COMPILED UACE CHEMISTRY PAPER 1 MOCK EXAMINATIONS 2026

A compilation of Uganda Advanced Certificate of Education Chemistry Paper 1 mock examination papers from multiple examination boards, 2026.

Compiled document — contents transcribed from the original scanned papers.

Contents

1. Uganda Muslim Teachers' Association (UMTA)

UMTA Joint Mock Examinations – 2026

Uganda Advanced Certificate of Education — Chemistry — Paper 1

July – August 2026 Duration: 2 Hours 45 Minutes Code: P525/1

Instructions to Candidates

This paper consists of two sections A and B. Section A has two compulsory items. Section B has two parts, I and II; respond to only one item from each part. All responses should be written on the answer sheet(s) pr ovided. Illustrate your responses with well-balanced equations where applicable.

Constants: Molar gas constant R = 8.31 $JK^{-1}mol^{-1}$; Molar volume of a gas at s.t.p = 22.4 litres; Standard te mperature = 273 K; Standard pressure = 101325 Nm^{-2}; Faraday's constant = 96500 C.

SECTION A — Respond to all items in this section

Item 1

Portable electrochemical power units and oxidising disinfectants are essential in rural health centres for ster ilising reusable medical instruments and providing emergency electrical power during immunisation outreac hes.

To improve these services, the research team of a secondary school in Mityana developed a portable acidifie d dichromate(VI) based disinfectant for sterilisation and a power unit constructed using the dichromate(VI) /chromium(III) and chlorine/chloride half-cell.

During field trials, health workers observed that disinfectant stored in the outreach box during hot afternoon s became ineffective much sooner than samples kept in a refrigerator at the health centre. They also found t hat a change in the energy associated with dissolving gaseous ions changes electrode potential value at ea ch electrode, affecting the operation of the steriliser. Their supervisor provided the required electrochemical data while the students monitored the concentration of dichromate(VI) ions remaining in the disinfectant an d obtained the following data.

Time (minutes)	0	10	20	30	40	50	60
Conc. (mol dm^{-3}) of $Cr_2O_7^{2-}$	2.500	1.581	1.090	0.631	0.420	0.250	0.160

Electrochemical data:

Half-cell reaction	E° (V)
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	+1.53
$Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$	+1.36

The project being developed was not understood by the health workers and they sought help from the resea rch team, who selected you to help in: analysing and interpreting the concentration data on a suitable conce ntration-logarithm graph to estimate the storage efficacy by determining the half-life, considering a half-life

of at least 10 minutes as making the disinfectant more efficient; interpreting disinfectant behaviour during tr ials; constructing the cell representation to evaluate the free energy change; and justifying optimal storage a nd electrode choices.

Task: As the selected project team member, make a write-up of the presentation to the health workers to make them understand and use the project being developed by the research team.

Item 2

Thermal extraction using steam and pH regulating mixtures are commonly used in manufacturing industries to preserve product quality during processing and storage. Chemical engineers collaborated with an essenti al oils factory in Gulu to improve eucalyptus oil extraction for antiseptic formulations. During production, the team observed that increasing the heating temperature reduced both the yield and aroma of the oil, while flu ctuations in the acidity of the blending tank caused variations in the quality and shelf life of the final antisep tic product. The factory proposed steam extraction of the oil, Q, in eucalyptus, and introducing a suitable bu ffer solution of Q during blending. The students collected the following data for steam extraction of a mixtur e containing 3.43% of Q at 101.3 kPa:

Temperature (°C)	70	80	90	100	110
Vapour pressure of Q (k Pa)	1.4	2.4	3.9	6.1	9.2
Vapour pressure of wat er (kPa)	19.0	47.0	72.0	104.0	132.0

In the laboratory, the team weighed 0.56 g sample of Q, known to contain carbon, hydrogen and nitrogen o nly, and subjected it to complete combustion, where 1.591 g of carbon dioxide and 0.379 g of water were co llected and measured, while a significant amount of soot was also observed.

On further analysis they added 35.0 cm^3 of 0.10M hydrochloric acid to 45.0 cm^3 of 0.10M solution of Q to p repare the blending solution. During one production run, a little sodium hydroxide accidentally poured into th e mixture before packaging worried the workers; however, the laboratory technician guided that this should not worry them as the solution's pH will not be affected, and informed them that the dissociation constant o f Q was 4.2×10^{-10} mol dm^{-3}.

Before approving the new production system, the factory management requested the engineers, who lack s ufficient theoretical principles, to: justify the change in oil quality by predicting the outcome if direct heating or no buffer is used; analyse the steam distillation data on a suitable graph and use the data to deduce the structural formula of Q and the pH of the blending solution; justify the laboratory technician's guidance on t he stability of pH after accidental addition of sodium hydroxide; and understand the applications of the syst em in the factory.

Task: Your brother, the main chemist in the company, is very busy and has asked you, a senior chemistry student, to write a detailed report to guide the engineers. Write the report.

SECTION B — Part I (Respond to any one item from this part)

Item 3

Certain chemical elements play a vital role as raw materials in the production of substances that enhance h ygiene and sanitation in everyday life. A group of Senior Three students at a secondary school in Mbarara is participating in an innovation project to produce disinfectants and surface-cleaning agents using organic su bstances as solvents, for use within the school and for sale to the surrounding community. The best disinfe

ctant or surface-cleaning agent is one with the most oxidising ingredient. To help them select a suitable acti ve ingredient, the laboratory technician provided information about three elements and the data shown belo w.

Element	Fluorine	Chlorine	Iodine
Action with water	Reacts vigorously	Reacts slowly	Slightly soluble
Boiling point (°C)	-188	-35	189
Standard electrode potential (V)	+2.87	+1.36	+0.54

The technician hinted that a suitable choice might emerge only after carefully weighing the given informatio n against less obvious considerations such as environmental consequences and the differing ways each su bstance interacts with water and aqueous sodium hydroxide.

Task: Help the learners address their challenge.

Item 4

The relevance of some metals as raw materials for making different laboratory tools depends on their ability to withstand and respond to varying thermal conditions, their densities, and how their chemical properties i nfluence performance under practical laboratory conditions. An engineer at a metal fabrication company is helping two teams of senior five students at a secondary school in Iganga to select metals for laboratory eq uipment. One team studied selected transition metals for heating apparatus, while another examined some Group 2 elements for lightweight fittings recoverable with alkalis and analysed the action of the selected alk aline earth metals on water.

Group 2 element	Be	Mg	Ca	Ba
Atomic number	4	12	20	56
Density (g/cm^3)	1.85	1.74	1.55	3.54

Metal	Sc	Ti	V	Cr	Mn	Co	Ni	Cu
Melting point (°C)	1541	1668	1907	1907	1247	1495	1455	1085
Atomic number	21	22	23	24	25	26	27	28

Task: As the class coordinator of Senior six chemistry class, write a report that the engineer will use to g uide the senior five class, clearly highlighting all the issues and evaluation of any environmental impacts arising from the process.

