P525/1
Chemistry
Paper 1
July/August 2026
2¾ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda advanced certificate of education

CHEMISTRY

(Theory)

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

- This examination paper consists of **two** sections; **A** and **B**. It has **six** 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 2

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 a **table 3** below and analysed.

Table 3

Mass of glucose in 360 g of 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

Part I

Respond to **one** *item from this section.*

Item 3

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 below.

Table 4

Halogen acid	Boiling point (°C)	Bond energy (kJ mol^{-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

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

Compound	Decomposition temperature (°C)	Solubility (mol/100g of water)
$Be(OH)_2$	138	insoluble
$Mg(OH)_2$	330	2.0×10^{-4}
$Ca(OH)_2$	450	1.5×10^{-3}
$Sr(OH)_2$	540	3.4×10^{-3}
$Ba(OH)_2$	780	1.52×10^{-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 Uganda synthesizes a fumigant for citrus fruits and post-harvest grain preservation. The active ingredient in this formulation is **1,2-dibromoethane (EDB)** which is dissolved in **propan-2-ol** as a **co-solvent.**

The industrial chemists at Bukoola explained that **1,2-dibromoethane** is a more effective active ingredient than **1,2-dichloroethane** due to its **volatility.**

During a workshop organized by National Agricultural Research Organisation **(NARO),** farmers were discouraged from using **EDB** due 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:
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 fumigants as guided by NARO.

Item 6

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 antiskining 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 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.

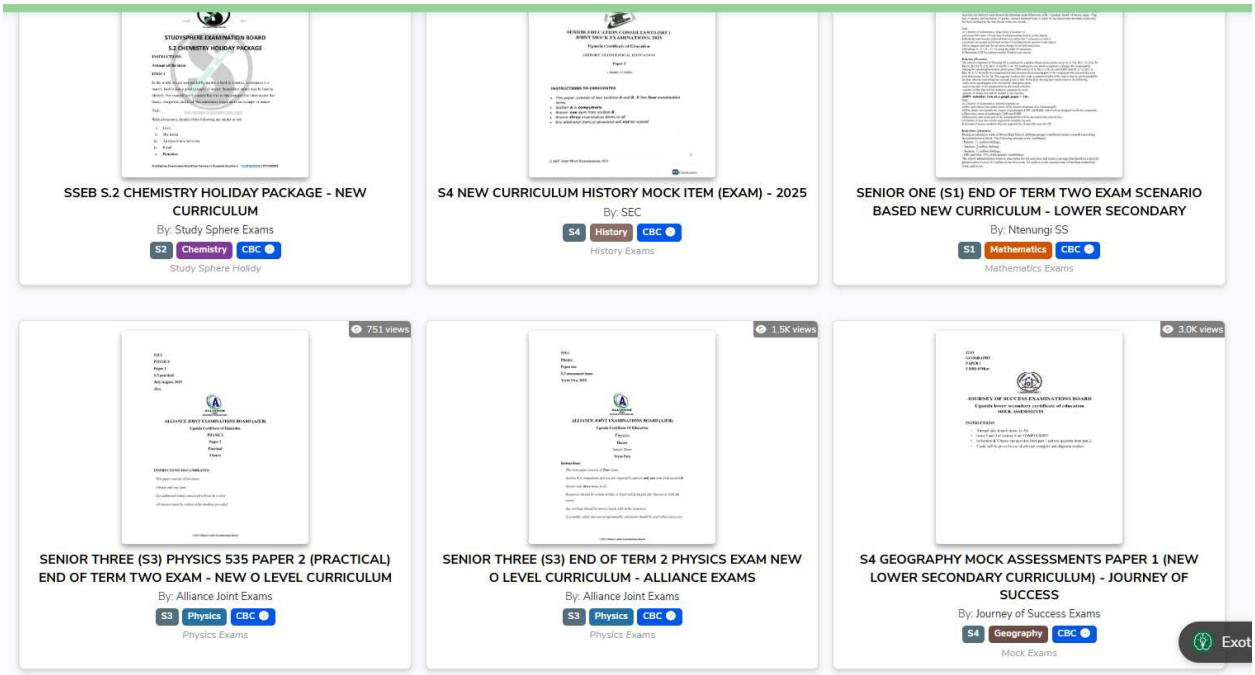
(b) how ethanal can be converted to **phenylethanone** which is a fragrance additive to soaps and lotions and how propanone is **synthesized from ethanol** which is more readily available in the laboratory.

(c) how propanone reacts to form **propanone oxime** that acts as an antiskining 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



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