

P525/1
CHEMISTRY
Paper 1
Aug, 2026
2¼ hours



MATIGO EXAMINATIONS BOARD

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 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.

SECTION A

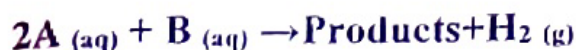
Respond to both items from this section

Item 1

As the demand for clean and sustainable energy continues to grow, a renewable energy company is exploring the production of hydrogen gas for use in hydrogen powered fuel cells. Hydrogen is regarded as a promising source of energy because it generates electricity without release of carbon dioxide making it a potential solution for reducing greenhouse gas emissions.

Before establishing a pilot production facility, the company is assessing the chemical reaction that produces hydrogen gas from the aqueous reactants, A and B. They have been informed that a rate constant less than $0.08 \text{ mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$ and an enthalpy change in the reaction above -300 kJ mol^{-1} which would indicate an efficient production process

The reaction is represented by the equation:



A series of experiments was conducted at 25°C and the following results were obtained.

Table 1: Initial Rate Data.

Experiment	Concentration of A (mol dm^{-3})	Concentration of B (mol dm^{-3})	Initial Rate ($\text{mol dm}^{-3} \text{ s}^{-1}$)
1	2.50×10^{-1}	4.00×10^{-1}	1.50×10^{-3}
2	2.50×10^{-1}	8.00×10^{-1}	3.00×10^{-3}
3	5.00×10^{-1}	4.00×10^{-1}	6.00×10^{-3}

Table 2: Thermochemical Data.

Species	ΔH_f° (kJ mol^{-1})
A _(aq)	-95.0
B _(aq)	-105.0
Products	-650.0
H ₂ (g)	0.00

The company also wants to investigate the conditions that affect the rate of hydrogen production. The company intends to establish production units in remote communities where efficiency, safety, and sustainability are critical

Task

- Analyse the data provided and use it to comment on whether the reaction can actually be used for electricity generation and help the company assess the efficiency of the production process.
- Explain the factors that may affect the production rate of the fuel.
- Analyse the importance of the principles in the experiments conducted in real life.

Item 2.

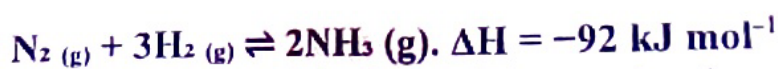
The knowledge of steam distillation is employed in pharmaceutical and medicinal formulations.

A chemical company wants to extract a compound to be applied in drug formulation using steam distillation. During the process of extraction, a distillate containing water and organic compound Z was obtained. On analysing the components of the distillate at various temperatures, the following data was obtained.

Temperature(°C)	20.0	40.0	60.0	80.0	100.0
Vapour pressure of water (atm)	0.22	0.26	0.30	0.35	0.39
Vapour pressure of Z (atm)	0.35	0.42	0.49	0.56	0.63

At a temperature of 97°C, the distillate contained 4.2g of substance Z and 1.1g of water.

The company also operates an ammonia synthesis plant based on the Haber process. In one production trial, a 4.0 dm³ reaction vessel was charged with 2.5 moles of nitrogen gas and 7.5 moles of hydrogen gas. At equilibrium, 1.6 moles of ammonia had been formed.



The chemical engineers are interested in determining molecular mass of the organic compound and evaluating the conditions used in the ammonia synthesis plant.

The company has been advised that best organic compound should have molecular mass above 32g and a K_c value greater than 0.15 mol⁻²dm⁶ in ammonia synthesis would represent optimal production efficiency at the company.

$$0.041 = \frac{(1.6)^2}{(2.5-x)(7.5-x)^3}$$

$$= \frac{(1.6)^2}{(0.4)(1.6)^3}$$

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

$$K_D = \frac{[\text{Z}]_{\text{H}_2\text{O}}}{[\text{Z}]}$$

$$2.5-x + 7.5-x = 1.5$$

$$x = 0.16$$

Tasks

- Analyse the data provided and use it to comment on the efficiency of the company.
- Explain the ways the company would use to increase the amount of ammonia produced during the trial production.
- Explain other real-life applications of the principles used in the company.

