite concerns, company intends to commercialise Isotope Y for use in consumer-grade maritime
equipment to maximise profits. Manager wants to understand possible health, environmental and ethical
implications associated with use of radioactive material.

Task:
a. Analyse nuclear properties and behaviour of two isotopes based on information provided.
b. Justify scientific explanations and recommendations that should be given to company manager
regarding use and management of Isotope Y.

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ITEM 4 - Lead in Lead-Acid Battery Manufacture

Lead is widely used in manufacture of lead-acid batteries for motor vehicles and backup power systems.
Your class visited Ssembutle battery manufacturing factory for a study tour. To guide your data collection,
your teacher provided following questions for investigation:
a) Why company considered lead to be suitable material for manufacturing batteries.
b) How lead released during battery production and recycling can react with oxygen and dilute acids to
form different lead compounds.
c) Why company uses waste treatment facilities and recycling programmes before disposing of lead-containing wastes.

At the factory, you presented these questions to production manager who provided necessary responses.
He further informed you that lead wastes are collected for recycling while wastewater containing lead
compounds is treated with chlorine and filtered before discharge into environment.

During production process, you observed that lead was easily melted, cast into battery plates and later used
as electrodes in finished batteries. You also observed fine lead dust and waste electrolyte were produced
during manufacturing.

Task:
a) Analyse observations you made during study.
b) Justify responses provided by production manager in regard to waste management.

Part II - Respond to one item

ITEM 5 - Acetone Production from Propene

A chemical manufacturing factory in Uganda produces acetone (propanone), an important organic solvent used
in manufacture of nail polish removers, heavy-duty paint thinners and other industrial products.
At present, factory obtains acetone from propene through series of industrial chemical processes.
During routine quality assurance, laboratory technicians observed that acetone mixes readily with water
and many organic solvents and evaporates rapidly under normal storage conditions.

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ITEM 5 continued - Acetone Quality Control

To ensure product quality, quality control department routinely analyses samples of acetone using
acidified Brady's reagent (2,4-dinitrophenylhydrazine), which produces a yellow precipitate.
[Structure: 2,4-DNPH - Benzene with NO2 at para and ortho to NHNH2]

Due to growing concerns over depletion of petroleum resources and environmental impacts, factory is considering producing acetone from ethanol obtained from biomass. Before adopting new process,
production team requires information on reaction mechanisms, synthetic pathway, reagents and conditions
involved in converting ethanol into acetone.

The environmental and safety department further emphasises that all raw materials and manufacturing processes
must undergo impact assessment before approval to minimise risks to human health and environment.

Task:
a) Assess observations made by laboratory technicians.
b) Analyse reaction mechanisms and synthetic pathway involved in preparation and identification of acetone.
c) Provide synthetic pathway for proposed new production process of acetone.
d) Evaluate industrial application(s) of acetone and assess environmental implication(s) associated with its
production and use, and propose appropriate mitigation measure(s).

ITEM 6 - Organic Synthesis - Chlorobenzene, Nitrobenzene, Ethylamine etc

Organic compounds including aromatic compounds and alkyl halides are widely used in manufacture of
pharmaceuticals, agrochemicals, dyes and industrial solvents.
Kampala Pharmaceuticals uses these compounds as raw materials for production of several industrial chemicals.
The industry manufactures chlorobenzene and nitrobenzene from Compound B, while Compound A is used to
produce ethylamine, propanenitrile and ethene under different reaction conditions.

During recent inventory, following compounds were identified in chemical store:
> Compound A: An alkyl halide containing two carbon atoms and one chlorine atom with molecular mass ~64.5
> Compound B: An aromatic hydrocarbon containing six carbon atoms with molecular mass of 78
> Compound C: An aromatic hydrocarbon containing seven carbon atoms with molecular mass of 92

The suitability of each compound as reactant depends on its solubility behaviour and boiling point,
which influence handling, separation and reaction efficiency. Further information obtained during study
showed that industry routinely carries out environmental and safety impact assessments before introducing
any raw materials or products into large-scale production.

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UGANDA ADVANCED CERTIFICATE OF EDUCATION - CHEMISTRY (Theory) Paper 1 P525/1 - 2h 45m

NAME ..... SIGN .....

INSTRUCTIONS TO CANDIDATES:

- This examination paper consists of two sections, A and B. It has six examination items.
- Section A has two compulsory items.
- Section B has two parts, I and II. Respond to only one item from each part.
- Respond to four items in all.
- Any additional item(s) responded to will not be scored.
- Begin each item on a fresh page.

SECTION A - Respond to both items from this section.

Item 1 - Biogas Digester - Methane Production and Combustion

The increasing cost of conventional fuels has encouraged many institutions in Uganda to explore alternative sources of energy.

A boarding school installed a biogas digester that uses animal waste and food remains to produce methane for cooking.

During operation of the digester, the following observations were made:

i. The temperature of the contents of the digester increased during decomposition of the waste.

ii. Gas production was initially high after fresh waste was added but gradually decreased with time.

iii. Food cooked faster when the supply of methane to the burner was increased.

The following information about methane production and combustion is provided.

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Data set 1: C6H12O6(s) -> 3CH4(g) + 3CO2(g)

Substance Enthalpy of formation kJ/mol: C6H12O6(s) -1273, CH4(g) -75, CO2(g) -394

Data set 2: CH4(g) + 2O2(g) -> CO2(g) + 2H2O(g)

Experimental results for combustion:

Experiment A [CH4] 0.10 mol/dm3 [O2] 0.10 rate 2.0 x 10^-4 mol/dm3 s-1

Experiment B 0.20 0.10 4.0 x 10^-4

Experiment C 0.20 0.20 1.6 x 10^-3

Task a) Analyse observations made during production and use of biogas, using information provided.

Task b) Assess conditions and practices school should adopt to maximise production and efficient use of methane as fuel.

Item 2 - Fruit-processing Company - Benzoic Acid Buffer & Sugar - Acidity & Freezing

A fruit-processing company produces bottled passion-fruit juice for sale in supermarkets.

