

Name: Stream:

P525/1

CHEMISTRY

Paper 1 (Theory)

August, 2026

2³/₄ Hours

BULOBA ROYAL COLLEGE
Uganda Advanced Certificate of Education
END OF TERM II ASSESSMENT, 2026
CHEMISTRY
Paper 1
2 Hours 45 Minutes

INSTRUCTIONS TO STUDENTS:

- This paper consists of two sections section A and section B. It has six (6) examination items.
Section A has two (2) compulsory items.
- Section B has two parts, part I and II, **attempt one** item in each part.
- Answers must be written in the answer booklet(s) provided.
- Graph paper and A Periodic Table are provided.
- You are advised to carefully read each item and the **plan** appropriately before starting. You may use mathematical tables and a silent, nonprogrammable scientific calculators.

items	1	2	3 or 4	5 or 6	total
scores					

SECTION A

Attempt **all** items from this section

ITEM 1

Iron metal is the most widely used metal on earth; its low cost and structural versatility make it commonly used in infrastructure and in biological systems in form of Fe^{2+} soluble salt in water. A metallurgy research Team is optimizing the extraction of iron from hematite (Fe_2O_3) while analyzing the thermodynamic stability and solubility of its side-product halide, **iron (II) Chloride**. During extraction in the blast furnace, carbon monoxide acts as the primary reducing agent. The activation energy for the forward reaction is $+2.3\text{kJmol}^{-1}$

$$\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \longrightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$$

However, the research unit manager wants to find out the **enthalpy change for reduction of Hematite and activation energy for backward reaction on an energy profile diagram, obtain the lattice energy and the enthalpy of solution of iron (II) Chloride and analyze the factors that affect the enthalpy of solution of the salt in water hence assess its suitability for use**. The team researched and found the following thermochemical data which could be used.

Table 1

Process;	$\Delta H^\ominus$ (KJmol^{-1})
Enthalpy of formation of Iron (III) Oxide	-824.2
Enthalpy of formation of carbon monoxide gas	-110.5
Enthalpy of formation of carbon dioxide gas	-393.5
Enthalpy of atomization of solid iron	+416
Second ionization energy of iron	+1561
Bond dissociation energy of chlorine gas	+244
Electron affinity of chlorine	-349
Enthalpy of formation of iron (II) chloride	-341.8
Enthalpy of hydration of iron (II) ions	-1920
Enthalpy of hydration of chloride ions	-364

TASK;

As a S5 learner, help the research unit manager to analyze and interpret the data in order to address his concerns.

(25scores)

ITEM 2

A pharmaceutical manufacturing company in Uganda is developing a new Sulphur-based antiseptic ointment using **carbon disulphide (CS_2)** as a non-aqueous solvent. During initial processing, the quality control team observed a significant reduction in the solvent's vapor pressure upon dissolving elemental Sulphur.

Since CS_2 is **extremely volatile, highly toxic, and flammable**, the plant manager requires a comprehensive technical report before scaling up production. The **Laboratory Quality Control Chemist**, has been assigned to evaluate the batch using principles of colligative properties and write a report that will **guide the company in analyzing briefly why the vapor pressure of the solution is lower than that of pure CS_2 , verifying the molecular mass and structure of Sulphur dissolved in CS_2 , understanding industrial applications of vapor pressure lowering, and establishing critical safety protocols for handling CS_2 .**

The laboratory quality control team provided the following data obtained at 20°C

Vapor pressure of pure CS_2 (P°) = 400mmHg

Vapor pressure of the solution (P) containing 5.0 g of Sulphur dissolved in 63cm^3 of

CS_2 = 392.58mmHg. Density of carbon disulphide = 1.27 g cm^{-3} . Relative Atomic Masses:

C = 12, S = 32

Task;

As a chemistry student, analyze and interpret the information then write a structured report to help the Quality control chemist. (25 scores)

SECTION B

PART I (INORGANIC) Attempt *one* item.

ITEM 3

During a regional industrial safety and environmental assessment of a chemical manufacturing park, research scientists collected sample data on eight elements belonging to Period 3 of the Periodic Table (labeled **A** through **H** in order of increasing atomic number from $Z = 11$ to $Z = 18$). To evaluate material reactivity, storage risks, and runoff hazards, the laboratory compiled physical data on these elements into the reference table below:

Element Code	Element Symbol	Atomic Number (Z)	Atomic Radius (pm)	First Ionization energy(kJmol⁻¹)
A	Na	11	186	496
B	Mg	12	160	738
C	Al	13	143	578
D	Si	14	118	789
E	P	15	110	1012
F	S	16	103	999
G	Cl	17	100	1251
H	Ar	18	98	1521

During an inspection of the park's chemical waste storage facility, two containers containing Element **A** and element B were accidentally exposed to water and steam nearby.