Part II (Respond to any one item from this part)

Item 5

The production of pharmaceuticals, disinfectants and other industrial chemicals relies heavily on aromatic c ompounds because they serve as versatile intermediates in the synthesis of a wide range of valuable produc ts. A pharmaceutical manufacturing company in Kampala is expanding its production line to dyes, pharmac eutical intermediates and household cleaning products. During planning, research chemists recommended u sing benzene as the starting material for preparing an intermediate compound X through nitration, which w

ould undergo further transformations to produce a target pharmaceutical intermediate. The company's envi ronmental management team warned that compound X is considerably more toxic than benzene, and any e xcess should be chemically converted back into benzene before storage or disposal. The research team also established that benzene could be converted into another aromatic compound Z by chlorination, which can react with an alkyl halide in the presence of a halogen carrier to produce an intermediate required for the ma nufacture of biodegradable household detergents.

Task: As the senior chemistry student attached to the project, prepare a technical report that explains, us ing reaction schemes with arrows, how compounds X and Z are synthesised from benzene, how excess co mpound X can be converted back into benzene, how Z can be converted to the intermediate for manufact ure of the biodegradable household detergent, the applications of the compounds formed, and the enviro nmental hazards associated with the various processes.

Item 6

A medium-sized specialty chemical company in Jinja plans to diversify its operations by manufacturing poly mer-processing additives and industrial coating modifiers for use in the plastics and surface-engineering ind ustries. The research and development team identified propanone hydrazone as a key raw material for the s ynthesis of polymer stabilising additives, while cyclohexene was selected as an important raw material for p roducing coating-performance modifiers. Propanone and cyclohexanol were selected as the immediate chea per precursor compounds required for the respective production pathways. Since ethanol is readily available from local bioethanol producers, it was chosen as the principal feedstock from which both intermediates wo uld first be synthesised before conversion into the desired products.

Task: As a Senior Chemistry student, prepare a concise technical write-up that addresses the company's concerns: determine the suitability of the selected raw materials, critically assess the methods for conve rting ethanol into the required intermediates, and, using arrows, analyse the subsequent transformations leading to the target intermediates for industrial production.

2. Lugazi Diocese Mock Examinations Board (LUDISSEB)

Uganda Advanced Certificate of Education — Chemistry — Paper 1

Duration: 2¾ Hours Code: P525/1 (@LUDISSEB2026)

Instructions

This paper consists of TWO Sections A and B. Section A has TWO Compulsory Items. Section B has two par ts, I and II. Respond to only ONE Item from each part. Respond to FOUR Items in all. Begin each question on a fresh page.

SECTION A — Attempt all Items

Item 1

Volatile radioactive Iodine species can pose biological and environmental hazards. The S.5 Chemistry class carried out research on the factors affecting the rate of Iodine production for the reaction:

$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow 2H_2O(l) + I_2(aq)$

They measured the rate of reaction by the time taken for the Iodine produced to react with a small fixed am ount of Sodium thiosulphate added to the constant volume system and obtained the following data.

Experiment	$[I^-]$ (mol dm^{-3})	Time (s)
1	0.004	74.0
2	0.006	49.4
3	0.008	37.0
4	0.010	30.0
5	0.012	25.0

The students are interested in the order of reaction with respect to I^- ions, factors affecting the rate of reacti on, and feasibility of the reaction. Additional data:

Half-cell reaction	E° (V)
$H_2O_2(aq) + 2H^+(aq) + 2e \rightarrow 2H_2O(l)$	+1.77
$I_2(aq) + 2e \rightarrow 2I^-(aq)$	+0.54

Task: As a student of Chemistry, analyse and interpret the data provided to address the learners' concern s. (Assuming the reaction is first order with respect to H_2O_2 and also first order with respect to I^-)

Item 2

Equilibrium reactions are widely employed in optimization of industrial processes. In a bid to improve agricul tural yield, a new factory has been constructed in Uganda to produce fertilizer. However, locals have complai ned about the fumes released by the factory. It was discovered that the fumes were of gas Z, which contain s 50.05% Sulphur and the rest Oxygen. Gas Z burns in oxygen to form gas W according to the equation:

$2Z(g) + O2(g) \rightleftharpoons 2W(g) \quad \Delta H = -190\ kJ\ mol^{-1}$

The process was carried out in the presence of Vanadium pentoxide at about 700 K and at a pressure of 12 0 kPa. Under these conditions, the partial pressures of Z and W at equilibrium are 33 kPa and 39 kPa respec tively.

Task: As a student of Chemistry, analyse and interpret the data provided to address the production mana ger's concerns about the molecular formula of Z, factors that can increase the equilibrium yield of W, and the value of equilibrium constant Kp, and analyse the application of the process.

SECTION B — Part I (Attempt only one item)

Item 3

Knowledge of the chemistry of group (II) elements is employed in the medical profession. A group of S.5 Che mistry students, after a tour visit to a pharmaceutical industry, noticed that most medicines contain at least one group (II) element. The tour guide told them periodic properties affect reactivity, and that during manuf acture they incorporate reactions of elements with water, alkalis and dilute acids.

Element	Be	Mg	Ca	Sr	Ba
Atomic Radius (nm)	0.112	0.160	0.197	0.215	0.222
Ionisation Energy (kJ/m ol)	890	738	590	550	503

Task: As a learner of Chemistry, analyse and interpret the data to address the issues of the S.5 Chemistr y Class — how periodic properties affect reactivity, reactions of elements, and any health implications.

Item 4

Access to safe and clean drinking water is important in human life. A chemical plant is exploring the use of o ne of group 17 elements for water treatment. An industrial chemist has advised that knowledge of the react ivity of the elements and their reactions with water and alkalis should be considered and provided the follow ing data:

Element	F	Cl	Br	I
Atomic radius (nm)	0.072	0.099	0.114	0.133

Task: As a chemistry learner, your teacher has requested you to analyse and interpret the data for the co mpany — reactivity, reactions with water and alkalis, and associated health implications.

Part II (Attempt only one item)

Item 5

Use of perfumed deodorants is becoming of high demand in Uganda. A manufacturing company has decide d to enter into business. The company chemist has advised that a perfume, methyl ethanoate, can be obtai ned from chloroethane. In a parallel chain synthetic route, ethene can be used as a starting material for pre paration of propanoic acid. In a mitigation side chain reaction, the chemist recommended reacting the unrea cted chloroethane with benzene and unreacted ethene with bromine in organic solvent.

Task: As a learner of chemistry, analyse and interpret the data to address the company's concerns about suitability of products, synthetic pathways, mitigation reactions for unreacted raw materials, and the ass

ociated environmental impact.

Item 6

Use of polymers and solvents for grease is becoming of high demand in Uganda. A manufacturing company uses propene to manufacture polythene and propanol to prepare a solvent for grease. In a parallel chain rea ction as a mitigation measure, the company reacts propene with bromine water and propanol with concentr ated sulphuric acid at 180°C.

Task: As a student with knowledge of Chemistry, prepare a write-up to help the technical team of the com pany on suitability of raw materials, synthetic pathways, mitigation reactions, and an evaluation of envir onmental impacts of the application of its products.