The company uses benzoic acid and sodium benzoate to control acidity of juice and sugar to improve taste.

Customers complained that one batch tasted unusually sour and froze more readily than another batch when placed under similar refrigeration conditions.

The company investigated two formulations used to prepare 100 cm3 samples of juice.

Substance Sample P Sample Q

Benzoic acid /g 1.22 1.22

Sodium benzoate /g 0.288 0.288

Sugar /g 8.0 24.0

The pKa of benzoic acid is 4.20.

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Recommended pH range for juice is 3.5-4.0

Relative molecular masses: C6H5COOH =122, C6H5COONa=144

Task a) Assess customers' concerns about acidity and freezing behaviour of two juice samples.

Task b) Evaluate benefits and possible consequences of additives used in juice, and recommend appropriate practices for their use.

SECTION B PART I - Respond to only one item from this part.

Item 3 - Ceramic and Glass Manufacturing - Period 3 Oxides & Chlorine Water Treatment

A ceramic and glass manufacturing company uses compounds of silicon and other Period 3 elements in its production processes.

During a study visit, learners observed that:

i. silicon(IV) oxide was used as major raw material in making heat-resistant products;

ii. magnesium oxide was used to neutralise some acidic industrial wastes;

iii. aluminium oxide could not be used effectively to treat strongly alkaline waste;

iv. gaseous oxides of sulphur and phosphorus produced during some processes could contaminate rainwater and nearby water sources.

The company also uses chlorine-containing substances during water treatment.

Task a) Analyse observations made by learners in terms of structure, bonding and chemical properties of substances involved.

Task b) Explain, using appropriate chemical equations, the reactions relevant to treatment of industrial wastes and water.

Task c) Evaluate environmental importance and possible dangers associated with substances used or produced by company, and suggest suitable mitigation measures.

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Item 4 - Company Plans to Construct Pedestrian Bridge - Aluminium and Iron as Main Structural Materials

During discussions, engineers noted that:

i. the bridge would be exposed continuously to air and moisture;

ii. iron components could be protected by attaching blocks of magnesium;

iii. aluminium normally remains resistant to further corrosion despite being a reactive metal;

iv. a worker suggested replacing aluminium with beryllium because the two elements occur in related positions in Periodic Table.

The company is also concerned about environmental and health effects associated with extracting, processing and using these metals.

Task a) Analyse physical properties of aluminium and iron in relation to their structures and suitability for bridge construction.

Task b) Explain chemical behaviour of metals in stated environment, including methods by which corrosion may be controlled.

Task c) Assess suggestion to use beryllium and evaluate environmental and health impacts associated with materials under consideration.

PART II - Respond to only one item from this part.

Item 5 - Plastic Waste Accumulation - Polymers X and Y

Plastic waste from packaging materials has increasingly accumulated around markets and drainage channels in an urban area.

An environmental chemist identified two major polymers, X and Y.

Polymer X has repeating unit: [-CH2-CH2-]n

Polymer Y has repeating unit: [-CH(C6H5)-CH2-]n

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Further investigations showed that:

i. the monomer used to manufacture X can be prepared from ethanol;

ii. ethanol can be manufactured from ethanoic acid through suitable chemical transformations;

iii. the monomer used to manufacture Y is obtained from an aromatic compound;

iv. an aromatic ketone used in another industrial process can be prepared from benzene using an acyl chloride derived from ethanoic acid.

Task a) Analyse structural features and properties of polymers X and Y that contribute to their accumulation in environment.

Task b) Analyse reaction pathways involved in:

- the formation of monomers of X and Y;

- the polymerisation of monomers;

- the conversion of ethanoic acid into stated organic intermediates; and

- the formation of aromatic ketone.

Include appropriate reagents, conditions, equations and reaction mechanisms.

Task c) Evaluate useful applications and environmental and health impacts of polymers X and Y, and recommend appropriate waste-management practices.

Item 6 - Pharmaceutical Company - Organic Solvents Extraction & Synthesis

A pharmaceutical company extracts active ingredients from plant materials using organic solvents. Company also manufactures several organic compounds for use as solvents and chemical intermediates.

The following compounds were found in company's chemical store:

- Compound A: straight-chain hydrocarbon containing six carbon atoms and having relative molecular mass 86.

- Compound B: aromatic hydrocarbon containing seven carbon atoms and having relative molecular mass 92.

- Compound C: alcohol containing two carbon atoms and having relative molecular mass 46.

The company uses suitable starting materials to manufacture:

- nitrobenzene;

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- ethyl ethanoate;

- propanone; and

- phenylethanone.

Before selecting any compound for industrial use, company assesses its physical properties, chemical behaviour, usefulness and possible effects on human health and environment.

Task a) Identify compounds A, B and C, and examine their structures and physical properties to determine their suitability as solvents for extracting organic substances from plant materials.

Compound A = hexane C_6H_{14}, Compound B = toluene $C_6H_5CH_3$, Compound C = ethanol C_2H_5OH

Task b) Analyse reaction pathways and mechanisms involved in preparation of nitrobenzene, ethyl ethanoate, propanone and phenylethanone from suitable starting materials related to compounds in scenario.

Include appropriate reagents, conditions, equations and mechanisms.

Task c) Evaluate practical applications and health and environmental impacts of organic compounds involved, and recommend appropriate measures for their safe handling and use.

END OF PAPER

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UGANDA ADVANCED CERTIFICATE OF EDUCATION - CHEMISTRY (Theory) Paper 1

P525/1 CHEMISTRY Paper 1 Jul/Aug 2026 - 2 3/4 hours

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

This examination paper consists of two sections; A and B. It has six examination items.

Section A has two compulsory items.

Section B has two parts; I and II. Respond to only one item from each part.

Respond to four items in all.

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All responses must be written in the answer booklet(s) provided.

Begin each item on a fresh page.

Turn Over

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SECTION A - Respond to both items from this section.

Item 1 - Environmentally Friendly Electrochemical Technologies - Electroplating

The government is encouraging local industries to adopt environmentally friendly electrochemical technologies to improve industrial efficiency and reduce energy consumption.

