Name: ..... Centre/Index No: .....

School..... Signature.....

P525/1
CHEMISTRY
Paper 1
July/August 2023
2 ¾ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

Instructions to Candidates

- *Attempt all questions in section A and any six questions from section B.*
- *All questions are to be answered in the spaces provided.*
- *A Periodic Table with relevant atomic masses is supplied at the end of the paper.*
- *Mathematical tables (3 figures) and non-programmable silent scientific calculators may be used.*
- *Illustrate your answers with equations where applicable.*
- *Molar gas volume at s.t.p = 22.4 dm^3*

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

SECTION A (46 MARKS)

Attempt all questions in this section.

1. (a) Sodium -24 which is used as an electrolytic tracer decays by emission of a beta particle and two gamma rays with half-life of 15 hours. (01 mark)
Write the nuclear reaction for the decay of sodium –24.

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(b) 2.4g of sodium -24 were allowed to disintegrate for 72 hours. (04 marks)
Calculate the mass of the radioactive isotope that decayed.

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(c) State any two other uses of radioactive isotopes. (01 mark)

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2. The atomic number of chromium is 24.

(a) Write the;

(i) electronic configuration of chromium. (01 mark)

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(ii) formulae of three common oxides of chromium. (1½ marks)

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(b) The oxide(s) in a(ii) are either basic, amphoteric or acidic. Write an equation for the reaction between the;

(i) basic oxide of chromium and dilute mineral acids. (1½ marks)

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(ii) acidic oxide of chromium and sodium hydroxide solution. (1½ marks)

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3. Complete the following equations and in each case outline a suitable mechanism for the reaction.

(a) $CH_3CH_2Br \xrightarrow[Heat]{CH_3CH_2\,\bar{O}Na^+/alcohol}$ ..... (03 marks)

Mechanism:

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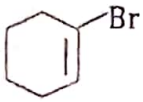
(b)  $\xrightarrow{HBr}$ ..... (03 marks)

Mechanism:

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4. (a) Define the term **common ion effect**. (01 mark)

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(b) The solubility of Lead (II) chloride in 0.02 M calcium chloride at 25°C is 2.951625 gdm^{-3}.

(i) Calculate the solubility of lead (II) chloride in gdm^{-3} in pure water at 25°C. (05 marks)

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(ii) Comment on your answer in b(i) above. (½ mark)

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5. The enthalpies of some chemical reactions are given below.

Reaction	$\Delta H^{\theta}\ (KJmol^{-1})$
$MgO_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H2O_{(l)}$	- 146.2
$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H2_{(g)}$	- 478.4
$2H_{2(g)} + O2_{(g)} \longrightarrow 2H_2O_{(l)}$	- 572

(a) Calculate the enthalpy of formation of magnesium oxide. (03 marks)

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(b) State whether Magnesium oxide is stable or not. Give a reason for your answer. (1½ marks)

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6. The physical properties of the hydrides of fluorine and Iodine are shown below.

Hydride	HF	HI
Boiling point	+19.9°C	-35.1°C
Physical state	Liquid	Gas

(a) Explain the variation in physical properties of the hydrides. (02 marks)

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(b) Describe the reactions of the hydrides with;

(i) sodium carbonate solution. (1½ marks)

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(ii) concentrated sulphuric acid. (1½ marks)

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7. Methylbenzoate was warmed with excess acidified water to form two organic products which were separated by distillation.

(a) Write an equation for the reaction that took place. (01 mark)

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(b) Name a reagent that can be used to distinguish the products in (a) above. State what would be observed if each of the products is separately treated with the reagent you have named.

Reagent. (03 marks)

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Observation.

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(c) State one other physical method by which the products of the reaction can be separated. (½ mark)

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8. Compound E expand normally and has a critical temperature of 31°C at 73.9 atm pressure. The triple point of E is −57°C at 5.2 atm pressure.