3. Provincial Examinations Agency (PEA) — COUHEIA Mock Examinations

Uganda Advanced Certificate of Education — Chemistry — Paper 1 (Theory)

July/Aug 2026 Duration: 2 Hours 45 minutes Code: P525/1

This examination paper consists of two Sections A and B, with six examination items. Section A has two compulsory items. Section B has two parts, I and II; respond to only one item from each. Respond to four items in all.

SECTION A (Compulsory)

Item 1

A manufacturing company specializing in construction materials uses thermal stability as a key factor when choosing raw materials. An industrial chemist advised that aluminium oxide, Al2O3, could be a suitable raw material despite the fact that it is amphoteric and reacts with both acids and bases. An environmental chemist, after noticing a high level of concentration of aluminium ions in water discharged by the company, advised that before discharge, aluminium metal could be recovered from solution using metal Q, and provided the following data.

Thermochemical data: standard enthalpy of formation of Al2O3 = −1675 kJ/mol; standard enthalpy of atomization of Al = +330 kJ/mol; 1st, 2nd, 3rd ionization energies of Al = +577, +1817, +2745 kJ/mol; standard enthalpy of atomization of O = +249 kJ/mol; 1st electron affinity of O = −141 kJ/mol; 2nd electron affinity of O = +798 kJ/mol.

Electrochemical data: Al3+(aq)/Al(s) Eo = −1.66 V; Q2+(aq)/Q(s) Eo = −0.76 V.

Task: a) Analyse the observations made using the data provided. b) Assess how the use of metal Q can optimize the recovery of aluminium ions from the solution and make recommendations, if any.

Item 2

Chemical industries producing dyes and pharmaceuticals rely on solvents like naphthalene and precise knowledge of molecular characteristics of additives and impurities. The local water supply shows signs of contamination, with an unknown weak acid solute T affecting the freezing point of water in storage tanks. Data on solute T:

Concentration of T (g/dm³)	0	30	60	90	120	150
Freezing point (°C)	0	-0.16	-0.32	-0.49	-0.65	-0.81

Cryoscopic constant for water = 1.86 °C kg mol^{-1}. T is a weak monobasic acid HT. To make a disinfectant solution for equipment cleaning, the technician must prepare a sample solution whose pH change should be less than 5.0, because bacteria don't thrive well in that range. The technician mixes sodium hydroxide with the purified acid HT to form its salt NaT, but is confused why the solution does not appear neutral.

Technical Data: Ka for HT = 1.8×10^{-5} mol dm^{-3}; Kw = 1.0×10^{-14} mol^2 dm^{-6} at 25°C. Batch 1: 50 cm^3 of 0.05 M HT with 50 cm^3 of 0.02M NaOH. Batch 2: 50 cm^3 of 0.02M HT with 20 cm^3 of 0.05M NaOH.

Task: a) Assess the company's concerns on solute T used. b) Evaluate the technician's disinfectant batches and comment on their effectiveness and safety uses.

SECTION B Part I (Respond to any one item)

Item 3

An aerospace construction company is in the process of selection of materials based on their durability once put into use. A class of senior five students are exploring the materials that make aeroplane body and engines. The materials needed are aluminium and iron; selection depends on structural properties, interaction with environmental conditions, and health/environmental side effects. The engine propellers made of iron can be coated with magnesium but not the engine blocks, while the aeroplane body can be constructed with beryllium instead of aluminium due to similar properties.

Task: a) Assess the properties of the materials and comment with reason which would best be selected for aerospace construction. b) Analyze the interactions of the materials with the environment. c) Assess the impacts of using these materials to the environment.

Item 4

A chemical plant near Lake Victoria is exploring Group 17 elements and their compounds to treat drinking water for a nearby community, focusing on atomic radii and boiling points to balance effectiveness and safety.

Guiding questions: 1. Between chlorine and iodine, which one would be suitable for water treatment and why? 2. Why would dumping industrial wastes containing hydrofluoric acid into water be considered less harmful compared to hydroiodic acid? 3. Why is concentrated sodium hydroxide used to trap fumes containing chlorine gas produced in the production process?

Element	F	Cl	Br	I
Atomic radius (nm)	0.072	0.099	0.114	0.133
Boiling point (°C)	-188	-34	+58	+185

The site safety quality officer responded that the gaseous fume should be treated using strong alkalis to prevent its emission into the atmosphere, and that liquid industrial wastes containing the strong hydride can be treated with calcium oxide before disposal.

Task: a) Analyze the observations obtained during the study at the plant. b) Justify the responses given by the tour guide. c) Assess the impacts of using these products to the environment.

Section B Part II (Respond to any one item)

Item 5

Use of perfumed deodorants is growing fast in Uganda. Abacus Pharmaceutical Company plans to start production. Chloroethane is obtained from compound X, a straight chain hydrocarbon with 2 carbon atoms, used to make compound Y, methyl ethanoate, serving as fragrance. Compound X is used as feedstock to make organic compound W, an alcohol with 3 carbon atoms, which produces propanoic acid needed for deodorant action. For waste control, the analyst suggested reacting any leftover chloroethane with benzene, and any leftover of compound X with liquid bromine with a suitable organic solvent.

Task: a) Examine the compounds to determine production of the most suitable active organic ingredients. b) Analyze the reaction mechanisms and processes for formation of organic products from any leftover

chloroethane, with benzene, compound X and bromine. c) Evaluate the practical applications of the vario us organic products intended to be produced, including any side effects.

Item 6

The use of polymers and solvents in grease production is growing rapidly in Uganda. A manufacturing comp any uses propene to make polystyrene, and propanol as a solvent for grease. Their daily routine mitigation measures run two parallel reactions: 1. Propene with bromine water. 2. Ethanol with concentrated Sulphuric acid at 180°C to form a hydrocarbon R. 3. Compound R serves as feedstock for making benzene, a six-carb on hydrocarbon, and phenylethane, an aromatic hydrocarbon with 8 carbon atoms and molar mass of 104.

Task: a) Examine the compounds to help the team determine the most suitable for making plastic materi als and solvents. b) Analyze the reaction mechanisms in the formation of propene and bromine water, et hanol to hydrocarbon R, benzene to phenylethane. c) Evaluate the impact(s) of the product(s) intended to be produced.

4. ASSHU Kigezi Regional Mock Examinations

Uganda Advanced Certificate of Education — Chemistry (Theory) — Paper 1

July/August 2026 Duration: 2 Hours 45 Minutes Code: P525/1

The Paper consists of two sections A and B. It has six examination items. Section A is compulsory. Section B has two parts, I and II; respond to only one item from each part. Molar gas volume at s.t.p = 22.4 dm^3.

SECTION A — Respond to all items

Item One

A Conglomerate Industry located in Kampala manufactures industrial coolants, fertilizers, and storage batte ries for solar energy systems used in rural electrification projects. The chemists investigate the effect of diss olved salts on freezing points, the energetics of dissolving ionic compounds, the rate of industrial reactions, and the performance of electrochemical cells. A highway department dissolves 117 grams of sodium chlorid e in 1.5 kg of water during transportation during a snowstorm in Canada. The cryoscopic constant for wate r used is 1.86°C mol^{-1} kg. They also want hydration enthalpy of sodium chloride and the rate constant for th e reaction leading to the formation of nitrogen(IV) oxide.