One metal-finishing company started using electroplating to coat iron tools with zinc to minimise corrosion. Before electroplating, laboratory technician prepared electrolyte solutions using different salts.

After some time, the technician made the following observations:

i. Salt A required a much higher temperature to melt than salt B. He explained that this was due to difference in their lattice energy.

ii. When equal amounts of the two salts were dissolved in water, the solution of salt A became warm whereas salt B solution became cold.

iii. Different electrochemical cells i.e. I and II have different emf values, which influence energy efficiency of electroplating process.

The production manager became concerned about the observations and requested an explanation. The information in Tables 1, 2 and 3 has been provided to guide you in explanation required.

Data set 1 Table 1 Salt to be used as electrolyte

Salt A-CaCl2 Lattice energy of formation -2250 kJ/mol Hydration energy -2337 kJ/mol

Salt B-KCl Lattice energy -715 Hydration energy -681

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Data set 2 Table 2 Half cell Eo(V)

Zn2+(aq) + 2e -> Zn(s) -0.76 V

Cu(s) -> Cu2+(aq) + 2e -0.34 V

Ag+(aq) + e -> Ag(s) +0.80 V

Table 3 Cell Cell notation

Cell I Zn(s)/Zn2+(aq)//Cu2+(aq)/Cu(s)

Cell II Cu(s)/Cu2+(aq)//Ag+(aq)/Ag(s)

The emf of electrochemical cells will also be required.

Task: a) Analyse observations made by laboratory technician using information provided in Table 1.

b) Assess how efficiency of electroplating process can be maximised using information provided in Tables 2 and 3.

Item 2 - Reversible Reactions & Solution Processes - Ammonia & Boiling Point Elevation

Many chemical industries depend on reversible reactions and solution processes to manufacture quality products efficiently. Obtaining high yield of products from reversible reactions and controlling boiling behavior of solutions are essential for reducing production costs and ensuring safe industrial operations. Failure to control these processes may lower production efficiency and increase operational costs.

An agrochemical company in one of industrial towns of Uganda manufactures ammonia for production of nitrogen fertilizers. During routine quality control, production department reported that one production batch produced a lower amount of ammonia than expected. Production records also showed that reaction temperature during synthesis process was 450°C. At same time, utilities department observed that cooling solution prepared for use in plant boiled at a higher temperature than previous batches.

Some technicians claimed that elevated reaction temperature was responsible for production department report by affecting equilibrium of reversible reaction,

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while others claimed that higher boiling temperature of cooling solution resulted from quantities of non-volatile solute, ethane-1,2-diol (ethylene glycol) added during its preparation.

To investigate technicians' claims, company analysed and recorded data for equilibrium reaction at 450°C and data for cooling solution shown in data set 1 and table 4 respectively.

Data set 1: The manufacture of ammonia is represented by reversible reaction:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92$ kJ/mol

0.8 moles nitrogen and 0.9 moles hydrogen were heated in 1500 cm3 closed vessel. At equilibrium, mixture contained 20% hydrogen.

Table 4 During investigation; two batches were heated to boil.

The equilibrium favors formation of ammonia when equilibrium constant, Kc value for reversible reaction is more than 45 mol2 dm-6 at given temperature.

Quantity Previous Batch-X Investigated Batch-Y

Mass of water (kg) 0.50 0.50

Mass of ethylene glycol added (g) 0 90

Task (a) Assess technicians' claims.

(b) Evaluate impacts of non-volatile solute in real life.

SECTION B Part I - Respond to any one item in this part.

Item 3 - Heating Tanks & Water Storage Tanks & Acidic Cleaning Solutions - Mg Al Si

A company that manufactures heating tanks, drinking water storage tanks and containers used for preparing mineral acidic cleaning solutions requires suitable materials to serve these applications.

A chemistry science club from certain school visited this factory to learn how materials are selected for different products. Production engineer showed them samples of magnesium, aluminium and silicon and emphasized that selecting unsuitable material could result in corrosion, contamination of contents, equipment failure and increased production costs.

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On their return to school, learners discussed which material would be most suitable for manufacturing different products. One learner suggested using magnesium for all purposes. Another learner argued that aluminium would be best material, while third learner insisted that silicon is best. The rest of class could not explain why engineer did not fully agree with any of three suggestions.

Task: a) Analyse properties of materials and their interactions with other substances to enable learners to select most suitable material for making heating tank, water storage tank and container used for preparing acidic cleaning solution.

b) Assess impact of these materials on environment.

Item 4 - Charcoal Stove Liners Manufacture - Oxide Materials - SiO2 and CO2

Charcoal stove liners manufacture requires careful selection of oxide materials because their properties determine quality, durability and safety of final products.

Your science group wants to start up charcoal stove liners manufacturing project in school. They have selected silicon dioxide (SiO2) and carbon dioxide (CO2) as possible oxides to use during manufacturing process. However team has failed to agree on best compound to use based on properties. They have visited nearby chemical engineer for more advice. To guide study, your project supervisor asked you to investigate:

i. The best raw material for charcoal stove liner making.

ii. How compounds behave in acidic and basic medium.

iii. The health implications of any one of selected materials.

During visit, you presented those questions to chemical engineer who provided you with necessary responses. He further provided following data to help you analyse.

Table 5 Oxides Melting point (°C)

Carbon dioxide -56.6

Silicon dioxide 1640

Task a) Analyse information obtained during study.

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Part II - Respond to any one item in this part.

Item 5 - School Science Club - Liquid Soap & Fruit Flavoured Products - Liquids P and R

Your school science club group making liquid soap and fruit flavoured products noticed two different colourless liquids in chemistry laboratory labeled P and R. During practical lesson, your chemistry teacher suggested that liquid P was commonly used for removing paints, grease and nail polish from metal and glass surfaces, while R was used in preserving animal feeds due to their properties.

To identify liquids, your group carried out simple laboratory tests and consulted preparations kept in laboratory.

