

Candidate's Name.....

Signature.....Index number.....

P525/1

CHEMISTRY

Paper 1

JULY/AUGUST 2026

2½ hours

BUGANDA EXAMINATIONS COUNCIL MOCKS

Uganda Advanced Certificate of Education

Chemistry

Paper 1

Theory

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; Part I and Part II. Respond to only one item from each part.

Responses to all the items attempted must be written in the answer booklet(s) provided.

Responses to each item in both sections should start on a fresh page.

All working must be clearly shown. Graph paper will be provided. Mathematical table and silent non-programmable scientific calculators may be used.

Turn Over

Section A

Respond to all items in this section in the spaces provided.

Item 1

Chlorides of Group II elements are widely employed in various fields, such as food preservation, road de-icing, and as desiccants. Their utility in these fields depends on several factors, including the enthalpy change accompanying their dissolution and reactivity of the parent metal atoms. Generally, the more soluble the chloride, the more suitable it is for these applications.

Juma, your cousin who relocated to USA, recently experienced his first winter. Due to the extensive formation of ice, he was advised by a neighbour to use calcium chloride instead of the readily available magnesium chloride for de-icing his surroundings. He followed this advice and it proved to be effective. Juma is now concerned and wants to understand the reasoning behind this preference. Upon researching, he discovered that the data in Table 1 could be useful to explain the choice of chloride and its effectiveness but he does not know how to interpret it. He has contacted you for assistance.

Table 1: Available thermochemical data:

Process	$\Delta H^\theta (\text{kJ mol}^{-1})$
First ionization energy of calcium	+590
Second ionization energy of calcium	+1145
Enthalpy of atomization of calcium	+178
First ionization energy of magnesium	+738
Second ionization energy of magnesium	+1451
Enthalpy of atomization of magnesium	+148
First electron affinity of chlorine	-360
Enthalpy of atomization of chlorine	+122
Enthalpy of formation of calcium chloride	-795.8

Enthalpy of formation of magnesium chloride	-641.6
Enthalpy of hydration of chloride ion	-360
Enthalpy of hydration of calcium ion	-1650
Enthalpy of hydration of magnesium ion	-1923
Lattice energy of calcium chloride	-2258
Lattice energy of magnesium chloride	-2493

Juma also wants to know if adding excess tin dust to the de-icing runoff can remove the dissolved calcium ions. He was advised that the data in Table 2 can be used to determine the feasibility of this recovery process, but he does not know how to proceed. He has approached you further assistance.

Table 2

Process	$E^{\theta}(\text{V})$
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Ca}(\text{s})$	-2.87
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Sn}(\text{s})$	-0.14

Task

As a Chemistry learner:

- Address the concerns of Juma.
- Use the data in Table 2, construct a cell and explain if the proposed recovery process is feasible.
- Explain other applications of the values provided in Table 2 in daily-life.

Item 2

Salts such as nitrates, chlorides, sulphates and phosphates can be used as fertilizers to boost crop production; however, care must be taken to avoid applying them in excess.

Kim Farm Limited specializes in growing of sorghum and cabbages, which thrive in alkaline soils. For many years, the farm manager has been using ammonium nitrate fertilizer to boost productivity.

Recently, however, yields have declined sharply, even with the application of more fertilizer.

The manager is concerned about these developments and suspects the fertilizer is the cause. Upon researching the effects of ammonium nitrate on soil, he found the data in Table 3 from another farmer who had previously experienced a similar issue:

Table 3:

Laboratory analysis of the soil sample for the concentration of hydrogen ions from one of Okwi gardens after repeated use of ammonium nitrate fertilizer:

- K_b of ammonia at $25^\circ\text{C} = 1.85 \times 10^{-5} \text{ mol dm}^{-3}$
26.4 g of the soil sample, to which ammonium nitrate had been applied, was dissolved in 500 cm^3 of distilled water.
- *25.0 cm^3 of the resulting filtrate required 10.0 cm^3 of 0.05 M sodium hydroxide solution for a complete reaction using methyl orange as an indicator.*

In addition, the manager has been advised to occasionally spray gardens containing sorghum with a mixture of ammonium chloride and ammonia to maintain a soil pH of approximately 8.95. The farmer has run out of this mixture and needs guidance on how to prepare it, as he has ready access to both ammonia solution and ammonium chloride at a relatively low cost.