Thermochemical data for sodium chloride:

Process	Enthalpy change (kJ/mol)
Atomization of sodium	+108
Atomization of chlorine	+121
First ionization energy of sodium	+496
Electron affinity of chlorine	-349
Enthalpy of formation of sodium chloride	-411
Enthalpy of solution of sodium chloride	+4

The fertilizer branch investigates the kinetics of $2NO(g) + O2(g) \rightarrow 2NO2(g)$. Sample data obtained at const ant temperature:

Experiment	[NO] (mol/dm^3)	[O2] (mol/dm^3)	Initial rate ($mol\ dm^{-3}\ s^{-1}$)
1	0.10	0.10	2.0×10^{-3}
2	0.20	0.10	8.0×10^{-3}
3	0.20	0.20	1.6×10^{-2}

The electrochemistry branch constructs a galvanic cell using Zinc and Copper electrodes: $Cu2+(aq)+2e \rightarrow Cu(s)$ $Eo=+0.34$ V; $Zn2+(aq)+2e \rightarrow Zn(s)$ $Eo=-0.76$ V.

Task: As a learner of chemistry help the chemists to: a) Assess the industrial chemist's concerns. b) Eval uate the amount of energy that will be produced from the cell formed, and also the impacts of using such

cells to the local communities.

Item 2

Aroma Chem Industries produce perfumes, pharmaceutical solvents, soaps, and water-treatment chemicals for industries across Uganda. In the perfume section, Ethanol reacts with Ethanoic acid when catalyzed usi ng concentrated sulphuric acid to produce an ester used in fragrances: $CH_3COOH(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3COOCH_2CH_3(l) + H_2O(l)$. The production manager wonders about what mass of the ester will be formed at equilibrium when 90.1 g of ethanoic acid is added to 92.1 g of ethanol at 100°C, given Kc = 4.00 at 100°C, a nd the acid dissociation constant is 1.8×10^{-5}. The Quality-Control laboratory food scientist is testing preve ntion of spoilage in fruit juice based on microorganisms not growing well in acidic conditions, by dissolving 8.3 g of ethanoic acid and 16 g of sodium ethanoate in one litre of juice, and determining its pH. The water t reatment section mixes 50 cm^3 of 0.02 mol dm^{-3} silver nitrate solution with 100 cm^3 of 0.01 mol dm^{-3} sodiu m chloride solution; Ksp of silver chloride = 1.8×10^{-10}.

Task: As a chemistry learner and member of science club: a) Assess the concerns of various department s in this industry. b) Evaluate the impact of additives used in juice to human life.

SECTION B Part I (Respond to only one item)

Item 3

A chemical Plant near Lake Victoria invited the chemistry class to a one-day workshop to evaluate different oxides of period 3 elements for use in industrial furnaces, ceramics, water treatment, glass manufacture an d refractory linings, investigating melting points, structures, and oxidation states.

Element	Atomic No.	First ionization ener gy (kJ/mol)	Melting point of oxid e (°C)
Sodium	11	496	1275
Magnesium	12	738	2800
Aluminium	13	578	2072
Silicon	14	786	1710
Phosphorus	15	1012	580
Sulphur	16	1000	-58
Chlorine	17	1251	-119

Task: a) Analyze the data given. b) Discuss the reactions of the oxides of magnesium, aluminium and pho sphorus with water, dilute hydrochloric acid, and sodium hydroxide. c) Draw the structures, name the sha pes of oxides of Sulphur, state the oxidation state of Sulphur in these oxides, and explain the dangers of emission of these oxides to the environment.

Item 4

Uganda faces persistent challenges in rural electrification. A Ugandan Company is developing solar-powere d micro-grids in Kigezi region and invited the class to help identify suitable materials for solar batteries and wiring — affordable, corrosion-resistant, and durable under Uganda's rural conditions, investigating element s similar to period 2 and 3.

Element	Atomic radius	1st IE (kJ/mol)	Electronegativit	Bonding type

	Atomic radius (pm)		Electronegativity	
Li	145	520	1.0	Metallic
Mg	130	738	1.3	Metallic
Al	110	578	1.5	Metallic
Si	95	786	2.0	Covalent
P	85	1012	2.1	Covalent

Environmental scientists studying pollution and soil erosion in Lake Bunyonyi due to damaged lead batteries found a freshly deposited sediment layer with activity of 960 counts per minute while a deeper sediment layer showed 120 counts per minute, due to disintegration of lead-210; they want to know the age of the sediment layer. They also wish to study application of halogens in water treatment:

Element	Fluorine	Chlorine	Bromine	Iodine
Atomic Number	9	17	35	53
Boiling Point (°C)	-188	-34	59	184

Task: a) Evaluate the suitability of the materials for solar batteries and wiring for Uganda's micro-grid systems basing on the data. b) Analyze the halogen data and discuss the reactions of these elements with sodium hydroxide, relating the reactions with daily life applications where possible.

Part II (Respond to only one item)

Item 5

Albertine chemical facility produces fuels, solvents and organic feedstocks used in plastic disinfectant additives in food and other chemical syntheses. Organic Compound Q was isolated from a distillation unit; on complete combustion it burnt with a sooty flame and yielded 8.8 g of carbon dioxide and 1.8 g of water. When 0.100 g of Q was vaporized at 273°C and 734 mmHg, it occupied a volume of 4.46×10^{-2} dm³. Treatment of Q with acidified water and heat yielded Compound Z, which on oxidation in presence of acidified potassium dichromate(VI) yielded a compound Y that gives no observable change with Fehling's solution.

Task: As a learner of Chemistry: (a) Analyze the data to identify Q, Y and Z (include equations/mechanisms where possible). (b) Propose mechanisms for: (i) reaction of Q with bromine water; (ii) conversion of Q to phenylethyne used in plastics (include mechanisms for all steps). (c) Using appropriate reagents and conditions, show how: (i) Q can be converted to any carboxylic acid; (ii) Q can be converted to benzene; (iii) Q can be converted to 3-phenylpropan-1-ol. (d) Discuss the environmental impacts of producing the associated compounds.

Item 6

A Small Cosmetic Start-up is producing herbal skin care. The production process generates significant amounts of waste materials currently disposed into nearby drainage systems, causing blockages and foul smells, leading to complaints. Analysis of the sample oil revealed a mixture of compounds:

Compound	IUPAC Name
K	Propan-1-ol

Compound	IUPAC Name
L	Propanone
M	Methylbenzene
N	But-2-ene

Task: (i) Analyze the composition of these waste materials, their functional groups and any physical properties. (ii) Design synthetic routes to: convert N to ethanol (a disinfectant); convert K to L; convert M to benzoic acid; convert L to propyne; convert N to poly(but-2-ene) repeat unit. (iii) Explore possible mechanisms for reactions of M with concentrated nitric acid and concentrated sulphuric acid; and L with 2,4-dinitrophenylhydrazine in acidic medium. (iv) Discuss the impacts of Compound M to health and environment.