They made following observations and deductions;

i. Liquid P is propanone (CH3COCH3); produces orange precipitate when reacted with acidified 2,4-dinitrophenylhydrazine.

ii. Liquid R is propanoic acid (CH3CH2COOH)

iii. Laboratory preparation shows that liquid P was synthesized from chloropropane while liquid R was synthesized from ethene.

iv. Record further indicates that, during synthesis of R from ethene, ethanol was first reacted with concentrated sulphuric acid at specific temperature to obtain ethene before being converted into final product.

The group requires detailed information and you have been selected to make them understand more.

Task: a) Analyse chemistry teacher's suggestions.

b) Analyse groups' observations, all reactions of synthesis of liquid P and R and those highlighted in scenario.

c) Evaluate impact of P and R.

Item 6 - Organic Compounds in Agriculture and Manufacturing - Chlorobenzene & Phenylethene (Styrene)

Organic compounds are widely used in agriculture and manufacturing. A youth innovation hub in certain village plans to establish two small scale production units; one to manufacture chlorobenzene for producing pesticides and herbicides and another to manufacture phenylethene (styrene) for producing plastics and synthetic rubber.

The innovators propose using ethanol and benzene, which are readily available from local suppliers, as starting materials. They suggest producing chlorobenzene from ethanol and producing phenylethene from benzene.

During project planning, environmental officer observed that chlorobenzene and phenylethene possess properties that make them suitable for their intended applications. The officer also warned that some raw materials and products are hazardous if improperly handled. To minimize environmental pollution, officer recommended converting excess benzene into more useful product (methylbenzene) through alkylation and reacting excess ethanol with ethanoic acid in presence of acid catalyst instead of releasing chemicals into environment.

The innovators have approached you, as chemistry consultant, for scientific guidance.

Task: a) Analyse observations and recommendations made by environmental officer.

b) Analyse innovators' suggestion about synthesis reactions of polyphenylethene and chlorobenzene.

c) Evaluate impacts of suggested raw materials of production suggested.

END OF PAPER

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P525/1

CHEMISTRY

Paper 1

AUGUST 2026

$2\frac{3}{4}$ hours

UNNASE MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

*This paper consists of **two** sections **A** and **B** and **six** examination items*

*Section **A** has **two** compulsory items*

*Section **B** has **two parts : I and II.** Answer one item from **each** part.*

*Answer **four** items in all.*

*Answers to **both** sections **A** and **B** must be written on the answer booklet(s) provided.*

*Any additional item(s) answered will **not** be scored.*

Graph papers are provided.

Where required use the following; **C=12** **N=14** **H=1**

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SECTION A

Answer all the items in this section.

ITEM 1

The values of enthalpy changes in chemical reactions can be used to predict feasibility of reactions hence establishment of some chemical processes for use in society.

A group of students from science club wanted to venture into a project of making an electrochemical cell that can generate more than 1.2 volts for use. They wanted to use metal M and zinc however they were not certain whether they could be able to achieve their objective. They decided to consult the laboratory technician for guidance. He provided them with some thermochemical data and other information to use.

Thermochemical data

Enthalpy of atomization of zinc =+126 kj mol^{-1}

First and second ionization energies of zinc are ; + 906 and +1733 kjmol^{-1} respectively

Bond dissociation energy of oxygen = +498 kj mol^{-1}

First electron affinity of oxygen = -142 kj mol^{-1}

Second electron affinity of oxygen = +731 kj mol^{-1}

Enthalpy of formation of metal oxide, MO = -602 kj mol^{-1}

Lattice energy of zinc oxide = 4010 kj mol^{-1}

1Faraday =96500C.

$$ZnO_{(S)} + M_{(S)} \longrightarrow MO_{(S)} + Zn_{(S)}$$

He told them they should use the information provided and equation of reaction given in order to overcome their challenge. In addition, he said it's important to have knowledge on factors affecting lattice energy.

The students lacked sufficient knowledge to address their challenge.

The laboratory technician has identified you as a potential learner who can help the students and has asked you to give guidance to the students to address their challenge.

TASK:

Write a report to help the students overcome their challenge, and make recommendation.

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ITEM 2

Pharmaceutical industries employ essential processes in purification of products for use in society.

A group of senior five students in the science club under their chemistry teacher went for a study tour in a pharmaceutical industry. They were informed by the production manager that some of the raw material used are aromatic organic substances from plant extracts while others are synthesized. The substances are purified using steam and the process works under a principle that enables it to be achievable. She further said the process also helps in determining molar masses of the organic extracts and the specific conditions under which the process operates such as pressure is also identified. She also said the composition of the organic substance in the distillate obtained during the purification exercise is usually determined to monitor the effectiveness of the process. She said the process is more effective in purifying organic compounds with molar mass between 100 and 300g mol^{-1}. The process has some advantage over other methods employed in purification processes. The students were grateful but remained not fully contented since did not clearly understand some processes.

After the tour the teacher gave a follow up exercise. He said that the data obtained from the industrial process indicated that when the process was carried out at 101kPa a distillate that contained 1.6g of water and 1.1g of the organic substance was obtained. In addition, the data in the table was also provided.

Temp /^{0}C	92	94	96	98	100
V.P of organic substance / kPa.	6	8	12	15	17
V.P of water/ kPa	74	80	88	94	101

Data analysis of the organic substance indicated that it contains by mass 77.42% carbon, 15.05 nitrogen and the rest hydrogen.

The learners were challenged and have approached you for guidance.

TASK:

Write a report to help the learners

(a) Understand the principle of the process

(b) (i) analyze the data and the process.
(ii) evaluate the molecular formula of the compound.

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SECTION B

Answer **one item** from each of the **parts I** and **II.**

Part I

ITEM 3

Metals are essential material for use in manufacture of basic items for use in community.

A group of investors in a community wanted to start on a project of marking portable durable electronic equipment for use. They consulted the project planner and provided them with some information and materials to choose from.

Elements	Be	Sr	Ba
Atomic radius /nm	0.112	0.215	0.222
Melting points /^{0}C	1280	850	714
Density /gcm^{-3}	1.85	2.64	3.51

He told them in order to make correct choice of the material they should base on the information given and its impact on health. They should also have knowledge on their differences in atomic radii. It's also important to have knowledge on how the elements interact with water and sulphuric acid. The investors lacked sufficient knowledge and therefore approached the chemistry teacher for guidance. The teacher has asked you to write a report for guidance to the entrepreneurs.