SECTION B

Part I

Respond to any one item from this part

Item 3

Chlorides of different elements are used in industries such as food, agricultural and fiber optics, where their properties affect heating, safety, and environmental pollution. Farmers near a certain factory reported crop damage and faster corrosion of iron sheets, while workers and engineers raised concerns about irritating chlorine fumes and the high temperatures required to process some chloride materials.

With increased complaints from the neighbourhood, the district environmental officer has organised a joint industrial inspection involving agricultural officers, industrial chemists and Senior Five chemistry learners from neighbouring schools and communities.

Samples of several chlorides formed by Period 3 elements were collected from different industrial processes and analysed in the district analytical laboratory. The table below shows the results as obtained from the analysis.

Chloride	NaCl	MgCl ₂	AlCl ₃	SiCl ₄
Melting point(°C)	801	714	180	-69

During the inspection, the learners observed that some chlorides reacted vigorously with water and others contributed to acidic soils.

The district committee later requested the learners to prepare a scientific report that could help industries improve safety, reduce pollution, and select suitable chloride materials for industrial use.

Task:

As one of the senior five learners of chemistry:

- Explain the trend in the melting points of the chlorides of the elements in period 3.
- Analyse and explain the observed reactions of the chlorides during inspection.
- Assess the environmental, health, or industrial implications associated with the production and use of the chlorides investigated, and recommend suitable safety measures.

Item 4.

Halogens are important in synthesis of organic compounds

A chemical industry is planning to produce more halogens from group VII hydrides in their standard states by reacting them with concentrated sulphuric acid in presence manganese (IV) oxide. The manager of the industry has consulted the chemical engineer who has availed him with the data below that can be used to know how the best halogen can be selected after the production process.

Data 1

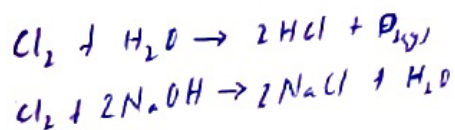
Element	Fluorine	Chlorine	Bromine	Iodine
Electronegativity	4.10	2.83	2.71	2.21

The manager would like to know why the halogens have different electronegativity, how fluorine and chlorine react with water and sodium hydroxide solution. He is also concerned about the uses and health impact of the halogens produced. The manager is seeking for assistance and has contacted your teacher who has selected you to help the manager

Task:

As one of the senior five learners of chemistry:

- Explain the trend in electronegativity of group 17 elements.
- Explain the reactions of fluorine and chlorine with water and sodium hydroxide solution.
- Assess the environmental, health, or industrial implications associated with the production and use of the halogens investigated, and recommend suitable safety measures.



SECTION B Part II

Respond to any one item from this part

Item 5

Knowledge of organic chemistry is important in manufacture of important products.
A manager of a certain industry is planning to produce phenyl ethene and a dye to be used in manufacture of polyethene and clothes respectively.

During a planning meeting, a board member proposed the use of ethanal and benzene as raw materials in the production of respective products, however some members don't know how the raw materials will be treated in order to yield the desired products.

Another member became concerned about the impacts of the proposed raw materials in case they become excess during the production process and he was assured of reacting these excess raw materials respectively with hydroxy amine and fuming sulphuric acid in a mitigation measure but he lacks knowledge on how the reactions go on. This has prompted the manager to seek for some information before heading for the second planning meeting.

The manager has requested your chemistry teacher through the head teacher for help. The teacher has selected you and you have been tasked to;

Tasks

- Make the manager be aware of the property that make the products he is intending to produce be applied for the intended purpose.
- Help the manager solve their challenges about the reactions and formation of the intended products.
- Analyse the application of one of the compounds selected for producing the specified product, it's associated dangers and their mitigations .