You have been contacted by the farm manager for help.

Task:

As Chemistry learner,

- Use the data provided in Table 3 to help the farm manager justify the observations.
- Explain to the farm manager how the shortage can be overcome locally.

- (c) Explain other real-life applications of the mixtures which behave in a similar way like the mixture of ammonium chloride and ammonia.

Section B

Part I

Respond to only one item in this part in the answer booklet(s) provided.

Item 3

Oxides are widely used in industrial applications due to their unique properties. Recently, a group of Senior Five students visited a newly established factory. The factory utilizes furnaces lined with magnesium oxide and crucibles specially coated with the same material. The students observed no phase changes occurred in the furnace linings or crucible coatings during operations. Consequently, they questioned whether it would be possible to use sodium oxide or phosphorous (V) oxide as alternative for these linings and coatings.

The students also discovered that during the production process, solid waste containing phosphorus oxides and fumes containing sulphur oxides are released into the environment without treatment. The local health and environment team raised concerns regarding the impact of this pollution on the surrounding area. They advised that the solid waste should be treated with calcium oxide, while the waste fumes should be passed through a tower packed with moist calcium oxide, through which air is circulated. The students are wondering about the chemical the chemical basis for these recommendations.

The data in the Table 4 below shows the melting points of selected oxides.

Table 4

Oxide	Na ₂ O	MgO	P ₂ O ₅	SO ₃
Melting point (K)	1548	3150	573	290

Your teacher, who accompanied the students on the study trip, has provided this information and requested your interpretation

Task

As a chemistry learner;

- prepare a report that addresses the concerns raised by the students.
- assess the environmental impact of using the material chosen for the furnace lining and crucible coating.

Item 4

Elements and their compounds are selected for everyday use based on their specific properties. A newly established chemical plant intends to manufacture heat-resistant engine parts and industrial catalysts. Due to the financial constraints and the necessity of utilizing locally available resources, the engineers have opted to use some elements from Period 3 of the Periodic Table.

However, the site engineers have reported several significant challenges. Silicon was the only element successfully chosen for engine parts, whereas sodium and magnesium proved unsuitable. When a sample of a catalyst prepared using aluminium and chlorine was accidentally introduced into the facility's water tank, the pH of the water dropped drastically below 7. Furthermore, when containers holding stored samples of stored sodium, magnesium, and aluminium were accidentally emptied into water troughs used for cleaning, the sodium sample reacted violently, catching fire, and the resulting mixture caused skin burns. The magnesium sample produced only a few bubbles, whereas the aluminium samples demonstrated resistance to water.

When samples of magnesium and aluminium turnings spilled into tanks containing sodium hydroxide used for industrial cleaning, the site engineers were able to only recover magnesium turnings.

Your laboratory technician visited the chemical plant and reviewed this report with the engineering team. The engineer has requested that your laboratory technician provides a comprehensive analysis of these events for an upcoming board presentation to ensure that safety protocols are established.

The following data are available to facilitate a deeper investigation into the current situation at the chemical plant:

The atomic radius and melting points of the elements in Period 3 are:

Element and atomic number	Na(11)	Mg(12)	Al(13)	Si(14)	P(15)	S(16)	Cl(17)
Atomic radius (nm)	0.191	0.160	0.130	0.118	0.110	0.102	0.099
Melting point (°C)	97.8	650	660	1414	44.2	115.2	-101.5

You have met with the laboratory technician and wish to assist him with this task.