TASK:

Write a report for guidance to the entrepreneurs .

ITEM 4

Physical properties of elements can be improved by integrating it with others depending on the desired property.

A group of members from a community near areas where iron is extracted decided to improve on properties of iron by making alloys that can be used in community... They consulted their project planner who provided them with some material together with information to use in identifying the material.as shown in the table.

Element	Iron	Carbon (Graphite)	Silicon	Lead
Atomic radius/nm	0.116	0.077	0.117	0.194
Melting points/^{0}C	1538	3600	1410	327

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She said the choice of the element should be based on the information provided and its impact on the environment. In order to implement on the project, the members should have knowledge on differences in melting points among the elements provided to be combined with iron, and how these elements interact with water and chlorine.

The community members failed to implement the project because they lacked adequate knowledge and therefore approached the laboratory technician for guidance. The laboratory technician has asked you to write a report for guidance.

TASK

Write a report that you will use to give guidance to the community members.

Part II

ITEM 5

Organic compounds are important material used in manufacture of some items for use in society.

A group of investors in a community want to produce polymers for making materials for sale to the society. They decided to use ethanoyl chloride as the raw material from one of their service provider. They consulted the project planner and she suggested they should prepare polyphenyl ethene as the major product in their project. She also said they can transform some of the raw material by reacting it with benzene in presence of halogen carrier to form compound W that can be used to prepare another compound Z which is the immediate compound in manufacture of polyphenyl ethene. She also suggested that in case they have generated excess amount of Z they can transform into phenyl ethanoic acid that can be reacted with the product formed from fermentation of carbohydrates from the society to produce perfumes. The investors had partial knowledge and therefore approached the chemistry teacher for better write up. The teacher has approached you and asked you to make a write up and help the investors. For better understanding the investors should have knowledge on physical properties of the polymer in relation to its formation, its application and impact on health. They should also have knowledge on writing equations using arrows to show how compound W is formed from the raw material and how the perfume is formed. It's also important for them to have knowledge on how to write equations showing reaction pathways leading formation of polymer from the raw material and, the perfume from compound Z.

TASK:

Write a report to guide the investors.

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ITEM 6

Organic compounds are essential materials used to produce variety of products used in community.
Community members a round a school in Masaka city developed idea of producing perfumes for use in the community using ethanoic acid as a raw material available from their supplier. They consulted the laboratory technician for help. He advised them to reduce some of the raw material and form compound Q which they should react with the remaining raw material in order to form the perfume. He also suggested that in case they produced excess amount of compound Q they can transform it into propanone and use it to prepare propan-1-ol which is an important industrial organic solvent. He further told them that in order to be certain that propanone has been formed they should add 2,4-Dinitrophenyl hydrazine in acidic media and see whether a yellow precipitate is formed. He further suggested that in case they remained with some raw material unused can also use it to prepare propylamine a product used in pharmaceutical industry. The community members failed to understand clearly the laboratory technicians' guidance and requested for a write up for better understanding. The laboratory technician has chosen you as a potential learner to help the community members. For better understanding the investors should have knowledge on physical properties of the perfume in relation to its formation, its application and impact on health. Furthermore, the community members should have knowledge on writing equations using arrows to show how the perfume is formed from the raw material, and how the yellow precipitate is formed. Its also important for them have knowledge on writing equations showing reaction pathways of how propylamine and how propan-1-ol are formed from the raw material.

TASK:
Write a report to guide the community members

END.

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P525/1 CHEMISTRY PAPER 1 2 3/4 Hours

ACEITEKA JOINT MOCK EXAMINATIONS 2026 - Uganda Advanced Certificate of Education

CHEMISTRY PAPER 1 - 2 Hours 45 Minutes

INSTRUCTIONS TO CANDIDATES:

The paper consists of two Sections: A and B. It has six examination items.

Section A has two compulsory items.

Section B has two parts; I and II. Respond to only one item from each part.

Responses to section A and B must be written in the answer booklet(s) provided.
Respond to four items in all.

Responses to each item should start on a fresh page.

Any additional item(s) responded to will not be scored.

For Scorers Use Only: Item No | Basic Code | Weighted Score | Scorers Initials - Items 1,2,(3/4),(5/6)

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A gift to serve

SECTION A - Attempt all questions in this Section

Item 1 - Rates of Reactions - Acetone + Hydrogen Cyanide in Acidic Conditions

Rates of reactions are very important in optimizing industrial processes. As Senior 5 chemistry class interested in the rate of reaction between acetone and hydrogen cyanide in acidic conditions approached their chemistry teacher for guidance and he gave them the following information.

CH3COCH3(g) + HCN(g) --H+--> (CH3)2C(OH)CN(g)

Experiment	Concentration (mol dm-3)			Rate (mol dm-3 s-1)
	[CH3COCH3]	[HCN]	[H+]	
1	1 x 10-2	1 x 10-2	1 x 10-2	2 x 10-2
2	1 x 10-2	2 x 10-2	1 x 10-2	2 x 10-2
3	2 x 10-2	1 x 10-2	1 x 10-2	4 x 10-2
4	1 x 10-2	1 x 10-2	2 x 10-2	4 x 10-2

Bond Energy / kJ mol-1: C=O +743, C-H +412, C-O +360, C-C +348, H-O +463

The chemistry teacher further advised that the rate constant, factors affecting rate of reaction, enthalpy change for the reaction and the associated applications of the enthalpy of reaction are all vital in understanding the reaction rate.

The S.5 chemistry class is now challenged and have approached you.

Task: As a student of chemistry analyse and interpret the data to address the concerns of the S.5 chemistry class.

Item 2 - Pharmaceutical Company Dealing in Syrups - Salt X Bitterness - Buffer

A pharmaceutical company dealing in syrups has realized a decline in its sales after persistent complaints from its customers for its bitterness. The chemist has advised the company to procure salt X labelled:

29.27% Carbon, 3.71% Hydrogen, 28.05% Sodium and 38.98% Oxygen with molar mass of 82.

