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. 2024
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1
(Theory)

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of **two** *Sections;* **A** *and* **B**.

Section **A** *is* **compulsory**. *Attempt* **six** *questions from Section* **B**. *Any additional question(s) attempted will* **not** *be marked.*

All questions **must** *be answered in the spaces provided. Use* **blue** *or* **black** *ink. Any work done in pencil,* **except** *drawings, will not be marked.*

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

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

Illustrate your answers with equations 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** *the questions in this section.*

1. (a) Define the term **standard electrode potential.** *(01 mark)*

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(b) The standard electrode potentials of some half cells reactions are given below:

	E^{θ} (V)
$Co^{2+}_{(aq)} + 2e \longrightarrow Co_{(s)}$	−0.28
$Zn^{2+}_{(aq)} + 2e \longrightarrow Zn_{(s)}$	−0.76
$Cl_{2\,(aq)} + 2e \longrightarrow 2\,Cl^{-}_{(aq)}$	+1.36
$MnO^{-}_{4\,(aq)} + 8H^{+}_{(aq)} + 5e \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$	+1.52

(i) Identify the strongest reducing agent and the strongest oxidising agent. *(01 mark)*

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(ii) Write the cell notation of the cell constructed by combining the half cells $Co^{2+}_{(aq)} / Co_{(s)}$ and $Zn^{2+}_{(aq)} / Zn_{(s)}$. *(01 mark)*

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(iii) Write the equation for the overall cell reaction for the cell in b(ii). *(01 mark)*

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(iv) Calculate the e.m.f. of the cell in b(ii). *(01 mark)*

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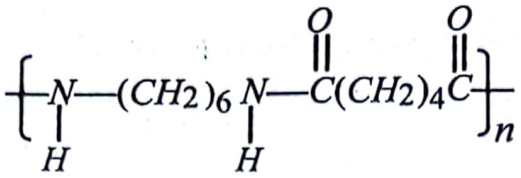
2. Nylon 6, 6  is formed by condensation polymerisation.

(a) State the meaning of the term condensation polymerisation. *(01 mark)*

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(b) (i) Write the structural formula(e) and name(s) of the monomers of nylon 6, 6. *(03 marks)*

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(ii) State **one** use of nylon 6, 6. *(01 mark)*

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3. Draw the structure and name the shape of each of the following ions in Table 1: *(4½ marks)*

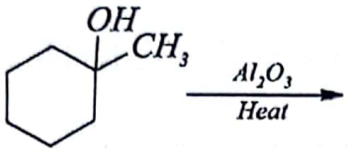
Table 1

Ion	Structure	Name of shape
NO_3^-		
SO_3^{2-}		
NH_4^+		

4. Complete the following equations and name the major organic product:

(a) $CH_3COOH \xrightarrow{PCl_5}$ ..... *(1½ marks)*

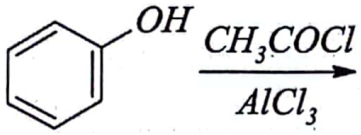
Name .....

(b)  ..... *(1½ marks)*

Name .....

(c) $(CH_3COO)_2Ca \xrightarrow{Heat}$ .....*(1½ marks)*

Name .....

(d)  .....*(1½ marks)*

Name .....

5. The vapour pressure of propanone is 37330 Nm^{-2} at 30 °C. When 33.4 g of cane sugar were dissolved in 120 g of propanone, the vapour pressure reduced by 1760 Nm^{-2}.

(a) Calculate the molar mass of cane sugar. *(2½ marks)*

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(b) Explain why the vapour pressure of the solution is lower than that of propanone. *(1½ marks)*

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6. (a) State what would be observed and write an equation for the reaction that takes place when dilute hydrochloric acid is added to aqueous potassium manganate(VI) solution.

Observation: *(1½ marks)*

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Equation: *(1½ marks)*

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(b) Explain why potassium manganate(VII) is **not** acidified using hydrochloric acid. *(2½ marks)*

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7. Complete the following equations and in each case write the mechanism for the reaction(s):

(a) $CH_3CH_2OH \xrightarrow[180\ ^\circ C]{Conc.H_2SO_4}$ ..... *(3½ marks)*

Mechanism:

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(b)  $\xrightarrow{Conc.\ HNO_3/Conc.H_2SO_4}$ .....*(2½ marks)*

Mechanism:

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8. (a) Write an equation for the reaction that takes place when methylamine is dissolved in water. *(1½ marks)*

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(b) The hydrogen ion concentration of a 1M methylamine solution is 2.5×10^{-13} *mol* l^{-1}. Calculate the base dissociation constant K_b, of methylamine. *(3½ marks)*

(The ionic product of water, $K_w = 10^{-14}$ $mol^2 l^{-2}$*)*

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9. The first ionisation energies and atomic radii for some elements of group(II) of the Periodic Table are given in Table **2**.

Table 2

Element	Beryllium	Magnesium	Calcium	Strontium	Barium
First ionisation energy (kJ mol^{-1})	899	738	590	550	503
Atomic radius (nm)	0.089	0.136	0.174	0.191	0.198

(a) State how the first ionisation energy varies with atomic radius. *(01 mark)*

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(b) Explain your answer in (a). *(04 marks)*

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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. The molecular formula of a compound ***P*** is $C_3H_6Cl_2$.

