(Do not write your School/ Centre Name or Number anywhere on this Booklet.)

525/1
CHEMISTRY
Paper 1
2026
2 Hours 45 min

Internal-Mock Examination

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1(Theory)

2 Hours 45 min

INSTRUCTIONS TO CANDIDATES

1. *This examination paper consists of **two sections: A and B**.*
2. *The paper contains **six examination items**.*
3. ***Section A** consists of **two compulsory items**.*
4. ***Section B** is divided into **two parts: I and II**.*
5. *Candidates should answer **only one item from each part of Section B**.*
6. *In total, candidates should answer **four items only**.*
7. *Any additional item(s) answered will **not be scored**.*
8. *All responses must be written in the **answer booklet(s) provided**.*
9. *Begin each item on a **fresh page**.*

SECTION A

*Respond to **One** item in this part*

ITEM 1

Iron scrap is recovered using electrochemical processes. During an educational visit, Amina, an S.4 student, in her vacation observed that the engineers were investigating whether iron(III) ions could be reduced to iron metal using different reducing agents. The engineers also monitored the energy changes accompanying the reactions in order to minimise fuel consumption.

In one experiment, iron(III) ions were reacted with zinc metal according to the equation:

$$2\mathrm{Fe}^{3+}(aq) + 3\mathrm{Zn}(s) \rightarrow 2\mathrm{Fe}(s) + 3\mathrm{Zn}^{2+}(aq)$$

The following standard electrode potentials were provided:

$$\mathrm{Fe}^{3+}(aq) + 3e^- \rightarrow \mathrm{Fe}(s) \qquad E^\circ = -0.04\ \mathrm{V}$$
$$\mathrm{Zn}^{2+}(aq) + 2e^- \rightarrow \mathrm{Zn}(s) \qquad E^\circ = -0.76\ \mathrm{V}$$

The engineers also determined the enthalpy change of the reaction using standard enthalpies of formation. The following data were available:

$$\Delta H_f^\circ(\mathrm{Fe}^{3+}, aq) = -48\ \mathrm{kJ\ mol^{-1}}$$
$$\Delta H_f^\circ(\mathrm{Zn}^{2+}, aq) = -154\ \mathrm{kJ\ mol^{-1}}$$

The standard enthalpies of formation of the elements in their standard states were taken as zero.

The calculated enthalpy change showed that the reaction was highly exothermic. The plant manager suggested using the heat evolved to preheat incoming reactants, while another engineer proposed replacing zinc with copper because it was cheaper. The students were asked to determine whether the proposed changes would still produce iron efficiently.

To make use of the above system, the following investigations were carried out:

A : The feasibility of extracting iron using zinc and copper was evaluated by calculating the standard cell potentials and predicting the direction of electron flow during each reaction.

B : The energy released during the extraction process was analysed to determine its industrial significance. The company also investigated how efficient heat recovery

could reduce fuel consumption and minimise environmental pollution.

Task

As a learner of Chemistry:

a. Analyse the data to assess the suitable material.
b. Assess applications and environmental impacts of the systems, suggesting suitable mitigation measures.

ITEM 2

Sulphur trioxide is used as an intermediate raw material for sulphuric acid production in Uganda. Aidah a student of S.4 during her vacation visted a company producing sulphuric acid.

She noticed that during processing, 2.00 moles of sulphur dioxide and 1.00 mole of oxygen were fed into a 4.50 dm^3 converter at 450°C and 2.00 atm. She observed that the gases reached equilibrium an equation represented as;

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g), \quad \Delta H = -196\,\text{kJ mol}^{-1}$$

Checking on the equilibrium mixture, 40% of sulphur dioxide was found to remain in the vessel.The plant manager proposed increasing the concentration of sulphur dioxide, operating at a higher pressure and temperature, and introducing a catalyst to improve sulphur trioxide production.

To make use of the above system, the following steps were carried out by the workers:

X : The sulphur trioxide produced was absorbed to form sulphuric acid. Some effluents containing sulphate ions polluted a nearby water source. To remove the sulphate ions, barium chloride solution was added, forming insoluble barium sulphate.

Y : A saturated solution of barium sulphate at 25°C was found to contain 1.0×10^{-5} mol dm^{-3} of Ba^{2+} ions. The treated water was later mixed with 0.10 mol dm^{-3} sodium sulphate (Na_2SO_4) to investigate the common ion effect and precipitation. the learner seek assitance on this issue.

Task

As a learner of Chemistry:

a. Analyse the equilibrium and solubility data to assess precipitation for sulphate removal.
b. Assess applications and environmental impacts of the system in Y, suggesting suitable mitigation measures.