The laboratory attendant provided 1 dm3 of ethanoic acid of concentration 0.1 M and Ka = 1.86 x 10-5 mol dm-3.

The company's management is now interested in the molecular formula of the salt, the amount of the salt that must be added to the acid provided to produce a buffer solution of pH = 5.73 and the associated applications of the resultant solution. The laboratory attendant is challenged and has approached you.

Task: As a student of chemistry analyse the data provided to address management concerns.

SECTION B PART I - Attempt only one Question from this Section

Item 3 - Gastric Ulcers - Group II Elements as Remedy - Periodic Trends

Gastric ulcers is a major complaint in one of the schools in Uganda. In one of the meetings of the science club, one chemistry student suggested that one of the Group II elements can be a better remedy. Their chemistry teacher advised that periodic trends for the elements and their compounds can affect reactivity and reactions of elements with water, alkalis and dilute acids should be put into consideration and also an assessment of the health implications of any element or compound and provided the following information

Element: Be Mg Ca Sr Ba

Atomic radius (nm): 0.112 0.160 0.197 0.215 0.222

Solubility of hydroxide (mol per 100cm3 water): 1.1x10-5 2x10-5 1.5x10-3 3.4x10-3 1.5x10-2

Members of the science club are now challenged and have approached you.

Task: As a Senior 6 student of chemistry, help the members of the science club to analyse and interpret the data provided to address their concerns.

Item 4 - Enzymes and Cell Receptors - Transition Metal Complexes - VSEPR Theory

In chemistry, enzymes and cell receptors act like locks while molecules are the keys. Transition metal complexes facilitate highly efficient catalysis, power biological systems and drive advancements in medicines and material science. S.5 chemistry students under their science club put themselves in two groups. One group is to use the principle of electron pair repulsion theory to explain and analyse the shapes of simple molecules by illustrating how it determines molecular shapes and bond angles. The second group is to analyse transition complexes by giving the IUPAC name of the complex, oxidation state of the central metal atom and its coordination number.

Their chemistry teacher gave them the following support data:

Molecule: NH_3 , BF_3 , SF_4 , PCl_5 , CCl_4

Complex: $[Co(NH_3)_5H_2O]Cl_3$, $Cu(NH_3)_4^{2+}$, $Co(SCN)_4^{2-}$, $CoCl_6^{2-}$, $CuCl_4^{2-}$

The S.5 students have been challenged and have approached you.

Task: As a chemistry student help the S.5 students to address their concerns.

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PART II - Attempt only one Question from this Section

Item 5 - Coolants for Car Engines - Ethane-1,2-diol - 1-Phenylethyne - Mitigation Reactions

Coolants for car engines are of high demand in a Ugandan population. A manufacturing company is using 1,2-dibromoethane to make ethane-1,2-diol and benzene to make 1-phenylethyne to address the high demand. As a mitigation measure the manufacturing company reacts excess 1,2-dibromoethane with hot alcoholic potassium hydroxide solution and the unreacted benzene with bromomethane. The company's management is interested in the suitability of ethane-1,2-diol to its application, an analysis of the mitigation reactions with equations and an evaluation of the company's synthetic routes with the possible environmental implications of its operations.

Task: As a chemistry student, analyse and interpret the data to address the management's concerns.

Item 6 - Agricultural Output - Fertilizer Phenyl Ethanamide & Propanoic Acid - Benzene & Propene

In a move to improve agricultural output in a certain country, an industrial plant is using benzene to make a fertilizer, phenyl ethanamide ($C_6H_5NHCOCH_3$), and propene to make propanoic acid. In integrating the plant, it reacts the unreacted benzene with a mixture of concentrated nitric acid and concentrated sulphuric acid and then reacts propene with acidified warm water.

The company's management wants to know the suitability of its fertilizer to its application, an analysis of the integration reactions with equations, an evaluation of its synthetic pathways with the possible associated health implications. The plant's management is challenged and your teacher came across this information.

Task: As a student of chemistry analyse and interpret the data to address the plant's management concerns.

END

The Periodic Table of the Elements

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Includes: H He Li Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn Fr Ra Ac Rf Db Sg Bh Hs Mt etc.

Lanthanides: Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu

Actinides: Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

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UGANDA TEACHERS' EDUCATION CONSULT (UTEC)

Uganda Advanced Certificate of Education - CHEMISTRY (Theory) Paper 1 - 2h 45m

INSTRUCTIONS TO THE CANDIDATES:

This examination paper consists of two sections; A and B. It has six examination items.

Section A has two compulsory items.

Section B has two parts; I and II. Respond to only one item from each part.

Respond to four items in all.

Any additional item(s) responded to will not be scored.

All responses must be written in the answer booklet(s) provided.

Begin each item on a fresh page.

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SECTION A - Respond to both items from this section.

Item 1 - S.5 Science Club - Electrochemical Cell - Zinc and Copper Electrodes

A group of S.5 chemistry students in their science club want to construct an electrochemical cell that generates electrical energy from spontaneous chemical reactions between Zinc and Copper electrodes. When they consulted their chemistry teacher, he gave them the following data after advising them that they needed the second ionisation energy of Copper.

Thermochemical data:

ΔHf CuCl2 = -220 kJ mol-1

ΔHa Cu(s) -> Cu(g) = +338 kJ mol-1

ΔHdiss Cl2(g) -> 2Cl(g) = +121 kJ mol-1

ΔHIE Cu(g) -> Cu+(g) = +754 kJ mol-1

ΔHEA Cl(g) -> Cl-(g) = -364 kJ mol-1

Lattice energy of CuCl2 = 2824 kJ mol-1

Zn(g) -> Zn+(g) = 906 kJ mol-1

Zn+(g) -> Zn2+(g) = 1733 kJ mol-1

Half Cell E0/V: Zn2+(aq)/Zn(s) +0.76 , Cu2+(aq)/Cu(s) -0.34

Task: As a chemistry student analyse and interpret the data provided for the S.5 chemistry students and make any recommendations if possible.

