Candidate's Name: .....

Signature: .....

Random No.					Personal No.		

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

P525/1
CHEMISTRY
(Theory)
Paper 1
Nov./ Dec. 2022
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education

CHEMISTRY
(THEORY)

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

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

All your answers **must** *be written 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. Complete the following nuclear reaction equations:

(a) $^{30}_{15}P \longrightarrow {}^{30}_{16}S + \ldots\ldots\ldots\ldots$ *(01 mark)*

(b) $^{56}_{26}Fe + {}^{2}_{1}H \longrightarrow \ldots\ldots\ldots\ldots + {}^{1}_{0}n.$ *(01 mark)*

(c) $^{1}_{1}H + {}^{7}_{3}Li \longrightarrow \ldots\ldots\ldots\ldots$ *(01 mark)*

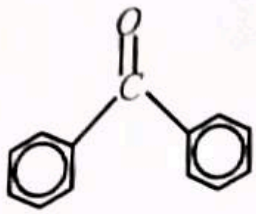
(d) $^{234}_{90}Th \longrightarrow \ldots\ldots\ldots\ldots + {}^{0}_{-1}e.$ *(01 mark)*

2. Draw the structure and state the shape of each of the following species in table 1. *(4½ marks)*

Table 1

Species	Structure	Shape
SiO_3^{2-}		
BrO_3^-		
Cl_2O		

3. Complete the following equations and write a mechanism for the reaction in each case: *(03 marks)*

(a)  $+ NaHSO_3 \longrightarrow$

$\ldots\ldots\ldots\ldots$

Mechanism:

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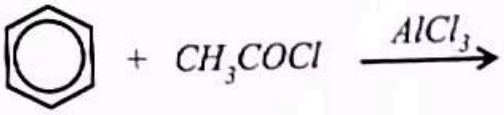
(03 marks)

(b)



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Mechanism:

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4. (a) State what is meant by **bond energy**. *(1½ marks)*

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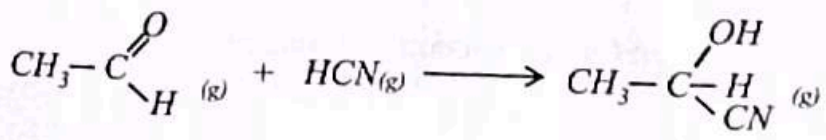
(b) Table **2** shows standard average bond energies for some selected bonds.

Table 2

Bond	$C-C$	$C-O$	$C-H$	$H-O$	$C=O$
Average bond energy ($kJmol^{-1}$)	348	360	412	463	743

Use the data in the table to determine the standard enthalpy change of the reaction. *(03 marks)*



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5. (a) To a mixture of chromium(III) sulphate solution and excess sodium hydroxide solution, was added hydrogen peroxide solution and the resultant mixture heated.

(i) State what was observed. *(½ mark)*

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(ii) Write an equation for the reaction that took place. *(1½ marks)*

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(b) The resultant solution in (a) was divided into portions and treated as follows:

(i) To the first portion dilute sulphuric acid was added. State what was observed and write an equation for the reaction that took place.

Observation: *(½ mark)*

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Equation: *(1½ marks)*

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(ii) To the second portion, a few drops of lead(II) ethanoate solution was added. State what was observed and write an equation for the reaction that took place.

Observation: *(½ mark)*

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Equation: *(1½ marks)*

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6. (a) State what would be observed if benzene was added to water. *(01 mark)*

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(b) An organic compound **Q** is soluble in both water and benzene. 0.5 moles of **Q** was shaken with a mixture containing 40 cm^3 of water and 20 cm^3 of benzene and the mixture allowed to stand until equilibrium was attained.

(*KD for* **Q** *between benzene and water at 25 ^oC is 5.*)

Calculate the number of moles of **Q** in the water. *(04 marks)*

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7. (a) Propylamine is a weak base.

Write an;

(i) equation for the dissolution of propylamine in water. *(1½ marks)*

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(ii) expression for the base dissociation constant, K_b for propylamine. *(01 mark)*

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(b) Determine the degree of dissociation of a 0.1 M propylamine solution. *(2½ marks)*
(K_b *for propylamine* 6.918×10^{-4})

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8. The industrial reaction in which sulphur dioxide is converted into sulphur trioxide in the contact process is reversible and exothermic.

(a) Write equation to illustrate the reaction. *(02 marks)*

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(b) Giving reason(s) in each case, state the effect on the equilibrium position of the reaction in (a) if;

(i) the temperature was increased. *(1½ marks)*

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(ii) helium was added to the reaction mixture at constant volume. *(1½ marks)*

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9. Write equations to show how the following compounds can be synthesized: *(03 marks)*

(a) $(CH_3CH_2)_2O$ from ethene.