The research team was interested in analyzing the general trend in atomic radius across Period 3 from Element A to Element H, analyze chemical equations (including state symbols) for the reactions of Element A and Element B with water under standard/ambient conditions and under heated/steam conditions (where applicable). Account for the differences in reactivity between sodium and Magnesium when interacting with liquid water based on their ionization energies and electronic structures and account for the immediate health and environmental risks to the reaction of sodium with water of local aquatic ecosystems.

Task;

As a chemistry student, write a structured technical report addressing the above concerns.
(25 scores)

ITEM 4

A medical research laboratory synthesizes a sample of **Cobalt-60** to supply radiation therapy units. Because **Cobalt-60 decays by emitting a beta particle β into stable Nickel-60** researchers must track the remaining mass of pure Cobalt-60 over several years. To separate pure Cobalt-60 from its decay products, the sample is ionized and passed through a **Mass Spectrometer**: Singly charged ions (Co^+ and Ni^+) enter a perpendicular magnetic field

Because Nickel-60 and Cobalt-60 have slightly different atomic masses (m), their ions curve at different radii (r). This allows the detector to isolate and weigh the remaining Cobalt-60 mass accurately. The mass spectrometer recorded the mass of pure Cobalt-60 remaining in a 100g sample at various intervals over a 16-year period.

Time(years)	0.0	2.5	5.3	7.9	10.6	13.3	16.0
Mass (g)	100	72.1	50.0	35.6	25.0	17.7	12.5

The researchers were advised that beta particle properties, nuclear process decay equation for cobalt-60, decay constant, how ionization of sample occurs and associated health and environmental implications are vital in understanding the whole research.

The research team is now challenged and has approached you.

TASK; As a chemistry student, analyze and interpret the data to address the medical research team issues. (25 scores)

PART II (ORGANIC), *Attempt one item*

ITEM 5

A chemical manufacturing laboratory receives a bulk delivery of **propene (C₃H₆)** Gas and an **industrial solvent** mixture containing three structural isomers of **pentane (C₅H₁₂)** **Compound A, Compound B, and Compound C**. As part of the initial intake quality control, a chemist measures the boiling points and miscibility of the unbranched and branched isomers, recording the following dataset:

compound	A	B	C
Boiling point (°C)	36.1	27.8	9.5

Based on this analytical data with the isomers identified, the synthesis division selects **Compound A** as a feedstock to produce organic intermediates via UV-catalyzed monochlorination. During the reaction, chlorine gas is bubbled through liquid Compound A under ultraviolet light. Analysis of the chlorination vessel reveals that the reaction does not produce a single isomer, but rather a mixture of monochlorinated positional isomers. **The chemist is interested in knowing the other monochlorinated position isomers of compound A.**

The technical team isolates **propene gas** to use as a precursor for chemical synthesis of propan-2-ol in presence of acidified water (H⁺/H₂O). In a secondary process, the laboratory also needs to regenerate pure **Compound A** from an available batch of **pent-2-ene**. Because pentane isomers and chlorination reagents pose significant hazards in an industrial setup, safety protocols must be established before running these reactions at scale. **The chemist was interested to identify the compounds A, B, and C with IUPAC names and structural formulae, physical properties of isomer A to its application and boiling point, a mechanism of reaction of compound A with chlorine gas and reaction of propene with acidified water and possible environmental and health impacts associated with handling pentane isomers.**

Task.

As a chemistry student, analyze and interpret the data to address the chemist's concerns.

(25 scores)

ITEM 6

During a safety inspection at a chemical manufacturing facility, technicians identified an unlabeled storage drum containing a clear, volatile liquid **W** with a sharp, vinegar-like odor. Mass spectrometry and elemental analysis revealed the compound's molecular formula to be **C₃H₆O₂**

Laboratory technicians confirmed that the compound contains a carbonyl group (**C=O**) directly bonded to a hydroxyl group (**-OH**). Laboratory tests revealed two key observations;

- The liquid reacts with sodium carbonate solution to liberate bubbles of a colorless gas (CO₂).
- Reacts with sodium hydroxide solution to form a colorless salt **solution Q**.

The technicians were interested in analysis of the observations made, knowing the structural formula and IUPAC name for the liquid W and solution Q, classify the liquid as either aliphatic or aromatic with a reason, Draw the full structural formula of a functional group isomer of W that belongs to the ester family and give its IUPAC name, and that contains both a hydroxy group and an aldehyde group and possible applications, dangers and mitigations associated with operating with liquid W.

Task; As a chemistry student, analyze and interpret the information to address the technician's concerns. (25 scores)

END

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

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