Item 2 - Miscible Liquids Alcohols and Water - Medical Disinfection - Substance Q

Miscible liquids of alcohols and water are commonly being used for medical disinfection and surface cleaning. A manufacturing company intends to use substance Q labelled 52.14% C, 13.13% H and 34.73% oxygen. In the mass spectrum of Q the peak at the largest value of M/e occurs at 46.

The vapour pressure of a solution containing 1 mole of Q and 4 moles of water is 0.76 atmospheres. The vapour pressures of pure Q and water are 0.675 and 0.454 atmospheres respectively at the same temperature.

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The company's management wants to know; molecular formula of Q, how a mixture of Q and water deviates from ideal behaviour and an analysis of the applications of the mixture in real life. Your laboratory attendant was given this information but he is challenged.

Task: As a student of Chemistry analyse and interpret the data to address the concerns of the company's management.

SECTION B Part I - Respond to any one item in this part.

Item 3 - Nuclear Plant in Uganda - Radioactive Elements - Clean Energy - Ra Bi U Pa

A nuclear plant in Uganda is undertaking pilot studies for the use of various radioactive elements to generate clean and safe energy. In one of the studies the plant's technical team discovered that on storage

226/88 Ra emits an alpha particle to form P.

210/83 Bi emits a beta particle to form Q.

234/92 U emits five alpha particles to form R.

231/91 Pa emits an alpha particle and a beta particle to form S.

226/88 Ra emits two alpha particles to form T.

In another parallel study, the technical team obtained the following data for the two radioactive elements Y and Z.

Time (minutes): 0 10 20 30 50

Disintegrations (s-1) Y: 200 161 135 110 76

Disintegrations (s-1) Z: 11.3 8.3 6.0 4.4 2.35

The plants management is interested in the identity of elements P, Q, R, S, T and the decay constants of Y and Z and the associated health implications of radioactivity. Your chemistry teacher was given this information.

Task: As a student of Chemistry, analyse and interpret the data to address the concerns of the plant's management.

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Item 4 - Newly Constructed Factory - Dioxides of Group (IV) Elements - Glass and Ceramics

A newly Constructed factory in town is Carrying out a feasibility study on using dioxides of group (IV) elements as raw materials for glass and Ceramics. The structural engineer advised that periodic trends, reactions of elements with water and halogens, reactions of the dioxides with alkalis play a vital role in deciding the raw material and provided the following data;

Element: C Si Ge Sn Pb

Melting Point (°C): 3800 1863 1211 505 601

Boiling point of dioxide (°C): -78 2590 1200 1900 Decomposes on heating

The Management of the factory is now interested in periodic trends, and the reactions of the elements and their Compounds and the possible environmental implication if any. Your laboratory attendant Came across this information.

Task: As a student of chemistry analyse and interpret the data to address the raised Concerns by the Management of the factory.

Part II - Respond to any one item in this part.

Item 5 - School Science Club - Phenol and Ethanoyl Chloride from Benzene and Propene

A school Science club has engaged its chemistry students to make phenol and ethanoyl chloride from benzene and propene respectively. The chairperson of the club suggested that as a mitigation Measure excess propene can be safely reacted with bromine water but excess benzene requires fuming sulphuric acid. The Headteacher of the School is interested in the Suitability of the products for their applications an analysis of mitigation reactions with equations evaluation of the Synthetic pathway routes and the possible environmental implications of their Products. Members of the School Science Club are challenged and have approached you for help.

Task: As a student of chemistry, make a write up you would present to address the Headteachers Concerns.

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Item 6

A chemical plant for dyes and solvents makes propanone hydrazone from propan-1-ol and n-ethyl-n-phenyl amine from benzene. As a mitigation Measure the excess propan-1-ol is reacted with hot concentrated Sulphuric acid and excess benzene with bromine in the Presence of Iron Catalyst. The Management of the Plant is interested in the Suitability of propanone hydrazone for its functions, an analysis of the mitigation reactions with equations, and evaluation of the Synthetic pathways for its operations and the possible health implications of its operations. Your teacher Came across the information.

Task: As learner of Subject analyse the data to address Managements Issue.

END

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18.UTES

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P525/1

CHEMISTRY
Paper 1
2026
2 ¾ hours

UGANDA TEACHERS' EXAMINATIONS SCHEME

Uganda Advanced Certificate of Education

JOINT MOCK EXAMINATIONS

CHEMISTRY
(Theory)

Paper 1

2 hours 45 Minutes.

INSTRUCTIONS TO CANDIDATES.

This examination paper consists of two sections; **A** *and* **B**. *It has* **six** *examination items.*

Section **A** *has two* **compulsory** *items.*

Section **B** *has two parts;* **I** *and* **II**. *Respond to only* **one** *item from each part.*

Respond to **four** *items* **in all**.

Any additional item(s) responded to will not be scored.

All responses **mus***t be written in the answer booklet(s) provided.*

Begin each item on a fresh page.

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SECT ION A

Respond to **both** *items from this section.*

1. A manufacturing company in Kampala called Green Fuel Industries has begun producing a new environmentally friendly liquid fuel X for industrial heating and cooking. During pilot production, engineers observed two major challenges.

First, the fuel burns slower than expected during industrial use, causing delays in production processes with the engineers suspecting that this is due to reaction conditions.

Secondly, the company wants to determine whether fuel X is economically viable compared to existing commonly used fuel whose enthalpy of combustion is $-890 kJmol^{-1}$. To do this, chemists carried out experiments to determine the enthalpy of combustion of fuel using the data shown in table 1 below.

Table 1

Substance	**Enthalpy of formation ($kJmol^{-1}$)**
Fuel X ($C_2H_4O_2$)	-485
Carbon	-394
Hydrogen	-286

$$C_2H_4O_{2\,(l)} + 2O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$$

Further experiments were conducted to study decomposition of fuel X vapour.

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Table 2

Experiment	[Fuel X] $moldm^{-3}$	Initial rate ($moldm^{-3}S^{-1}$)
1	0.10	0.020
2	0.20	0.080
3	0.30	0.180

The management team now seeks scientific advice on improving production efficiency and safe use of the fuel.