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(b) Propanone from 1, 2 - dibromopropane. *(03 marks)*

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SECTION B (54 MARKS)

Answer **six** *questions from this section.*
Any additional question(s) answered will **not** *be marked.*

10. Nitrogen reacts with hydrogen according to the following equation:

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(a) State the condition(s) that favour formation of ammonia. *(1½ marks)*

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(b) Write equation(s) to show how ammonia can be converted to nitric acid. *(4½ marks)*

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(c) Write an equation for the reaction between tin and

(i) cold dilute nitric acid. *(1½ marks)*

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(ii) hot concentrated nitric acid. *(1½ marks)*

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11. Ethylbromide reacts with aqueous sodium hydroxide solution according to the following equation:

$$CH_3CH_2Br + NaOH_{(aq)} \xrightarrow{heat} CH_3CH_2OH + NaBr_{(aq)}$$

(a) Write the mechanism for the reaction. *(02 marks)*

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(b) Name the type of mechanism in (a). *(01 mark)*

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(c) Write the rate equation for the reaction. *(01 mark)*

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(d) Sketch a labelled diagram to show an energy profile for the reaction. *(2½ marks)*

(e) Write equations to show how CH_3CH_2Br can be converted to CH_3CH_2CHO. *(2½ marks)*

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12. (a) State what is meant by the term **enthalpy of hydration**. *(01 mark)*

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(b) The hydration energies of barium and chloride ions are -1275 kJ mol^{-1} and -394 kJ mol^{-1} respectively and the lattice energy of barium chloride is -2056 kJ mol^{-1}.
Calculate the;

(i) hydration energy of barium chloride. *(1½ marks)*

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(ii) heat of solution of barium chloride. *(1½ marks)*

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(c) (i) State **two** factors that can affect the magnitude of enthalpy of hydration. *(01 mark)*

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(ii) Explain how the factors you have stated in (c) (i) affect the enthalpy of hydration. *(04 marks)*

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13. (a) A compound **J** contains 19.1% nitrogen, 43.6% oxygen by mass, the rest being manganese.

(i) Calculate the empirical formula of **J**. *(2½ marks)*

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(ii) 10 g of **J** in 1000 g of water lowered the freezing point of water by 0.127 °C. Determine the molecular formula of **J**.
(K_f *for water = 1.86 °C mol^{-1} kg^{-1}*) *(02 marks)*

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(b) When a few drops of concentrated nitric acid were added to a solution of **J**, followed by a little lead(IV) oxide and the mixture boiled, a purple coloured solution was formed.

Write the;

(i) formula and name of **J**. *(01 mark)*

Formula:

.....

Name:

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(ii) equation for the reaction leading to formation of the purple coloured solution. *(1½ marks)*

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(c) A few drops of aqueous sodium carbonate was added to a solution of **J**.

(i) State what was observed. *(½ mark)*

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(ii) Write an equation for the reaction that took place. *(1½ marks)*

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14. Name a reagent that can be used to distinguish between each of the following pairs of compounds. In each case state what would be observed if each member of the pair was separately treated with the reagent you have named.

(a) C_6H_5CHO and CH_3CHO. *(03 marks)*

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(b) $CH_3CH_2C \equiv CH$ and $CH_3CH_2CH = CH_2$. *(03 marks)*

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(c) $CH_3\underset{\underset{CH_3}{|}}{C}HCH_2OH$ and $CH_3\underset{\underset{OH}{|}}{C}HCH_2CH_3$. *(03 marks)*

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15. (a) Briefly explain what is meant by the term **basic buffer**. *(02 marks)*

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(b) 500 cm^3 of a 1 M solution of ammonia was mixed with 500 cm^3 of a 1 M ammonium chloride solution.

Calculate the ***pH*** of the resultant solution.

(pK_b *of ammonia solution = 4.74*) *(05 marks)*

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(c) Two drops of dilute sodium hydroxide solution were added to the resultant solution in (b). State what happened to the ***pH*** of the solution. Give a reason for your answer. *(02 marks)*

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16. (a) State **three** properties in which cobalt differs from calcium. *(1½ marks)*

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(b) To an aqueous solution containing cobalt(II) ions was added concentrated hydrochloric acid dropwise until in excess.

Name the cobalt species present in the solution;

(i) before addition of hydrochloric acid. *(½ mark)*

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(ii) after addition of excess hydrochloric acid. *(½ mark)*

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(c) Concentrated ammonia solution was added dropwise until in excess to a solution containing cobalt(II) ions and the mixture allowed to stand.

(i) State what was observed. *(02 marks)*

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(ii) Write equation(s) for the reactions that took place. *(4½ marks)*

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17. (a) A 2% solution of a monomer, **M** has the same osmotic pressure as 11.6 cm^3 of a solution containing 1.65 g of a polymer of molecular mass 1040 at 298 K.

Calculate the relative molecular mass of **M**. *(03 marks)*

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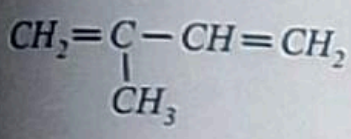
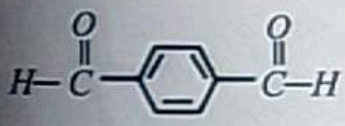
(b) The structural formulae of some monomers are shown in the table 3. Complete the table by writing in the spaces provided; the structural formula of the polymers formed, type of polymerisation and **one** use of each polymer.

Table 3

(06 marks)

Structural formula of monomer (s)	**Structural formula of polymer**	**Type of Polymerisation**	**Use of Polymer**
(i) 			
(ii) $HOCH_2CH_2OH$ + 			
(iii) $CH_2=CH-CN$			

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

END