Task

As a Chemistry learner;

- Analyse the data and provide a justification for the selection of the element used for the engine parts.
- Account for the accidental occurrences observed in the plant.
- Evaluate the industrial applications of the tested elements and suggest appropriate mitigation measures for their safe handling and use.

Part II

Respond to only one item in this part in the answer booklet(s) provided.

ITEM 5

A pharmaceutical factory in Arua town manufactures herbal products, using organic compounds as solvents to extract organic active ingredients from medicinal plants.

The compounds currently used as solvents are listed in Table 5:

Table 5

Compound	Description	Key data
Compound A	Straight-chain hydrocarbon	6 carbon atoms, molecular mass = 86
Compound B	Hydrocarbon with an aromatic ring	7 carbon atoms, molecular mass = 92
Compound C	Alcohol	2 carbon atoms, molecular mass = 46

Recently, your teacher visited the factory to study these organic solvents. During her visit, she learnt that the factory was facing challenges with certain compounds that were ineffective as solvents. In her interview with the managing director, she was informed that the factory intends to begin producing oximes (a chemical additive for paints) and propane, which can be used in indoor ovens and grain dryers to reduce moisture content in harvests before storage, using Compound C.

Additionally, they intend to convert Compound B into (chloromethyl) benzene (benzyl chloride), a useful chemical intermediate that can be sold to other chemical plants for profit. However, they currently lack the expertise to effect all these conversions to achieve their intended plans and also show the stepwise pathway for the conversion of B to chemical intermediate and final step reaction for forming chemical additive for paints.

The teacher also learnt that the long-term storage of these compounds at the factory could pose a danger to human health and have negative environmental impacts.

The teacher has decided to assign you the task of analyzing her experiences and concerns at the factory. She has informed you that oximes are derivatives of hydroxylamine.

Task

Prepare a report for the teacher addressing the concerns of the factory:

- (a) Select the most suitable organic solvent from the store and provide reasons for your choice.
- (b)
 - (i) Describe how the chemical additive for paints and propane can be obtained. Additionally, suggest a mechanism for the final step for forming the chemical additive for paints.
 - (ii) Explain how the chemical intermediate for sale can be obtained.
- (c) Evaluate the environmental and health impacts of the organic compounds in the store and propose possible mitigation strategies.

ITEM 6

A specialized chemical company focusing on gasoline additives, paint removers, and fragrances is currently evaluating compound Q ($C_4H_{10}O$) as a primary raw material. Compound Q produces effervescence when reacted with sodium metal. In the industrial sector, the physical properties of a precursor are critical for determining storage and processing protocols. Preliminary laboratory assessment reveal that compound Q exists as a set of non-cyclic isomers with varying physical profiles. To streamline distillation, the company specifically requires the isomer with the highest volatility. Observations also indicate that this isomer is miscible with water.

To modernize their production line, the facility has also proposed converting this stockpiled isomer into more commercially viable and environmentally friendly derivatives. One plan involves the production of propanone and 2-phenylpropane, both of which are highly useful industrial solvents; however, management is concerned about the specific synthetic routes and the precise reagents and reaction conditions needed for a high-yield transformation.

A secondary plan involves conversion into an ester, which is less toxic and highly useful in other industries. While the required reagents are known, the newly recruited workers lack a clear understanding of the step-by-step reaction pathways (mechanism) involved. You and your teacher have been invited to provide technical advice to these workers on behalf of the factory management.

Task

As Chemistry learner, prepare a report containing information to assist the workers in the following areas:

- (a) Identify the most suitable isomer, provide reasons for your choice, and justify its observed behaviour in water.
- (b) Explain how to obtain the two useful solvents. Additionally, suggest the mechanisms of the reactions involved in the formation of the suggested ester and the first step in the production of the solvents.
- (c) Evaluate the potential long-term environmental and health hazards associated with the use of compound Q and formulate a strategic mitigation plan for its safe industrial use.

End