

Candidate's Name:

Signature:

545/1

CHEM

Paper 1 2026

2 ½ hours



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Uganda Certificate of Education

END OF TERM I EXAMINATIONS

CHEMISTRY

Paper 1

S.6

SCAN ME



INSTRUCTIONS TO STUDENTS:

- The paper consists of **two** Sections; **A** and **B**. It has **SEVEN** examination items.
- Section **A** has **three compulsory** items.
- Section **B** has two **Parts; I and II**. Respond to only **one** item from **each** part.
- Responses to section **B must** be written in the answer booklet(s) provided.
- Respond to **five** items in all.
- Responses to each item in Section **B** should start on a fresh page.
- Any additional item(s) responded to will **not** be scored.

SECTION A (Compulsory)

ITEM ONE

Food processing company in Kampala is developing a new glucose-based beverage. To ensure product stability and shelf life, the quality control team is studying how adding glucose affects the vapour pressure of water at room temperature (27°C). During laboratory analysis, the following data is obtained when different masses of glucose are dissolved in 9.0 g of water:

Mass of glucose in 9.0g of water	0.00	0.45	0.90	1.80	3.60	4.50	7.20
Vapour pressure of solution (mmHg)	31.82	31.66	31.50	31.32	30.55	30.23	29.27

The team suspects that the behaviour follows Raoult's Law and wants to confirm the molecular nature of glucose in solution.

Task

(a)

- (i) Define the term vapour pressure.
- (ii) State Raoult's law of vapour pressure lowering.

(b) Using the data provided:

- (i) Plot a graph of lowering in vapour pressure (ΔP) against the mass of glucose dissolved in 9.0 g of water.
 - (ii) Use your graph to determine the molar mass of glucose.
- (c) Based on your results, explain the effect of water on the molecular state of glucose, giving a reason using the molar mass you obtained.

ITEM TWO

You are a chemistry student working as a junior researcher in a local fruit flavoring laboratory. Your team is studying the efficiency of producing ethyl ethanoate (a sweet-smelling ester used in food flavorings) from the reaction between ethanoic acid and ethanol. To optimize the production process, you need to understand the equilibrium state of this reaction. You set up an experiment by mixing 3.0 g of ethanoic acid and 2.3 g of ethanol in a sealed flask, allowing the mixture to reach equilibrium at 100°C for one hour. To analyze the equilibrium mixture, you stop the reaction by cooling it rapidly in an ice bath. You then add 50cm^3 of 1.0M sodium hydroxide solution to the mixture. Upon titration with 1.0M hydrochloric acid, you find out that 33.3 cm^3 of the acid is required to neutralize the excess sodium hydroxide.

Task:

- Based on your knowledge of reversible reactions and rate of reaction, explain why the cooling process was necessary before performing the titration. How would the results be affected if this step was omitted?
- Calculate the equilibrium constant K_c for the reaction

ITEM THREE

Misearch is a laboratory technician for a local enterprise that extracts medicinal compounds from native plant extracts using water. To obtain pure, concentrated products, you must employ solvent extraction to isolate a target compound, **X**, from the aqueous plant extract.

His supervisor asks him to design the most efficient protocol for the extraction process to maximize the yield of compound **X** while minimizing the amount of organic solvent used, as solvents are expensive and require safe disposal.

Tasks:

- Define the term "**solvent extraction**" as it applied to his work.
- Identify three practical limitations when performing this extraction in the lab.
- During the extraction process an aqueous solution contains 5.0g of **X** in 100 cm^3 of water. The partition coefficient (K_D) of **X** between water and your organic solvent is 0.200. Calculate and compare the mass of **X** extracted using:
 - A single extraction with 50cm^3 of the organic solvent.

(ii) Two successive extractions using 25cm^3 portions of the organic solvent each time.

c) Explain scientifically why it is more efficient to extract compound X using several small portions of organic solvent rather than using one large portion of the same total volume.

SECTION B (PART ONE)
(CHOOSE ONLY ONE ITEM FROM THIS PART)

ITEM 4

A chemical manufacturing company in Kampala is training new laboratory technicians on how to convert simple organic compounds into more useful industrial products. As a trainee, you are required to demonstrate your understanding of organic synthesis pathways used in industry. Your supervisor provides you with the following starting materials and target products:

Propene to Nitrobenzene

Benzene to benzoic Acid

Benzoic acid to Chlorobenzene

Ethyne to Benzaldehyde

Ethene to Phenylethanone

Phenol to Benzoic acid

Benzenesulphonic acid to Methylbenzene

Task

Describe how each of the above conversions can be carried out, clearly outlining the steps, reagents, and conditions involved at each stage of the process.

ITEM 5

Quality control chemist working in an industrial laboratory in Jinja is analyzing an unknown organic compound labeled T. The compound is suspected to be a hydrocarbon used in fuel production. During analysis, the chemist carries out a combustion experiment and obtains

the following results: Complete combustion of T produces 13.2 g of carbon dioxide and 2.7 g of water. When 4.7 g of T is vaporised at standard temperature and pressure (STP), it occupies a volume of $2.7 \times 10^{-3} \text{ m}^3$. The compound burns with a sooty flame. The chemist now needs your help to identify and understand the properties of compound T.

Task

(a) Using the data provided:

- (i) Calculate the empirical formula of compound T.
- (ii) Determine the molecular formula of compound T.

(b) Based on your findings and the observation of the sooty flame, identify compound T.

(c) Explain how compound T reacts with the following substances:

- (i) Bromine
- (ii) Propene
- (iii) Ethanoyl chloride

PART II

Choose one item for this part

ITEM 6

You are a junior process chemist at a bio-ethanol production plant in Uganda. Your team is refining a mixture of methanol and water to produce a specific grade of solvent. To optimize the distillation process and ensure product purity, you must understand how the solution behaves at a standard process temperature of 50°C .

The quality control department has provided you with data regarding the partial vapour pressure of methanol at various concentrations within an ideal solution, as shown in the table below:

Partial Vapour pressure of methanol (mmHg)	40.0	100.0	200.0	260.0	320.0
Mole Fraction of methanol in solution	0.10	0.25	0.50	0.65	0.80

- a) (i) Define the term **ideal solution**
(ii) State Raoult's law of Vapour pressure lowering
- b) On the same axes, plot a graph of;
 - i) Vapour pressure of methanol
 - ii) Total vapour pressure above the solution against mole fraction of methanol.
(the composition of methanol in the vapour is 50% when it's mole fraction in solution is 0.19)
- c) Use your graphs in b) above to determine the;
 - i) Saturated vapour pressure of methanol at 50°C
 - ii) Saturated vapour pressure of water at 50°C
- d) Draw a well-labeled boiling point-composition diagram for the methanol-water system.
How would this diagram help an engineer decide whether to use simple distillation or fractional distillation to separate the two liquids

ITEM 7

You are working as a material science intern for a manufacturing company that specializes in industrial alloys and electrical components. Your supervisor wants you to analyze the physical properties of Period 3 elements to determine which materials are best suited for high-temperature applications versus those suitable for insulators.

You have been provided with the following data on the melting points of Period 3 elements:

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic No.	11	12	13	14	15	16	17	18
Melting point (°C)	97.8	650	660.3	1414	44.2	115.2	-101.5	-189.4

Tasks:

- Plot a graph of melting points against atomic number of the elements.
- Explain the shape of the graph.



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