5. Wakiso-Kampala Teachers' Association (WAKATA)

WAKATA Mock Examinations 2026 — Uganda Advanced Certificate of Education — Chemistry (Theory) — Paper 1

Jul./Aug. 2026 Duration: 2 hours 45 minutes Code: P525/1

This paper consists of two sections A and B; six examination items. Section A has two compulsory items. Section B has two parts, I and II; respond to only one item from each. Constants: C=12, H=1, O=16, Cl=35.5; 1 mole of gas at room temperature occupies 24 dm^3.

SECTION A — Respond to all items

Item 1

Calcium chloride (CaCl2) is an important industrial chemical widely used in road construction to melt ice and snow because of its ability to absorb moisture and lower the freezing point of water. A road construction engineer wants to determine the lattice energy and enthalpy of solution of calcium chloride, understand the effect of temperature on its solubility in water, and determine whether the formation of calcium chloride in an electrochemical cell provides evidence that the reaction between calcium and chlorine is thermodynamically feasible.

$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$, $E^o = -2.87$ V; $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$, $E^o = +1.36$ V

Quantity	Process	Value
Atomization energy of calcium	$Ca(s) \rightarrow Ca(g)$	+193 kJ/mol
First ionization energy of calcium	$Ca(g) \rightarrow Ca^+(g)$	+590 kJ/mol
Second ionization energy of calcium	$Ca^+(g) \rightarrow Ca^{2+}(g)$	+1150 kJ/mol
Atomization energy of Cl	$\frac{1}{2} Cl_2(g) \rightarrow Cl(g)$	+122 kJ/mol
First electron affinity of Cl	$Cl(g) \rightarrow Cl^-(g)$	-349 kJ/mol
Enthalpy of formation of CaCl2	—	-795 kJ/mol
Hydration enthalpy of calcium ions	—	-1650 kJ/mol
Hydration enthalpy of chloride ions	—	-381 kJ/mol

Task: As a chemistry student, help the construction engineer address her concerns.

Item 2

Food additives play an important role in modern food production and preservation. Some of these additives are naturally derived from fruits. A food manufacturing company is developing a new artificial pineapple flavour for use in frozen desserts. The flavouring compound is the ester ethyl butanoate, which has a characteristic pineapple aroma. The company's chemists must first synthesise the ester through esterification and then determine its purity using freezing-point measurements.

A chemist reacts butanoic acid with ethanol in the presence of concentrated sulphuric acid to produce ethyl butanoate. The pure ester has a freezing point of −93.0°C, whereas the synthesised sample freezes at −95.

5°C. The cryoscopic constant (Kf) for ethyl butanoate is 7.2 °C kg mol^{-1}. A sample containing 0.50 g of impu rity is dissolved in 100 g of ethyl butanoate.

Task: As a chemistry student, prepare a comprehensive report to assist the company in evaluating the su itability of the product.

SECTION B Part I (Respond to only one item)

Item 3

Differences in melting points allow engineers to select materials that can either withstand high temperature s or melt easily when required. Similarly, bond energies determine how readily substances react during chem ical manufacturing processes. A company that manufactures electronic circuit boards uses components m ade from Group IV and Group VII elements.

Group IV element	Melting point (°C)	Group VII element	Bond energy (kJ/mo l)
Carbon	3730	Fluorine	158
Silicon	1410	Chlorine	242
Germanium	937	Bromine	193
Tin	232	Iodine	151
Lead	327	—	—

The research team wants an analysis of the trends in the physical properties shown, the reactions of Group IV elements with air, and the reactions of Group VII elements with water. The company manager is also inter ested in evaluating the applications and environmental risks.

Task: As a chemistry student, prepare a comprehensive report addressing the above concerns.

Item 4

Many construction materials are based on the chemical behaviour of Group II carbonates and Period 3 chlo rides. Group II carbonates are widely found in limestone, used in cement production, while Period 3 chlorides are important in water purification. A chemical company produces Period 3 chlorides for water treatment; it s furnace is heated by decomposition of Group II carbonates. The manager wants to know how the carbon ates neutralise acidic effluents containing hydrochloric acid.

Carbonate	$BeCO_3$	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
Decomposition temp (° C)	100	350	900	1290	1350

Chloride	$NaCl$	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_5	S_2Cl_2	Cl_2
Melting point (°C)	808	714	192	-68	160	-76	-101

Task: As a chemistry student, prepare a comprehensive report addressing the above concerns.

Part II (Respond to only one item)

Item 5

Alcohols are widely used as fuels and in consumer products, while alkyl halides are important in refrigeratio n systems and as industrial solvents. A chemical company is investigating suitable methods for producing p henol and 2-methylpropan-2-ol for use in the manufacture of resins and antiseptics. The company intends t o prepare phenol from bromobenzene and 2-methylpropan-2-ol from propan-2-ol. It also intends to study th e elimination reaction of propan-2-ol using concentrated sulphuric acid and the reaction between phenol an d propanoyl chloride, including the mechanisms involved.

Task: As a chemistry student, help the team address the above challenges — including physical propertie s of bromobenzene and propan-2-ol, and environmental/ethical implications of producing and using thes e chemicals.

Item 6

Customers prefer products that not only remove nail polish effectively but also leave a pleasant fragrance. C arbonyl compounds are widely used as fragrance ingredients because of their characteristic aromas. A cos metics company manufactures a scented nail-polish remover using propanone (acetone) and benzaldehyde. To ensure a steady supply of propanone, the company intends to prepare it from propan-1-ol, while benzene is to be converted into benzaldehyde. Quality-control chemists also study the nucleophilic addition reaction of hydrogen cyanide with propanone and the condensation reaction of benzaldehyde with 2,4-dinitrophenyl hydrazine, including the mechanisms involved.

Task: As a chemistry student, help the team address their concerns and evaluate whether the company's intended production processes are suitable.

6. ASSHU-Kasese Joint Examination Board (AKJEB)

Mock Examinations — Uganda Advanced Certificate of Education — Chemistry — Paper 1

July/Aug 2026 Duration: 2 ¾ hours Code: P525/1

Two sections A and B, 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 only four items in all.

SECTION A

Item One

An aluminium smelting company in Jinja used to use an aluminium compound as a flux to lower the melting point of cryolite during aluminium extraction. Options: A. Aluminium fluoride; B. Aluminium chloride. The pro duction unit faces high energy costs, and the environmental team reports challenges dissolving waste alumi nium fluoride or aluminium chloride residues before disposal.

Data: Standard enthalpy of formation of AlF_3 = −1301 kJ/mol; enthalpy of atomization of aluminium = +314 kJ/mol; bond dissociation energy of fluorine = +158 kJ/mol; bond dissociation energy of chlorine = +242 kJ/ mol; 1st, 2nd, 3rd ionization energies of aluminium = +577, +1820, +2740 kJ/mol; 1st electron affinity of fluo rine = −348 kJ/mol; 1st electron affinity of chlorine = −264 kJ/mol; standard enthalpy of formation of $AlCl_3$ = −704.2 kJ/mol; hydration enthalpies of aluminium, fluoride and chloride ions = −4690, −364, −378 kJ/mol respectively.

