P525/1
CHEMISTRY
Paper 1
April/May 2026
2¼ Hours

# KABALE DIOCESAN MOCK EXAMINATIONS

## UGANDA ADVANCED CERTIFICATE OF EDUCATION

### CHEMISTRY THEORY
**Paper 1**

### INSTRUCTIONS TO CANDIDATES

This paper consists of 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 for each part.

Responses to section A and section B must be written in the booklet(s) provided.

Respond to four items in all.

Where necessary, use the following;

Molar volume of gas st.p is 22.4 $dm^3$.

Standard temperature = 273k

Standard pressure = 101325$Nm^{-2}$.

| FOR EXAMINERS' USE ONLY | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | 1 | | | | | 2 | | | | | | $^3/_4$ | | | $^5/_6$ | | | | Total |
| Code | $F_1$ | $C_2$ | $D_1$ | $C_3$ | $D_2$ | $E_c$ | $C_4$ | $C_5$ | $E_1$ | $P$ | $D_3$ | $G_r$ | $T_r$ | $P_r$ | $D_4$ | $S_e$ | $M_C$ | $D_4$ | |
| Score | | | | | | | | | | | | | | | | | | | |

## SECTION A

***Respond to all the items in this section.***

### 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. To properly assess its commercial value in the manufacture of high energy fuel that could be used in rocket fuels, a sample of the mineral was collected and mass spectrometry recommended to be used during the analysis of the sample.

During the analysis, the analyzed sample was found to contain 20% Boron-10, 50% Boron-11, 15% Boron-12, and 15% Boron-13. The university team was briefed that these readings can help determine an accurate relative atomic mass (RAM) of Boron. Furthermore, it was also discovered that the hydride of Boron, diborane ($B_2H_6$), which is 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.

$$B_2H_6\,(g) + 3O_2\,(g) \longrightarrow B_2O_3\,(s) + 3H_2O\,(l)$$

The only challenge is that the hydride burns producing Boron oxide that clogs engines, is highly toxic and difficult to store, in addition to reacting with water and acids. It was also discovered that the standard enthalpy of combustion of Diborane is $+36KJmol^{-1}$, that of Boron oxide is $-1273KJmol^{-1}$, while that of water is $-286KJmol^{-1}$.

In the same project, the team wants to use diborane as a boron source for doping silicon wafers, in which 13.7g of diborane was heated until complete decomposition according to the equation;

$$B_2H_6\,(g) \longrightarrow 2B\,(s) + 3H_2\,(l)$$

However to ensure the safety and efficient rate of decomposition was studied at constant temperature and the experimental data obtained is as shown below.

| Experiment | $[B_2H_6]$ $(moldm^{-3})$ | Initial rate $(moldm^{-3}\ s^{-1})$ |
|---|---|---|
| 1 | 0.10 | $2.0 \times 10^{-3}$ |
| 2 | 0.20 | $4.0 \times 10^{-3}$ |
| 3 | 0.30 | $6.0 \times 10^{-3}$ |

You have been contacted to help the team in describing the process of obtaining the relative atomic mass of Boron, and explaining why it's not a whole number. The team is also inquisitive to know about the enthalpy of the reaction involving combustion of diborane, how much boron can be produced during thermal decomposition of Diborone, and also determining the rate constant for thermal decomposition of Diborone.

**Task;**

As a chemistry learner;

a) Prepare a write up you would use to help this team of university upon invitation.
b) Explain why the rate of decomposition of Dibrone 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

A 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. They prepare several sodium chloride solutions of varying concentrations and measure their freezing points. Sample data from their experiments is as shown below so as to determine the freezing point of pure solvent X.

| Concentration ($molkg^{-1}$) | 0.50 | 1.00 | 1.50 | 2.00 | 3.00 |
|---|---|---|---|---|---|
| Freezing point ($^0c$) | -1.90 | -3.65 | -5.40 | -7.10 | -10.20 |

In another department of the same company, a team is formulating a new medicine containing calcium hydroxide as an anti-acid and calcium supplement.

However, the formulation team has encountered challenges such as calcium hydroxide not dissolving sufficiently in water, inconsistent dosing and visible sedimentation in the bottles. This consequently has delayed regularly approval and risked the entire project. The product development team in the laboratory has determined that the solubility product, KsP, of calcium hydroxide at $25^0c$ is $5.5 \times 10^{-6}$ $mol^2dm^{-6}$ using chemistry data books.

The management urgently needs a scientific explanation of why calcium hydroxide is sparingly soluble, and how its solubility can be manipulated. They think that knowing the PH of its saturated solution will help in manipulating the solubility, formulation, and boarder insights into how the solubility product concept can be applied to solve challenges in the medicinal product development they may encounter later on in their work.

The head of formulation has invited your chemistry class to analyse the situation and submit expert recommendations before the critical formulation meeting scheduled for next week.

**Task;**

As a chemistry learner,

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

## SECTION B

### Part I

***Respond to only one item from this part***

### ITEM THREE

A chemical manufacturing company in Jinja is establishing a new facility to produce ionic compounds used in refractory lining in furnaces, anti-acids, flame retardant, cement and mortar production, medicinal X-ray imaging as well as fireworks among others. During pilot testing, engineers encountered several challenges as follows;

1. The reactivity of different metals with water varies significantly, posing safely and handling challenges.
2. The melting points of these elements exhibit differences, leading different suitability for different applications.
3. Beryllium displays a typical chemical behavior compared to other group 2 elements, instead showing similarities to Aluminium in certain aspects.
4. A beryllium chloride compound (Q) synthesized in the laboratory, containing 11.25% beryllium, has an unknown molecular and structural properties that require characterization for safe industrial application. The molecular mass of Q is 160.
5. A radium -226 source used in an industrial gauge in this factory to monitor pipe thickness had an initial count rate of 1200 counts per minute, and yet its half-life is 1600 years.

