Candidate's Name:.....

Signature: .....

Random No.					Personal No.		

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

P525/1
CHEMISTRY
Paper 1
(Theory)
Nov./Dec. 2023
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1
(Theory)

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **all** *questions in section* **A** *and* **six** *questions in section* **B**.

All questions **must** *be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is attached at the end of the paper.

Mathematical tables (3–figure tables) are adequate or non-programmable scientific electronic calculators may be used.

Illustrate your answers with equation(s) where applicable.

Where necessary, use the following:

Molar gas constant, $R = 8.31\ JK^{-1}\ mol^{-1}$.
Molar volume of gas at s.t.p is 22.4 litres.
Standard temperature = 273 K.
Standard pressure = $101325\ Nm^{-2}$.

For Examiners' Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A (46 MARKS)

Answer **all** *questions in this section.*

1. (a) Kinetic data for the decomposition of nitrogen(V) oxide is shown in table 1.

Table 1

$[N_2O_5]$ (mol dm^{-3})	Initial Rate (mol dm^{-3} s^{-1})
0.0016	0.12
0.0024	0.18
0.0032	x

Calculate the;

(i) order of the reaction. *(1½ marks)*

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(ii) rate constant for the reaction. *(1½ marks)*

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(iii) value of x. *(01 mark)*

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(b) Name **two** methods that can be used to determine orders of reactions. *(01 mark)*

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2. (a) Write an equation to show how soapless detergent can be prepared from alkyl benzene. *(02 marks)*

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(b) State;

(i) **one** advantage of soapless detergent over soapy detergent. *(01 mark)*

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(ii) **one** disadvantage of soapless detergent over soapy detergent. *(01 mark)*

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3. (a) A compound **Q** consists of 94.11% sulphur, the rest being hydrogen. Calculate the empirical formula of **Q**. *(02 marks)*

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(b) When 0.15 g of **Q** was vapourised at 293 K, the vapour produced occupied 106 cm^3 at 101325 Nm^{-2}. Determine the molecular formula of **Q**. *(02 marks)*

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(c) Write an equation for the reaction of **Q** with acidified potassium dichromate(VI) solution. *(1½ marks)*

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4. (a) The atomic number of cobalt is 27.

(i) Write the electronic configuration of cobalt. *(01 mark)*

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(ii) State how cobalt is able to form ions with oxidation state of +2 and +3. *(02 marks)*

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(b) When concentrated ammonia solution was added to cobalt(II) chloride solution, a blue precipitate was formed which dissolved giving a red-brown solution. Write equation(s) for the reaction(s) that took place. *(03 marks)*

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5. State what would be observed and write equation(s) for the reaction(s) that would take place when the following pairs of substances are mixed:

(a) $CH_3C(CH_3)=CH_2$ and bromine in tetrachloromethane.

Observation *(01 mark)*

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Equation *(01 mark)*

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(b) $CH_3\overset{\overset{O}{\|}}{C}CH_3$ and sodium hydroxide in iodine solution.

Observation *(½ mark)*

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Equation *(01 mark)*

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(c) $CH_3CH(OH)CH_3$ and acidified potassium dichromate(VI) solution.

Observation *(01 mark)*

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Equation *(01 mark)*

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6. (a) Define the term **standard enthalpy of formation.** *(01 mark)*

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(b) The bond energies of some bonds are shown in table **2.**

Table 2

Bond	Bond enthalpy (kJ mol^{-1})
$C-H$	+413
$C-C$	+347
$C=C$	+612

Calculate the enthalpy of formation of but-l-ene. *(03 marks)*

(The Standard enthalpies of atomisation of carbon and hydrogen are +717 and +218 kJmol^{-1} respectively.)

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7. The boiling points of some chlorides of period 3 elements of the Periodic Table are shown in table **3**.

Table 3

Formula of chlorides	$NaCl$	$MgCl_2$	Al_2Cl_6	$SiCl_4$
Boiling points (^oC)	1465	1418	423	57

(a) State the trend in the boiling points of the chlorides. (*01 mark*)

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(b) Explain your answer in (a). (*05 marks*)

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8. Write equation(s) to show how methylethanoate can be synthesised starting from ethene. *(05 marks)*

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9. (a) State **Kohlrausch's law.** *(01 mark)*

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(b) The molar conductivities at infinite dilution for some electrolytes at 18 °C are shown below.

$BaCl_2$, $\Lambda\infty = 240.6\ \Omega^{-1}\ cm^2\ mol^{-1}$.

NH_4Cl, $\Lambda\infty = 129.6\ \Omega^{-1}\ cm^2\ mol^{-1}$.

$Ba(OH)_2$, $\Lambda\infty = 457.6\ \Omega^{-1}\ cm^2\ mol^{-1}$.

Determine the molar conductivity of $NH_4\ OH$ at 18 °C. *(03 marks)*

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(c) State **one** application of conductivity measurements. *(01 mark)*

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SECTION B (54 MARKS)

Answer any **six** *questions from this section.*

Any additional question(s) answered will **not** *be marked.*

10. Complete each of the following equations and in each case outline a mechanism for the reaction.

(a) $(CH_3CH_2)_3C—Br \xrightarrow[\text{Heat}]{CH_3CH_2O^-Na^+ / CH_3CH_2OH}$ ..... *(01 mark)*

Mechanism *(02 marks)*

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(b) $CH_3CH_2OH \xrightarrow[140\ ^oC]{Conc.\ H_2SO_4}$ ..... *(01 mark)*

Mechanism *(02 marks)*

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(c)  $\xrightarrow{HBr}$ ..... *(01 mark)*

Mechanism: *(02 marks)*

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11. Beryllium and magnesium are elements in group (II) of the Periodic Table.