(a) Write the structural formulae of all the possible isomers of *P*. *(02 marks)*

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(b) When ***P*** was boiled with aqueous sodium hydroxide, a compound ***R*** which reacted with hydroxylamine (NH_2OH) in the presence of an acid and reduced Fehling's solution, was formed.

(i) Identify compounds ***P*** and ***R***. *(02 marks)*

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(ii) Write a mechanism for the reaction between ***R*** and hydroxylamine. (*05 marks*)

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11. (a) State **two** factors which affect the magnitude of lattice energy. (*01 mark*)

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(b) Some thermochemical data are shown below:

Enthalpy of atomisation of chlorine = +122 kJ mol^{-1}.
Enthalpy of atomisation of magnesium = +148 kJ mol^{-1}.
First ionisation energy of magnesium = +738 kJ mol^{-1}.
Second ionisation energy of magnesium = +1451 kJ mol^{-1}.
Enthalpy of formation of magnesium chloride = −641 kJ mol^{-1}.
First electron affinity of chlorine = −364 kJ mol^{-1}.

(i) Construct an energy level diagram for the formation of magnesium chloride. (*03 marks*)

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(ii) Determine the lattice energy of magnesium chloride. (*02 marks*)

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(iii) Calculate the enthalpy of solution of magnesium chloride.
(*03 marks*)

(*The hydration energies of magnesium ions and chloride ions are* -1891 *and* $-381\ kJ\ mol^{-1}$ *respectively.*)

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12. (a) One of the characteristics of transition elements, is formation of complexes. Explain how transition metal ions form complexes.
(*1½ marks*)

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(b) The formulae of some complex ions are shown in Table **3**. Write the name of the complex ion, its oxidation state and the co-ordination number of the central metal ion. (*03 marks*)

Table 3

Complex ion	Name of ion	Oxidation state	Co-ordination number
$[(Co\ (SCN)_4]^{2-}$			
$[Cr\ (NH_3)_4Cl_2]^{+}$			

(c) The molecular mass of a salt, $Cu\ (NH_3)_x Cl_y \cdot ZH_2O$ is 276.

When a solution containing 1.38 g of salt was reacted with excess silver nitrate solution, 2.87 g of silver chloride was formed.

Calculate the number of moles of chloride ions in 1 mole of the salt.
(*02 marks*)

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(d) When a solution containing 1.38g of the salt was mixed with aqueous sodium hydroxide and heated, the ammonia liberated completely neutralised 10 cm^3 of a 1.0 M hydrochloric acid.

Calculate the number of moles of;

(i) ammonia molecules in 1 mole of the salt. *(1½ marks)*

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(ii) water in 1 mole of the salt. *(01 mark)*

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13. Write the equations to show how the following compounds can be synthesised and in each case, indicate the conditions for the reaction.

(a) $CH_3CH_2CH_2Br$ from propanone. *(04 marks)*

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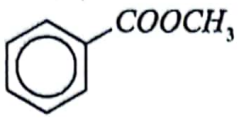
(b)  from benzene. *(3½ marks)*

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(c) $CH_3CH = CH_2$ from 2–bromopropane. *(1½ marks)*

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14. Sulphur dioxide and oxygen can react to form sulphur trioxide according to the following equation:

$2\,SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\,SO_{3\,(g)}$; ΔH is negative.

3 moles of sulphur dioxide and 2 moles of oxygen were heated at 450 °C in a 1 dm^3 vessel at 50 atmospheres. At equilibrium the vessel contained 20 % sulphur dioxide.

(a) (i) Write the expression for the equilibrium constant, K_p. *(½ mark)*

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(ii) Calculate the value of the equilibrium constant, K_p for the reaction at 450 °C. *(04 marks)*

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(b) State, giving reasons, how the concentration of sulphur trioxide at equilibrium would be affected if;

(i) pressure is increased. *(1½ marks)*

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(ii) temperature is increased. *(1½ marks)*

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(iii) an inert gas is added at constant pressure. *(1½ marks)*

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15. (a) State the meaning of the term **bond energy**. (*01 mark*)

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(b) The bond dissociation energies of fluorine, chlorine, bromine and iodine are 158, 242, 193 and 151 kJ mol^{-1} respectively.

(i) State the trend in the bond dissociation energies of the elements. (*1½ marks*)

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(ii) Explain your answer in (b)(i). (*3½ marks*)

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(c) Write an equation to show how cold dilute sodium hydroxide solution reacts with;

(i) fluorine. (*1½ marks*)

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(ii) chlorine. (*1½ marks*)

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16. Propan-1-ol (boiling point 97 °C) and water (boiling point 100 °C) are miscible in all proportions. A mixture of the two liquids containing 72 % propan-1-ol boils at 88 °C.

(a) Sketch a labelled boiling point–composition diagram for the mixture of propan-1-ol and water. (*03 marks*)

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(b) Briefly explain;

(i) why propan-1-ol and water form a minimum boiling point mixture. (*04 marks*)

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(ii) what would happen when a mixture containing 30 % propan–1–ol is fractionally distilled. (*02 marks*)

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7. Tin and lead are elements in group(IV) of the Periodic Table. Describe the reactions of the elements with;

(a) cold water. (*03 marks*)

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(b) sodium hydroxide solution. (*3½ marks*)

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(c) hot concentrated sulphuric acid. (*2½ 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