Task: a) Analyse the data to construct an energy cycle diagram for the formation of the solid substances. b) Evaluate whether the dissolution of the substances in water is thermodynamically feasible under stan dard conditions. c) State which of the substances is most appropriate basing on its properties. d) Sugges t the possible impacts and mitigations of the substance to the environment.

Item 2

An agrochemical industry (U) Ltd produces ammonia used in fertilizers and industrial cleaning products. 2.0 0 moles of nitrogen gas and 6.00 moles of hydrogen were mixed in a 5.00 dm^3 reactor at 200 atm and 450° C: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, ΔH = −92 kJ/mol. At equilibrium, the mixture contained 30% ammonia by vol ume. The ammonia produced was dissolved in 750 cm^3 of water; equal volumes of 250 cm^3 each of this am monia solution and 2.0M ammonium chloride solution were mixed to prepare an ammonia-ammonium chlori de buffer. Two separate 10.0 cm^3 portions of the buffer were tested with 10.0 cm^3 of 2.0M HCl and 2.0M Na OH respectively.

Task: a) Analyse the data and determine the equilibrium constant Kp; assess how the equilibrium is affe cted by (i) increased temperature (ii) increased pressure (iii) a catalyst. b) Calculate the pH of the ammo nia solution ($K_b = 1.8 \times 10^{-5}$ mol dm^{-3}). c) Analyse how the buffer works when small amounts of HCl or Na OH are added, and how buffers are applied in real life. d) Analyse the change in pH when 10.0 cm^3 each o f 2.00M HCl and 2.00M NaOH is added to the buffer.

SECTION B Part 1 (Respond to one item)

Item 3

Kilembe Chemical Works Ltd, in Kasese, is investigating how bonding and molecular structure affect the pro perties and industrial uses of several compounds used in fertilizer formulation, water purification and manuf

acturing of plastics and ceramics: water, phosphorus trichloride, carbon tetrachloride, tin(II) chloride, ammo nia, tin(IV) chloride, nitrate ion, and phosphorus pentachloride.

Task: a) Predict the molecular shapes and structures, bond type and approximate bond angles for the ab ove chemical species. b) Basing on the above shapes and structures, analyse and classify the above che mical species according to physical states, solubility in water, and electrical conductivity. c) Analyse the difference in: (i) type of bonds between water and ammonia, phosphorus trichloride and phosphorus pent achloride; (ii) electrical conductivity and melting points of tin(II) chloride and tin(IV) chloride.

Item 4

Roofing Rolling Mills Ltd, located Namanve industrial park, manufactures electric cable components, heat-re sistant furnace linings and chemical storage metallic tanks. The company received complaints: some metalli c tanks storing sodium hydroxide solution were corroding rapidly; a furnace-lining material was found to mel t at unexpectedly low temperatures; the waste management unit requested a metallic tank that can safely s tore acidic waste without corroding.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	15	16	17	18
Melting point (° C)	98	650	660	1414	44	115	-102	-189

Task: a. Analyze the above data (melting points) and recommend the most suitable element for heat-resi stant furnace linings, giving reasons. b. Analyse the chemical reactivity of the elements with the commo nly encountered substances stated by the company and recommend the most appropriate element for ea ch of the company's needs while identifying any element(s) unsuitable for structural or industrial use.

Part II (Respond to only one item)

Item 5

A hospital and research centre in Hoima city is investigating a new isolated organic compound Y for potenti al industrial application. 1.50 g of Y is burnt completely in dry oxygen, giving 2.870 g of carbon dioxide and 1.761 g of water. When vaporised, 0.1 g of Y occupied 78.8 cm^3 at 157°C and 740 mmHg.

Task: Determine the molecular formula of Y; identify all possible structural isomers of Y and their IUPAC names, and determine which isomer can undergo chemical transformations to produce an alkene Z; stud y the reactions of the identified isomers with sulphuric acid to form alkene Z, and how alkene Z reacts wit h acidified water, including mechanism; develop feasible pathways to convert the isomer into ethane for further pharmaceutical applications; analyse how important the isomer Z is in daily life situations. Analy se the data and address the plans to the hospital team and propose suitable solutions.

Item 6

Crude oil cracking produces unsaturated hydrocarbons such as Ethene, propene, butene and methylbenzen e, used respectively to manufacture polythene plastics, polypropylene plastics, synthetic rubbers/specialty c hemicals, and industrial solvents/chemicals. Ethene can be converted to ethanoic acid which reacts with an alcohol synthesized from butene to make an ester used in perfumes. Propene can be alternatively synthesiz ed from propanone used as a nail polish remover. Methylbenzene is used to make 2-nitromethylbenzene whi ch is used to manufacture dyes.

Tasks: a) Analyse the reaction processes involved in synthesis of polyethene, propanone and ethanoic ac id. b) Analyse the reaction mechanisms involved in the formation of 2-nitromethylbenzene and the ester.

c) Evaluate the practical applications of the various plastics and their environmental effects with their mi tigations.

7. Pre-Mock Examinations 2026 (Ssematimba Godfrey)

Uganda Advanced Certificate of Education — Chemistry (Theory) — Paper 1

Duration: 2 hours 45 minutes Code: P525/1

Two sections, A and B, six examination items. Section A has two compulsory items. Section B has two part s, I and II; respond to only one item from each part. Respond to four items in all.

SECTION A — Respond to both items

Item 1

The increasing cost of conventional fuels has encouraged many institutions in Uganda to explore alternative sources of energy. A boarding school installed a biogas digester that uses animal waste and food remains t o produce methane for cooking. Observations: (i) temperature of the digester contents increased during dec omposition; (ii) gas production was initially high after fresh waste was added but gradually decreased with t ime; (iii) food cooked faster when methane supply to the burner was increased.

Data set 1: $C_6H_{12}O_6(s) \rightarrow 3CH_4(g) + 3CO_2(g)$. Enthalpies of formation: $C_6H_{12}O_6(s)$ −1273 kJ/mol; $CH_4(g)$ −75 kJ/mol; $CO_2(g)$ −394 kJ/mol.

Data set 2: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$.

Experiment	[CH_4] (mol/dm³)	[O_2] (mol/dm³)	Initial rate (mol dm^{-3} s^{-1})
A	0.10	0.10	2.0×10^{-4}
B	0.20	0.10	4.0×10^{-4}
C	0.20	0.20	1.6×10^{-3}

Task: a) Analyse the observations made during the production and use of the biogas, using the informati on provided. b) Assess the conditions and practices that the school should adopt to maximise the produc tion and efficient use of methane as a fuel.

Item 2

A fruit-processing company produces bottled passion-fruit juice. The company uses benzoic acid and sodiu m benzoate to control the acidity of the juice, and sugar to improve taste. Customers complained that one b atch tasted unusually sour and froze more readily than another under similar refrigeration.