SECTION B

Part I

*Respond to **One** item in this part*

ITEM 3

A radioisotope, X-131 is known for its use in thyroid imaging. X-131 is a β-emitter used for diagnostic scans. A patient received an administered dose containing 64 MBq of X-131. After treatment, nuclear technicians recorded the activity of the isotope stored in the decay room to monitor safe handling and disposal.
The follow data were available for reference:

Time, t (hours)	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
Activity, A (MBq)	64	45	32	22	16	11	8	6

Technicians suspect that the isotope follows first-order decay and recommend plotting the data to estimate the decay constant (λ). The hospital safety officer reminds all staff that although X-131 is highly effective for thyroid diagnostics, unnecessary exposure to ionising radiation must be minimized.
To make use of the above information, the following investigations are required:
The investigation requires learners to determine the electronic configuration of iodine (Z = 53) and its relation to isotope formation, explain isotope effects on electronic configuration and chemistry, use the data to determine decay constant (λ) and half-life of X-131, calculate the time for activity to reach 4 MBq, discuss applications and environmental impacts of radioisotopes, and state a safety precaution for handling β-emitters.
You have been for assistance.

Task

As a learner of Chemistry,
a) analyse the data to offer necessary assitance with referenceto the scenario.
b) examine the environmental and health impacts that may result and mitigation measures.

ITEM 4

Chlorine is one of the most widely used Group 17 elements in water treatment because of its ability to destroy disease-causing microorganisms. Your class visited a

National Water treatment plant to study the use of halogens in water purification and maintenance of treatment equipment.

During the visit, you observed that chlorine was delivered and stored in pressurised cylinders as a gas, while bromine was kept in sealed containers as a liquid and iodine was supplied as a solid. The plant engineer explained that the company selected chlorine for large-scale water treatment because it was the most suitable halogen for the process.

You also observed that chlorine was reacted with water during disinfection, excess chlorine was removed before the treated water was supplied to consumers, and chlorine tablets were used for emergency water purification. The engineer warned that careless handling of chlorine and improper disposal of chlorine-containing wastes could endanger workers and pollute the environment.

Task

As a learner of Chemistry, a) analyse the observations made during the study and justify the methods used by the water treatment plant.

b) examine the environmental and health impacts that may result.

Part II

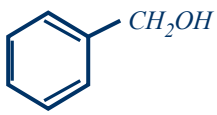
*Respond to **One** item in this part*

ITEM 5

In Kampala, increasing demand for processed foods, perfumes and pharmaceutical products has led to increased use of organic compounds as food additives, fragrance materials and preservatives.

Lydia, a learner interested in industrial chemistry, visited a food and cosmetics plant where she observed two organic compounds labelled Q and Y used in flavouring and fragrance applications.

She found out that;

i. Q is structurally represented as	$CH_3COOCH_2CH_3$
ii. Y is structurally represented as	
iii. Q is obtained from	*methanol under some conditions.*
iv. Y is obtained from	*bromoethane under some conditions.*

Lydia was further advised that efficient productionion should not imvolve alkanes since they are less reactive, she therefore requires detailed information about; the synthesis routes and explaination of key reaction(s) transformation of compounds Q and Y, formation of intermediate organic compounds, and the environmental and health impacts of the use of Q and Y and mitigation measures.

Task:

a) Analyse the observation made by Lydia about the pdoducts in the industry.

b) Analyse the reactions of synthesis of products Q and Y and those highlighted in the scenario.

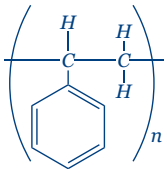
c) Evaluate the impact of the use of products Q and Y.

ITEM 6

The increasing demand for safe packaging materials and durable synthetic products in Uganda has led to large-scale production of polymers for food, pharmaceutical and industrial applications. However, improper disposal of non-biodegradable polymers has become an environmental concern due to accumulation in drainage systems and release of harmful substances during burning.

During an industrial visit to a polymer manufacturing plant in Jinja, learners observed two polymer products labelled **P** and **R**. The production chemist explained that the polymers are made from organic monomers obtained through petroleum processing and laboratory synthesis.

They found that;

i. *Polymer P is a flexible thermoplastic with repeating units:*	$[CH_2CH(CH_3)]_n$
ii. *Polymer R is a rigid heat-resistant polymer containing aromatic rings and represented as:*	
iii. *Polymer P is formed from:*	*a monomer produced from an alcohol obtained from petroleum processing.*
iv. Polymer R is formed from	*an aromatic monomer prepared from ethanoic acid.*

The chemist further explained that the differences in flexibility, strength and heat resistance of the polymers depend on their molecular structures and intermolecular

forces. The learners were required to investigate the production processes and assess the benefits and risks associated with the use of these polymers.

Task:

As a learner of Chemistry, analyse the observations made during the industrial visit.

a) Explain how the structures of polymers P and R influence their physical properties.

b) Analyse the synthesis routes and key organic reactions involved in the formation of polymers P and R.

c) Evaluate the environmental impacts of polymers P and R and suggest appropriate management measures.

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 Te 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 Ti 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 68	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