Candidate's Name…….

Signature…….

P525/1

Chemistry

Paper 1

July/August 2025

2 Hours 45 minutes

KAMTEC 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 from section **B**.*

All questions must be answered in the spaces provided.

The Periodic Table, with relative atomic masses, is supplied.

Mathematical tables (3-figure table) are adequate or 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 Examiner's Use Only.																	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**

TURN OVER

SECTION A (46 MARKS)

Answer **all** questions in this section

1. (a) Define the term **radioactivity**. (***01 mark)***

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(b) Uranium under goes nuclear decay according to the following the equation.

$^{238}_{92}U \longrightarrow {}^{206}_{82}Pb + x\beta + y\alpha$

(i) Explain why the decay process stopped with the formation of $^{208}_{82}Pb$. ***(0½ mark***)

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(ii) Determine the values of x and y. ***(02 marks)***

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(c) The half-life of uranium is 4.5×10^{9} years. Determine the time taken for 43.5% by mass of uranium to decay.

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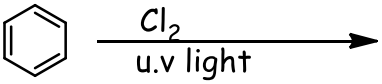
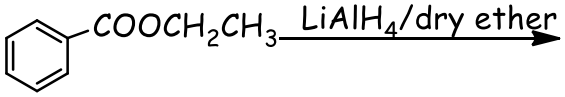
2. Complete each of the following organic reactions and name the major organic product(s).

(a)  ..... (01 mark)

Name of product .....(0.5 mark)

(b)  .....(02 marks)

Name of product(s) .....(01 mark)

(c) $NCCH_2CH_2CN$

$\xrightarrow{Na/ethanol}$…….....(***01 mark***)

Name of product……(***0½ mark***)

3. The standard reduction potentials for some half-cell reactions are shown below:

$Sn^{4+}(aq) + 2e^- \longrightarrow Sn^{2+}(aq)$	+0.15 V
$PbO_2(s) + 4H^+(aq) + 2e^- \longrightarrow Pb^{2+}(aq) + 2H_2O(l)$	+1.46 V

(a) Write the

(i) cell notation for the cell formed when the two half cells are connected.

(01 mark)

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(ii) overall equation for the cell reaction that would take place when the half cells are combined.

(***01 mark)***

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(b) (i) Calculate the e.m.f of the cell. ***(01 mark)***

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(ii) State whether the reaction is feasible or not and give a reason for your answer. ***(01 mark***)

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4. Write an equation for the reaction between trilead tetraoxide with warm concentrated solution of:

(a) hydrochloric acid. ***(1½ marks***)

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(b) sulphuric acid. ***(1½ marks***)

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(c) sodium hydroxide. ***(1½ marks***)

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5. During the production of ethanol by fermentation, aqueous starch is warmed with malt. The product is cooled and yeast added to produced crude ethanol.

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(a) Name **two** sources of starch used in this process. ***(01 mark***)

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(b) Write equation for the reaction leading to the formation of crude ethanol.
(***1½ marks***)

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(c) State how crude ethanol is concentrated. (***2½ marks)***

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6. (a) Write an;
(i) equation for the hydrolysis of ammonium chloride in water. (***01 mark)***

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(ii) an expression for the hydrolysis constant, K_h of ammonium chloride. ***(01 mark***)

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(b) 5.35 g of ammonium chloride was dissolved in 1 litre of solution at 25℃. Calculate the pH of the resultant aqueous solution. (***04 marks***)
($K_b\ for\ ammonia = 1.78 \times 10^{-5}$)

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7. State what would be observed and write equation(s) for the reaction(s) that would take place if to an aqueous lead(II) ethanoate solution is added

(a) concentrated hydrochloric acid drop wise until in excess. (***2½ marks***)

(i) Observation.

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(ii) Equation(s)

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(b) Bleaching powder and mixture warmed. (***02 marks***)

(i) Observation.

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(ii) Equation

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8. (a) 50cm^3 of a vapourised alcohol **Q**, $C_nH_{2n+1}OH$ diffused through a small hole in 119.85 seconds. Under the same conditions, the same volume of hydrogen diffused through the hole in 21.85 seconds.

(i) Calculate the molecular mass of **Q**. ***(1½ marks***)

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(ii) Determine the molecular formula of **Q**. ***(01 mark***)

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(b) (i) Write the structural formulae and IUPAC names of all the possible isomers of **Q**. (***02 marks***)

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(ii) **Q** reacts with aqueous sodium hydroxide and iodine solution to give a yellow precipitate. Identify **Q**. ***(0½ mark***)

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9. 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) $C_6H_5CO_2H$ and neutral iron(III) chloride solution.

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(i) **Observation** ***(01 mark***)

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(ii) **Equation** ***(01 mark***)

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(b) $(CH_3)_2CHC \equiv CH$ and ammoniacal silver nitrate solution.

(i) **Observation** ***(01 mark***)

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(ii) **Equation** ***(01 mark***)

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(c) $CH_3CH_2NHCH_2CH_3$ and ice-cold mixture of sodium nitrite and concentrated hydrochloric acid.

(i) **Observation** ***(01 mark)***

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(ii) **Equation** ***(01 mark***)

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SECTION B (54 MARKS)

Answer **six** questions from this section.