Substance	Sample P	Sample Q
Benzoic acid (g)	1.22	1.22
Sodium benzoate (g)	0.288	0.288
Sugar (g)	8.0	24.0

pKa of benzoic acid = 4.20. Recommended pH range for the juice: 3.5–4.0. Mr = C_6H_5COOH 122; C_6H_5COO Na 144.

Task: a) Assess the customers' concerns about the acidity and freezing behaviour of the two juice sampl es. b) Evaluate the benefits and possible consequences of the additives used in the juice, and recommen d appropriate practices for their use.

SECTION B Part I (Respond to only one item)

Item 3

A ceramic and glass manufacturing company uses compounds of silicon and other Period 3 elements in its production processes. Observations: silicon(IV) oxide used as major raw material in heat-resistant products; magnesium oxide used to neutralise acidic industrial wastes; aluminium oxide could not be used effectively t o treat strongly alkaline waste; gaseous oxides of sulphur and phosphorus produced during processes coul d contaminate rainwater and nearby water sources. The company also uses chlorine-containing substances during water treatment.

Task: a) Analyse the observations in terms of structure, bonding and chemical properties. b) Explain, usin g equations, reactions relevant to treatment of the industrial wastes and water. c) Evaluate the environm ental importance and possible dangers, and suggest mitigation measures.

Item 4

A company plans to construct a pedestrian bridge across a river, considering aluminium and iron as main st ructural materials. Notes: bridge exposed continuously to air and moisture; iron components could be prote cted by attaching blocks of magnesium; aluminium remains resistant to further corrosion despite being reac tive; a worker suggested replacing aluminium with beryllium as they occur in related periodic positions.

Task: a) Analyse the physical properties of aluminium and iron in relation to structure and suitability for bridge construction. b) Explain the chemical behaviour of the metals in the stated environment, including corrosion control methods. c) Assess the suggestion to use beryllium and evaluate environmental/health impacts.

Part II (Respond to only one item)

Item 5

Plastic waste from packaging materials has accumulated around markets and drainage channels in an urb an area. Polymer X repeating unit: [–CH2–CH2–]n. Polymer Y repeating unit: [–CH(C6H5)–CH2–]n. Investig ations: monomer of X can be prepared from ethanol; ethanol can be manufactured from ethanoic acid throu gh suitable transformations; monomer of Y is obtained from an aromatic compound; an aromatic ketone us ed in another industrial process can be prepared from benzene using an acyl chloride derived from ethanoic acid.

Task: a) Analyse the structural features/properties of X and Y contributing to their environmental accum ulation. b) Analyse reaction pathways for: formation of the monomers of X and Y; polymerisation of the monomers; conversion of ethanoic acid into the stated intermediates; formation of the aromatic ketone (include reagents, conditions, equations, mechanisms). c) Evaluate applications and environmental/healt h impacts of X and Y, and recommend waste-management practices.

Item 6

A pharmaceutical company extracts active ingredients from plant materials using organic solvents, and ma nufactures compounds for use as solvents/intermediates. Compound A: straight-chain hydrocarbon, 6 carb ons, Mr 86. Compound B: aromatic hydrocarbon, 7 carbons, Mr 92. Compound C: alcohol, 2 carbons, Mr 46. The company manufactures nitrobenzene, ethyl ethanoate, propanone, and phenylethanone.

Task: a) Identify compounds A, B and C, and examine their structures/physical properties for suitability a s extraction solvents. b) Analyse reaction pathways/mechanisms for preparation of nitrobenzene, ethyl e thanoate, propanone and phenylethanone from suitable starting materials (include reagents, conditions, equations, mechanisms). c) Evaluate practical applications and health/environmental impacts, and reco mmend safe handling measures.

8. Jinja Joint Examinations Board

Mock Examinations — August 2026 — Uganda Advanced Certificate of Education — Chemistry (Principal Subject) — Paper 1

Duration: 2 hours 45 minutes Code: P525/1

Two Sections A and B. Section A has two compulsory items. Section B has two parts, I and II; respond to on ly one item from each. Respond to four items in all.

Item 1

Electrochemical cells generate energy from spontaneous redox reactions. A group of S.5 students under thei r science club selected the strongest oxidizing/reducing agents between copper and zinc, constructed an ele ctrochemical cell, and applied quantitative chemical principles. Their teacher provided:

First ionization energy of Zn = 906 kJ/mol; Second ionization energy of Zn = 1733.3 kJ/mol; Hydration energ y of $Zn^{2+}(aq)$ = 2046 kJ/mol; First ionization energy of Cu = 754 kJ/mol; Second ionization energy of Cu = 1 958 kJ/mol; Hydration energy of $Cu^{2+}(aq)$ = 2100 kJ/mol.

Half cell: $Zn(s)|Zn^{2+}(aq)$ E^o = +0.76 V; $Cu(s)|Cu^{2+}(aq)$ E^o = −0.34 V.

Task: As a chemistry student analyse and interpret the data to address the S.5 issues.

Item 2

A manufacturing company in Uganda uses compound X as a primary intermediate for making a dye which gives blue jeans their iconic colour. Analysis: X is immiscible with water, contains 77.3% C, 7.58% H and the r est nitrogen; a mixture of X (boiling point 180°C) and water (boiling point 100°C), when steam distilled at 76 0 mmHg and 98°C, gave a distillate containing 85% by mass water. Saturated vapour pressure of water at 9 8°C is 734.9 mmHg.

Task: As a student of chemistry, analyse and interpret the available data to address management concer ns — molar mass of X, molecular formula of X, and associated applications of steam distillation.

SECTION B PART I (Attempt only one item)

Item 3

The chemistry of period 3 elements is vital to modern technology, biology and industry. A manufacturing pla nt dealing in modern technology equipment is interested in how periodic properties of elements affect reacti vity, reactions of elements and health implications. Data provided:

Element	Na	Mg	Al	Si	P	S	Cl
Electron affinity (kJ/mol)	-20	+67	-30	-135	-60	-200	-364
Ionization Energy (kJ/mol)	492	743	579	791	1060	1003	1254

Task: As a student of Chemistry, prepare a write-up to address the management's concerns.

Item 4

The chemistry of Group 17 elements is important for water sanitation, health and industrial manufacturing. Data:

Element	F2	Cl2	Br2	I2
Atomic radius (nm)	0.072	0.09	0.114	0.133
Boiling point (°C)	-188	-35	59	184

A manufacturing company dealing in antiseptics is interested in how periodic trends affect reactivity, reactio ns of the elements, and health implications, if any.

Task: As a Chemistry student, analyse and interpret the available data to address the company's issues.

PART II (Attempt only one item)

Item 5

Use of nail polish removers and polymers is increasing in Uganda. A chemical plant makes polythene and et hyl acetate, a nail polish remover, from propene and methane respectively. As mitigation, excess raw propen e is reacted with bromine water while excess methane is reacted with chlorine gas in UV light.

Task: As a student of chemistry, make a write-up to address the plant management concerns — suitabilit y of products for applications, analysis of mitigation reactions with equations, evaluation of synthetic pat hways, and possible health implications of products.