Task.

(a) Analyse the observations made using the data provided.

(b) Assess the ways through which the use of fuel X can be maximized with reference to the data in Table 2.

2. Milk preservation is important in ensuring the communities receive safe dairy products with good taste and nutritional value. A dairy processing company in a certain area produces and supplies packaged milk to nearby schools and hospitals.

Recently, consumers have raised concerns that some milk batches develop a slightly bitter taste after storage while others do not freeze at expected temperatures when placed in refrigerators, affecting product quality and transport.

The company acknowledged that during processing, they usually add sodium acetate as a preservative to control microbial growth and dissolve glucose to improve taste and maintain texture.

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The company is investigating whether the quantities of these additives are responsible for the consumers' concerns. The laboratory technician provided data in Table 3 for two sets of milk samples prepared using quantities always used for $100cm^3$ of milk.

Table 3.

Substance	Set A	Set B
Sodium acetate CH_3COONa (g)	4.10	4.10
Glucose $C_6H_{12}O_6$ (g)	18.0	6.0
Water (cm^3)	100	100

The two sets were then placed in a refrigeration unit.

The following information was provided: Ka of ethanoic acid = 1.8×10^{-5} $moldm^{-3}$ and $K_w = 1.0 \times 10^{-14}$ $moldm^{-3}$; Cryoscopic constant (K_f) of water = $1.86^0C\ Kgmol^{-1}$, normal freezing point of pure water = 0^0C. recommended pH range for packed milk products is 6.4-6.8. your chemistry teacher came across the company report and decided to give you an assignment.

(H = 1, C = 12, O = 16, Na – 23).

Task.

As a chemistry learner;

(a) Assess the above raised concerns.

(b) Evaluate the impact of additives used in food processing to human life.

4

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SECTION B.

Part I

Respond to any **one** *item in this part*

3. During a study visit to a cement and waste treatment factory in Tororo District, your chemistry class observed that compounds of calcium and magnesium are widely used in industrial production and environmental management.

The plant engineer explained that calcium oxide (CaO) is commonly used in cement manufacture. Calcium oxide and magnesium oxide are both useful in making industrial wastes harmless before disposal while the other is vital in soils. They were perplexed on seeing action of calcium and magnesium on water.

At the treatment section of the factory, it was observed that calcium oxide plays a vital role in treatment and also in manufacturing. However, the engineer warned that the calcium oxide should not be carelessly handled.

Task.

(a) Analyse the observations made during the study visit.

(b) Assess the impact of the compounds on the environment.

4. Access to safe drinking water remains a major challenge in many communities, especially during flooding seasons when water sources become contaminated with disease-causing microorganisms. In one district, the local health center recorded an increase in cases of cholera and typhoid linked to unsafe drinking water.

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A group of Senior Five learners decided to develop a community water treatment project aimed at supplying safe water to households using halogen-based disinfectants. They visited a chemical supplier who provided information about three Group VII elements that could be considered for the project.

Table 4

Element	Chlorine	Bromine	Iodine
Physical state at room temperature	Greenish yellow gas	Red-brown liquid	Grey-black solid
Boiling point (^{0}C)	-35	59	184
Solubility in water	Highly soluble	Slightly soluble	Slightly soluble
Relative effectiveness against microorganisms	Very high	moderate	moderate

The supplier explained that the final choice should depend on the element's physical properties, effectiveness in killing microorganisms, handling to avoid health related issues, reaction with water, reaction with sodium hydroxide,
The learners however lacked sufficient chemistry knowledge to make an informed decision and approached you for professional guidance.

Task.

Make a presentation you would make to guide the learners in selecting the most suitable halogen for the community water treatment project.

6

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Part II

Respond to any **one** *item in this part.*

5. Propan-1-ol and propan-2-ol are common organic substances used in many industries, laboratories and households. They are important raw materials for a wide range of products. A young entrepreneur together with a group of science learners intends to start a small-scale chemical enterprise that will use one or both of the substances to produce useful products for the local community. The project planner advised them to first understand the physical properties of them so that they can decide the correct storage, handling and choice of process.

In order to add value to their enterprise, they were advised to convert the compound with the highest boiling point of the two organic compounds into 2-hydroxy-2-methylpropane and 2-hydroxy-2-methyl propanoic acid which may be important intermediates.

The group also wanted to follow the pathway of the compound with the highest boiling point amongst the two organic compounds when it is used to form a sweet-smelling organic compound (perfume) and an intermediate compound for manufacturing plastics. However, the products are said to come with hazards. The group therefore seeks guidance from you as a learner with vast chemistry knowledge on how they can handle and transform the substance safely and effectively for their enterprise.

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Task.

Make a write up that you will follow to give the guidance they are seeking.

6. A chemical manufacturing company in Uganda was investigating pure organic liquid X intended for use in the production of disinfectants used in hospitals and food processing industries. Laboratory analysis showed that compound X has molar mass of $72gmol^{-1}$ and combustion analysis established its empirical formula is C_4H_8O.

Further laboratory tests were carried out and it was observed that it gave no observation with sodium metal, bromine water and ammoniacal silver nitrate solution but formed an orange precipitate with 2,4-dinitrophenyl hydrazine as well as reacting with sodium hydrogen sulphite solution. However, the stepwise process of achieving the reactions is a challenge.

Further investigations showed that compound X is an important intermediate in the manufacture of compounds such as ethanol used as a disinfectant and X can be prepared from 1-bromopropane but there was still a challenge of how to carry out the transformation. However, prolonged exposure to the vapour of X has raised concerns from the nearby community.

The management requested chemistry class that had visited the company to help them evaluate the substance and provide scientific explanations.

Task

As a learner who is a member of the chemistry class, make a presentation that you will follow to give the management the guidance they are seeking.

END

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$pH = -\log[H+]$

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$PV = nRT$

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$Ka = \frac{[H^+][A^-]}{[HA]}$

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$\Delta H = \sum H_{(products)} - \sum H_{(reactants)}$

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