10. Complete each of the following equations and write the mechanism for the reaction.

(a) $CH_3CHO \xrightarrow{H_2NOH/H^+}$ ..... (***04 marks)***

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(b) $C_6H_5COOH + conc.HNO_3 \xrightarrow{conc.\ H_2SO_4/\ 55-60℃}$ ***(2½ marks)***

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(c) $(CH_3)_3C - I \xrightarrow{EtO^-/EtOH;\ heat}$ ..... (***02 marks***)

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11. (a) State what is meant by the term **standard enthalpy of hydrogenation**.

(***01 mark***)

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(b) The standard enthalpies of combustion of some selected substances are given in the table below:

Substance	ΔH^{θ} **(kJ mo**l^{-1}**)**
Hydrogen	286
Benzene	3267
Cyclohexane	3920
Cyclohexene	3800

Use the values above to calculate the standard enthalpy of hydrogenation of each of the following substances.

(i) Benzene. ***(03 marks)***

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(ii) Cyclohexene. ***(03 marks)***

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(c) Comment and explain the difference in the values in (b)(i). ***(02 marks***)

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12. Ammonium dichromate(VI) dissolves in water to form an orange solution and decomposes on heating to form a green solid.

(a) Write equation to show the effect of heat on ammonium dichromate(VI).

(1½ marks)

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(b) State what would be observed and write equation for the reaction that would take place when the following substances are added to the solution of ammonium dichromate(VI) in water.

(i) Acidified hydrogen peroxide followed by ethoxyethane. (***02 marks)***

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(ii) Aqueous sodium hydroxide solution. (***02 marks)***

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(iii) Acidified iron(II) sulphate solution. (***02 marks)***

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(c) To the resultant solution in (b)(ii) was added silver nitrate solution.

(i) State what would be observed. ***(0½ mark)***

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

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13. Write equations to show how the following compounds can be synthesized and, in each case, indicate the condition(s) for the reaction.

(a) Propanone to propan-1-ol. (***03 marks)***

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(b) Nitrobenzene to iodobenzene. (***03 marks)***

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(c) $CH_3CO_2CH_3$ from ethene. ***(03 marks)***

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14. (a) Anhydrous solid, **Q** contains 48.9% by mass tin, 11.5% by mass nitrogen and the rest being oxygen.

(i) Calculate the empirical formula of **Q**. (***02 marks)***

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(ii) Determine the molecular formula of **Q**. ***(01 mark***)
(RFM of $Q = 242.7$)

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(b) Solution of **Q** reacts with iron(II) sulphate in the presence of concentrated sulphuric acid to form a brown ring. Identify **Q**.

(0½ mark)

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(c) Write equation for the reaction that would take place if

(i) **Q** was heated. (***1½ marks)***

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(ii) residue in (c)(i) was added to hot aqueous sodium hydroxide.

(1½ marks)

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(d) State what would be observed and write equation for the reaction that would take place if an aqueous solution containing tin(II) ions was added to iorn(II) sulphate solution. ***(2½ marks)***

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15. (a) State what is meant by the term;

(i) **Order of reaction.** ***(01 mark)***

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(ii) **Half-life of reaction**.

(***01 mark)***

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(b) The table below shows the kinetic data obtained for the decomposition of a compound **Y**.

[**Y**]/mol $dm^{-3} \times 10^{-4}$	2.90	2.30	2.00	1.60	1.30	1.00
Time/minutes	0.0	18.0	30.0	54.0	80.0	130.0

Plot a graph of concentration of **Y** against time. (***03 marks)***

(*Use graph paper provided*)

(c) Using the graph in (b), determine the:

(i) half-life of the reaction. (***1½ marks***)

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(ii) order of the reaction with respect to $CH_3CO_2CH_3$. Give a reason for your answer. (***01 mark)***

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(d) Calculate the rate constant and indicate its units. (***1½ marks***)

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16. The boiling points and molecular masses of group (VII) hydrides of elements of group (VII) of the periodic table are given in the table below.

Hydride	**HF**	**HCl**	**HBr**	**HI**
Boiling point (^{0}C)	19.6	$^-$85	$^-$67	$^-$35.4
Molecular mass (g/mol)	20	36.5	80.9	128

(a) Explain the trend in the boiling points of the hydrides. ***(03 marks***)

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(b) Write equation to show to how hydrogen fluoride ionizes in:

(i) a dilute aqueous solution. (***0½ mark***)

(ii)

(iii)……

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(iv) a concentrated aqueous solution. (***0½ mark)***

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(c) In which of the solutions, in (b) above is the compound more acidic? Explain your answer. ***(2½ marks)***

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(d) Hydrogen iodide was bubbled through warm concentrated sulphuric acid.

(i) State what was observed and give a reason for your answer. (***01 mark)***

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

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17. During the extraction of iron from spathic iron ore (siderite), the ore is crushed and roasted in air. The roasted product is mixed with coke and limestone. The mixture is heated in a blast furnace with a stream of hot air and impure molten iron is obtained.

(a) (i) Write the chemical formula of siderite. (***0½ mark***)

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(ii) Name **one** major impurity in the ore. ***(0½ mark***)

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(b) State the purpose of adding each of the following substances during the process.

(i) Coke. (***0½ mark)***

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(ii) Limestone. (***0½ mark***)

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(c) Write equation for the reaction;

(i) which occurs when the ore is roasted. ***(1½ marks)***

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(ii) leading to the formation of iron. ***(1½ marks)***

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(e) Write equation for the reaction between iron and

(i) steam. (***1½ marks***)

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(ii) hot concentrated sulphuric acid. (***1½ 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	35.4 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 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 Fr 59	144 Nd 60	145 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 Ea 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

End