(a) Sketch a well-labelled phase diagram of E. (03 marks)

(b) State what would happen when E at;

(i) 180 K temperature and 50 atm pressure was heated at constant pressure. (01 mark)

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(ii) −57°C and 5.2 atm pressure was compressed at constant temperature. (01 mark)

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9. Lead (IV) oxide reacts with excess ice cold concentrated hydrochloric acid to form a complex liquid which forms a yellow precipitate on addition of a saturated solution of ammonium chloride. The dry precipitate reacts with concentrated sulphuric acid to form a pale yellow liquid.

(a) Name the;

(i) complex liquid. (½ mark)

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(ii) yellow precipitate. (½ mark)

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(iii) pale yellow liquid. (½ mark)

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(b) Write an equation for the reaction between water and the pale yellow liquid. (01 mark)

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(c) Name the type of reaction that occurs in (b). (½ mark)

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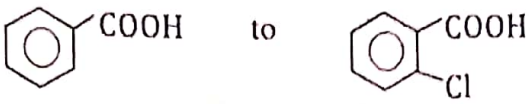
SECTION B (54 MARKS)

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

10. Write equations to show how the following conversions can be effected.

(a)  (3½ marks)

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(b) CH_3Br to $(CH_3)_2N-N=O$ (3½ marks)

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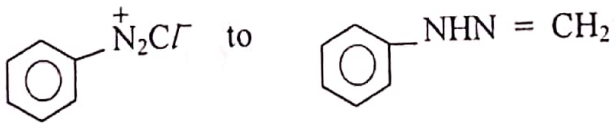
(c)  (02marks)

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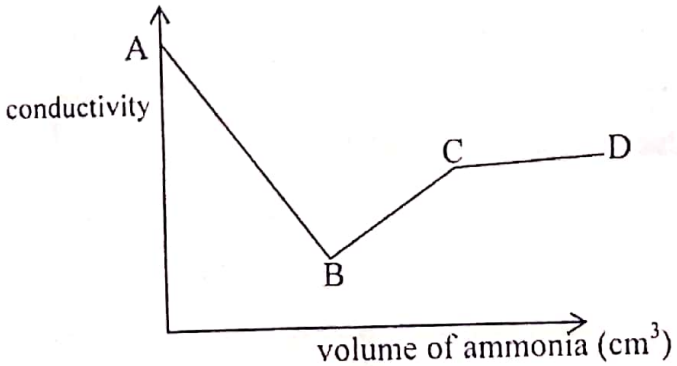
11. (a) 0.05M copper (II) sulphate was titrated with aqueous ammonia.
The conductivity of the mixture varies as shown by the graph below.



State the reason(s) why;

(i) conductivity is initially high at point A. (01 mark)

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(ii) conductivity almost remains constant along CD. (01 mark)

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(b) Write an equation for the reaction that takes place along;

(i) AB (01 mark)

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(ii) BC (01 mark)

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(c) The electrolytic conductivity of water at 25°C is $5.484 \times 10^{-8}\ \Omega^{-1}cm^{-1}$ and its concentration is 18 g per 18 cm^3. Given that the molar conductivity at infinite dilution of H^+ and $\bar{O}H$ are 349.8 and 198.6 $\Omega^{-1}cm^2mol^{-1}$ respectively. Calculate the;

(i) degree of ionization of water at 25°C. (3½ marks)

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(ii) ionic product of water, Kw at 25°C. (1½ marks)

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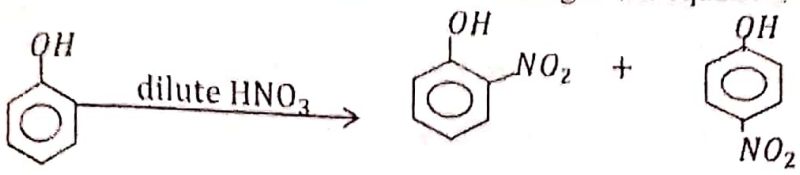
12. Dilute nitric acid reacts with phenol according to the equation;



The products were separated by steam distillation.