(a) Explain the following:

(i) The first ionisation energy of beryllium is higher than that of magnesium. *(02 marks)*

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(ii) The polarising power of magnesium ions is lower than that of beryllium ions. *(01 mark)*

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(b) Beryllium reacts with aqueous sodium hydroxide solution. Write an equation for the reaction. *(1½ marks)*

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(c) State the conditions under which beryllium oxide and magnesium oxide react with the following substances and where applicable, write equation(s) for the reaction(s):

(i) Water. *(02 marks)*

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(ii) Sodium hydroxide. *(2½ marks)*

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12. (a) Calcium phosphate(V), $Ca_3(PO_4)_2$, is sparingly soluble in water. Write the;

(i) equation for the solubility of calcium phosphate(V) in water. *(01 mark)*

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(ii) expression for the solubility product, ***Ksp***, of calcium phosphate(V). *(01 mark)*

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(b) The solubility product of calcium phosphate(V) is $2.0 \times 10^{-29} mol^5\ dm^{-15}$ at 25 °C. Calculate the solubility of calcium phosphate(V) in gdm^{-3} at 25 °C. (*03 marks*)

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(c) Explain how the solubility of calcium phosphate(V), would be affected if to its saturated solution a few drops of ;

(i) aqueous sodium phosphate(V) were added. (*02 marks*)

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(ii) dilute nitric acid were added. (*02 marks*)

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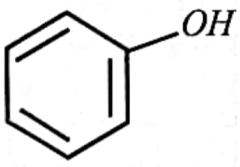
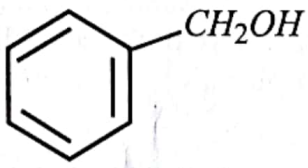
13. Name a reagent which can be used to distinguish between the following pairs of compounds and in each case state what would be observed if each member is separately treated with the reagent:

(a)  and  (*03 marks*)

Reagent .....

Observations .....

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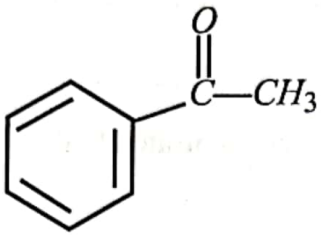
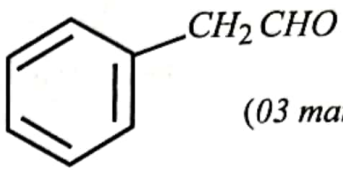
(b)  and  *(03 marks)*

Reagent .....

Observations .....

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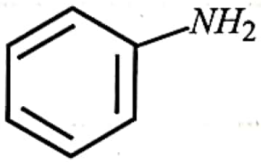
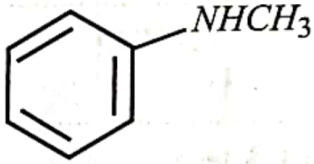
(c)  and  *(03 marks)*

Reagent .....

Observations .....

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14. (a) Some elements in group (IV) of the Periodic Table are given in table 4. Complete the table by;

(i) writing the formula of the oxide in which each element is in the +4 oxidation state. *(1½ marks)*

(ii) stating the class of each oxide. *(1½ marks)*

Table 4

Element	Formula of oxide	Class of oxide.
Tin		
Silicon		
Lead		

(b) Write an equation for the reaction between;

(i) tin(IV) oxide and concentrated sodium hydroxide. *(1½ marks)*

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(ii) lead(IV) oxide and cold concentrated hydrochloric acid. *(1½ marks)*

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(c) State the condition and write an equation for the reaction between concentrated nitric acid and;

(i) tin.

Condition *(½ mark)*

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Equation *(01 mark)*

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(ii) lead.

Condition *(½ mark)*

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Equation *(01 mark)*

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15. (a) Write an equation for the ionisation of benzoic acid in water. *(01 mark)*

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(b) Calculate the ***pH*** of a solution containing 2.06 g of benzoic acid per dm^3. *(04 marks)*

*(The acid dissociation constant, **Ka**, for benzoic acid = 6.3×10^{-5} mol dm^{-3}.)*

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(c) 4.32 g of sodium benzoate was dissolved in one dm^3 of benzoic acid in (b). Calculate the ***pH*** of the resultant solution. *(04 marks)*

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16. (a) During the extraction of aluminium from bauxite, $Al_2O_3 \cdot 2H_2O$, the ore is first purified.

(i) Name **two** major impurities in the ore. *(01 mark)*

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(ii) Write equations to show how the ore is purified. *(06 marks)*

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(b) Describe how aluminium is obtained from the pure ore.
(*Equations are* **not** *required.*) *(02 marks)*

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17. (a) State what is meant by the term **partition coefficient**. *(01 mark)*

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(b) 4.5 g of an impure sample of zinc sulphide was dissolved in excess concentrated solution of ammonia and the solution diluted to 500 cm^3. The resultant solution was shaken with 25 cm^3 of carbon tetrachloride and allowed to settle.
12.5 cm^3 of aqueous layer required 20.0 cm^3 of a 0.25 M hydrochloric acid for complete reaction, while 25.0 $cm^3$of the carbon tetrachloride layer required 12.5 cm^3 of a 0.025 M hydrochloric acid for complete reaction.

Calculate the number of moles of;

(i) free ammonia in aqueous layer. *(2½ marks)*
(*The partition coefficient,* K_D, *for ammonia between carbon tetrachloride and water is 0.04*)

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(ii) complexed ammonia. *(2½ marks)*

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(c) Determine the percentage by mass of zinc in the impure zinc sulphide. *(03 marks)*

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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	35.5 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 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 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