Item 6

A school science club wants to produce benzaldehyde hydrazone from ethane and propanone (solvent) fro m propan-1-ol. One student raised the issue of managing excess propan-1-ol and the product propanone. T he chairperson proposed reacting propanone with 2,4-dinitrophenylhydrazine and propan-1-ol with hot conc entrated sulphuric acid as a mitigation measure.

Task: As a student of chemistry, analyse and interpret the data to address the club's issues — suitability o f propan-1-ol for its application, analysis of mitigation reactions with equations, and evaluation of synthe tic pathways with associated health implications.

9. Kabale Diocesan Mock Examinations

Uganda Advanced Certificate of Education — Chemistry Theory — Paper 1

April/May 2026 Duration: 2¼ Hours Code: P525/1

Two sections A and B. Section A has two compulsory items while B has two parts, I and II, each with two ite ms; answer only one item for each part. Respond to four items in all. Molar volume of gas at s.t.p is 22.4 d m^3; standard temperature 273 K; standard pressure 101325 Nm^{-2}.

SECTION A — Respond to all items

Item One

At Lake Bunyampaka in the Albertine Rift Valley System, university students made an exciting discovery: a ri ch deposit of a mineral suspected to contain Boron. During analysis, the sample was found to contain 20% Boron-10, 50% Boron-11, 15% Boron-12, and 15% Boron-13, used to determine an accurate relative atomic mass (RAM) of Boron. It was also discovered that the hydride of Boron, diborane (B2H6), a valuable gaseou s fuel, could be used in semi-conductor fabrication since it produces more energy per unit mass than many c onventional fuels when burnt: $B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(l)$. The hydride burns producing boron oxide that clogs engines, is highly toxic and difficult to store, and reacts with water and acids. Standard ent halpy of combustion of diborane = +36 kJ/mol; boron oxide = −1273 kJ/mol; water = −286 kJ/mol.

The team also wants to use diborane as a boron source for doping silicon wafers, heating 13.7 g of diboran e until complete decomposition: $B_2H_6(g) \rightarrow 2B(s) + 3H_2(l)$. Rate of decomposition studied at constant temp erature:

Experiment	[B2H6] (mol/dm³)	Initial rate (mol dm^{-3} s^{-1})
1	0.10	2.0×10^{-3}
2	0.20	4.0×10^{-3}
3	0.30	6.0×10^{-3}

Task: a) Prepare a write-up you would use to help this team of university researchers upon invitation — d escribing the process of obtaining the relative atomic mass of Boron, and explaining why it's not a whole number, plus the enthalpy of combustion of diborane, how much boron can be produced during thermal d ecomposition, and the rate constant for thermal decomposition. b) Explain why the rate of decompositio n of diborane must be controlled in an industrial system. Suggest any two methods that can be used to r educe the rate of decomposition during storage.

Item Two

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. Sample data:

Concentration (mol/kg)	0.50	1.00	1.50	2.00	3.00
Freezing point (°C)	-1.90	-3.65	-5.40	-7.10	-10.20

In another department, a team is formulating a new medicine containing calcium hydroxide as an anti-acid

and calcium supplement. Challenges: calcium hydroxide not dissolving sufficiently in water, inconsistent dos ing, visible sedimentation in the bottles. Solubility product, Ksp, of calcium hydroxide at 25°C = 5.5×10^{-6} mo l^2 dm^{-6}. Management wants a scientific explanation of why calcium hydroxide is sparingly soluble, and how i ts solubility can be manipulated, and the pH of its saturated solution.

Task: As a chemistry learner: a) Describe how the freezing point of solvent X will be determined. b) Prepa re a technical report for the product development team at the meeting.

SECTION B Part I (Respond to only one item)

Item Three

A chemical manufacturing company in Jinja is establishing a new facility to produce ionic compounds used i n refractory lining in furnaces, anti-acids, flame retardant, cement and mortar production, medicinal X-ray im aging, and fireworks. Challenges encountered: 1. Reactivity of different metals with water varies significantl y. 2. Melting points of these elements exhibit differences, leading to different suitability for applications. 3. B eryllium displays atypical chemical behavior compared to other group 2 elements, instead showing similariti es to Aluminium. 4. A beryllium chloride compound (Q), containing 11.25% beryllium, has an unknown struct ure requiring characterization; molecular mass of Q is 160. 5. A radium-226 source used in an industrial gau ge had initial count rate of 1200 counts/minute; half-life 1600 years.

Task: As a chemistry learner: a) Prepare a scientific report addressing: (i) the trend in reactivity of group 2 elements in water; (ii) variations in melting points; (iii) anomalous behaviour of beryllium; (iv) the struc tural formula of compound Q. b) Help the engineers determine the count rates of radium-226 remaining after exactly 3200 years.

Item 4

Environmental chemists are investigating a chemical contamination incident in a local river following an ind ustrial discharge. Laboratory analysis of the water reveals the presence of sodium chloride, aluminium chlor ide, silicon(IV) chloride, phosphorus(V) chloride and disulphur dichloride. To assess environmental impact, t he chemists add water to samples of each chloride under controlled laboratory conditions to observe their c hemical behaviour.

Task: As a chemistry learner: a) Address the concerns of the environmental investigation team and propo se suitable explanations and observations made during the assessment. b) State how each of the anhydr ous chlorides can be prepared in the school laboratory.

Part II (Respond to only one item)

Item Five

An environmental agency is investigating air pollution near an industrial zone suspected of a hydrocarbon re lease and open combustion. A 20.0 cm^3 sample of hydrocarbon Z was reacted with 200.0 cm^3 of oxygen. Af ter cooling to room temperature, the total gas volume was 160.0 cm^3, and passing residual gases through a queous sodium hydroxide reduced the volume to 20.0 cm^3. Hydrocarbon Z burns with a sooty flame. When t reated with hot alkaline potassium manganate(VII), then acidified with dilute hydrochloric acid, it produces c ompound T, which reacts with magnesium to liberate hydrogen.

Task: As a chemistry learner, prepare a presentation covering 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, en vironmental hazards with mitigation measures, and conversion of Z into a more valuable product such as nitrobenzene to manufacture explosives and dyes.

Item Six

A hospital and research centre in Kigezi region is investigating a newly isolated organic compound Y for pot ential industrial applications. 1.50 g of Y burnt completely in dry oxygen gave 2.870 g of carbon dioxide and 1.761 g of water. When vaporized, 0.1 g of Y occupied 78.8 cm^3 at 157°C and a pressure of 740 mmHg.

Task: As a chemistry learner, address the plans of the hospital team and propose suitable solutions: 1. D etermine the molecular formula of Y. 2. Identify all possible structural isomers of Y and their IUPAC name s, and determine which isomer can undergo transformations to produce an alkene Z. 3. Study the reactio n of the identified isomer with sulphuric acid to form alkene Z, and how alkene Z reacts with acidified wat er, including mechanisms. 4. Develop feasible pathways to convert the isomer into ethane for further pha rmaceutical applications.