The management requires an investigation into these issues, an explanation of the underlying chemical principles and recommendations for solutions to ensure safe and efficient production and handling.

**Task.**

As a chemistry learner;

a) Prepare a scientific report addressing the following;
   (i) The trend in the reactivity of group 2 elements in water.
   (ii) The variations in the melting points of these elements
   (iii) Anomalous behavior of Beryllium.
   (iv) The structural formula of compound Q.

b) Help the engineers to determine the count rates of radium -226 that remain 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 Disulphur dichloride.

To assess the environmental impact of these substances, the chemists add water to samples of each chloride under controlled laboratory conditions to observe their chemical behavior.

**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 from this section**

**ITEM FIVE**

An environmental agency is investigating air pollution near an industrial zone suspected of a hydrocarbon release and open combustion. A 20.0cm$^3$ sample of hydrocarbon Z was reacted with 200.0cm$^3$ of oxygen. After cooling to room temperature, the total gas volume was 160.0cm$^3$, and passing residual gases through aqueous sodium hydroxide reduced the volume to 20.0cm$^3$.

Hydrocarbon Z burns with a sooty flame. When treated with hot alkaline potassium manganate(VII), and then acidified with dilute hydrochloric acid, it produces compound T, which reacts with magnesium to liberate hydrogen.

The agency seeks to understand 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. The agency would also wish to convert Z into more valuable product such as Nitrobenzene to manufacture explosives and Dyes.

You have been contacted to provide guidance.

**Task;**

As a chemistry learner; prepare a presentation you will use upon invitation.

**ITEM SIX**

A hospital and research centre in Kigezi region is investigating a newly isolated organic compound Y for potential industrial applications. During laboratory quality control, it was found out that when 1.50g of Y is burnt completely in dry oxygen, 2.870g of carbondioxide and 1.761g of water were formed. When vaporized, 0.1g of Y occupied $78.8cm^3$ at $157^0c$ and a pressure of 740mmHg. The hospitals chemistry team is interested in understanding Y chemical properties and potential transformations to ensure safe handling, formulation, mechanism for the reactions involved in some transformations especially during large scale applications.

To achieve this, the team plans to;

1. Determine the molecular formula of Y from this available data.
2. Identify all possible structural isomers of Y and their IUPAC names, and hence determine which isomer can undergo chemical transformations to produce an alkene Z.
3. Study the reaction of the identified isomer with sulphuric acid Y to form an alkene Z, and also how alkene Z reacts with acidified water; including the mechanisms to understand their reactivity.
4. Develop feasible pathways to covert the isomer into ethane for further pharmaceutical applications.

**Task;**

As a chemistry learner, address the plans for the hospital team and propose suitable solutions.

# THE PERIODIC TABLE

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 H 1 | | | | | | | | | | | | | | | | 1.0 H 1 | 4.0 He 2 |
| 6.9 Li 3 | 9.0 Be 4 | | | | | | | | | | | 10.8 B 5 | 12.0 C 6 | 14.0 N 7 | 16.0 O 8 | 19.0 F 9 | 20.2 Ne 10 |
| 23.0 Na 11 | 24.3 Mg 12 | | | | | | | | | | | 27.0 Al 13 | 28.1 Si 14 | 31.0 P 15 | 32.1 S 16 | 35.4 Cl 17 | 40.0 Ar 18 |
| 39.1 K 19 | 40.1 Ca 20 | 45.0 Sc 21 | 47.9 Ti 22 | 50.9 V 23 | 52.0 Cr 24 | 54.9 Mn 25 | 55.8 Fe 26 | 58.9 Co 27 | 58.7 Ni 28 | 63.5 Cu 29 | 65.7 Zn 30 | 69.7 Ga 31 | 72.6 Ge 32 | 74.9 As 33 | 79.0 Se 34 | 79.9 Br 35 | 83.8 Kr 36 |
| 85.5 Rb 37 | 87.6 Sr 38 | 88.9 Y 39 | 91.2 Zr 40 | 92.9 Nb 41 | 95.9 Mo 42 | 98.9 Tc 43 | 101 Ru 44 | 103 Rh 45 | 106 Pd 46 | 108 Ag 47 | 112 Cd 48 | 115 In 49 | 119 Sn 50 | 122 Sb 51 | 128 Te 52 | 127 I 53 | 131 Xe 54 |
| 133 Cs 55 | 137 Ba 56 | 139 La 57 | 178 Hf 72 | 181 Ta 73 | 184 W 74 | 186 Re 75 | 190 Os 76 | 192 Ir 77 | 195 Pt 78 | 197 Au 79 | 201 Hg 80 | 204 Tl 81 | 207 Pb 82 | 209 Bi 83 | 209 Po 84 | 210 At 85 | 222 Rn 86 |
| 223 Fr 87 | 226 Ra 88 | 227 Ac 89 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 139 La 57 | 140 Ce 58 | 141 Pr 59 | 144 Nd 60 | 147 Pm 61 | 150 Sm 62 | 152 Eu 63 | 157 Gd 64 | 159 Tb 65 | 162 Dy 66 | 165 Ho 67 | 167 Er 68 | 169 Tm 69 | 173 Yb 70 | 175 Lu 71 |
| | | 227 Ac 89 | 232 Th 90 | 231 Pa 91 | 238 U 92 | 237 Np 93 | 244 Pu 94 | 243 Am 95 | 247 Cm 96 | 247 Bk 97 | 251 Cf 98 | 254 Es 99 | 257 Fm 100 | 256 Md 101 | 254 No 102 | 260 Lw 103 |

*End*