(a) State the reason(s) why the;

(i) reaction occurs with dilute nitric acid in the absence of a catalyst unlike with benzene. (02 marks)

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(ii) two products can be separated by steam distillation. (02 marks)

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(b) When the mixture was steam distilled at 1.0 atm at 96°C, the mass of water in the steam distillate was 0.90 g. Calculate the mass of the second component of the distillate.
(Saturated vapour pressure of water at 96°C = 0.825 atm). (03 marks)

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(c) State two advantages of steam distillation. (02 marks)

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13. (a) Name one reagent that can be used to distinguish between the following pairs of compounds. State what would be observed when each member of the pair is separately treated with the reagent you have named.

(i) $K_2SO_{4(aq)}$ and $K_3PO_{4(aq)}$ (02 marks)

Reagent

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Observation

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(ii) $NaCl_{(aq)}$ and $Na_2C_2O_{4(aq)}$ (02 marks)

Reagent

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Observation

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(b) Explain each of the following observations.

(i) When sodium hydroxide solution is added to neutral potassium dichromate solution, the orange solution turns yellow and pale yellow precipitate is formed on addition of lead (II) nitrate solution.

(2½ marks)

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(ii) Manganese (II) sulphate solution in the presence of concentrated nitric acid forms a purple solution on addition of sodium bismuthate.

(2½ marks)

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14. An organic compound Q has a molecular formula; C_4H_8O.

Q has the following chemical properties;

- forms a yellow precipitate with both 2,4-dinitrophenyl hydrazine and aqueous Iodine in the presence of sodium hydroxide.
- forms a cloudy solution after 8 minutes on addition of a solution of anhydrous zinc chloride in concentrated hydrochloric acid.
- gives a silver mirror on addition of ammoniacal silver nitrate solution.

(a) Write the;

(i) structural formula of Q. (01 mark)

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(ii) IUPAC name of Q. (01 mark)

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(b) Write an equation for the reaction between Q and;

(i) anhydrous zinc chloride in the presence of concentrated hydrochloric acid. (01 mark)

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(ii) ammoniacal silver nitrate solution. (01 mark)

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(iii) saturated sodium hydrogensulphite solution (01 mark)

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(c) Suggest a suitable mechanism for the reaction between Q and acidified 2,4-dinitrophenyl hydrazine. (04 marks)

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Turn Over

15. (a) Ammonia is obtained on large scale in the Haber process according to the equation.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}, \quad \Delta H = -92\ KJ$

State the effect of the following on the yield of ammonia. Give a reason for your answer.

(i) high pressure of 150 – 200 atm. (1½ marks)

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(ii) high temperature above 450°C (1½ marks)

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(b) 3.0 moles of nitrogen gas were mixed with 1.0 moles of hydrogen gas in a 500 cm^3 bulb. The mixture was allowed to attain equilibrium at 450°C and the mass of ammonia in the equilibrium mixture was found to be 0.34 g. Calculate the concentration equilibrium constant, Kc at 450°C. (03 marks)

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(c) Write equations to show how the ammonia obtained from the Haber process can be converted to nitric acid. (03 marks)

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16. (a) Lithium belongs to group I of the Periodic Table but its properties resemble Magnesium of group II. State three;

(i) reasons why the chemistry of Lithium differs from other group I elements. (1½ marks)

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(ii) properties of lithium to show how its chemistry resembles that of Magnesium. (03 marks)

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(b) Write an equation for the reaction between;

(i) Magnesium nitride and water. (1½ marks)

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(ii) Beryllium chloride and sodium hydroxide solution. (1½ marks)

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(iii) Barium peroxide and dilute hydrochloric acid. (1½ marks)

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17. (a) Ethanol and hexane form an azeotropic mixture of composition 38.42% ethanol and 61.58% hexane. The density of the azeotrope is 0.687 gcm^{-3}.

Substance	Ethanol	Hexane	Azeotrope
Boiling point (^oC)	78.4	68.9	59.15

(i) State the type of deviation from Raoult's law. (01 mark)

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(ii) Explain your answer in (a)(i) above. (02 marks)

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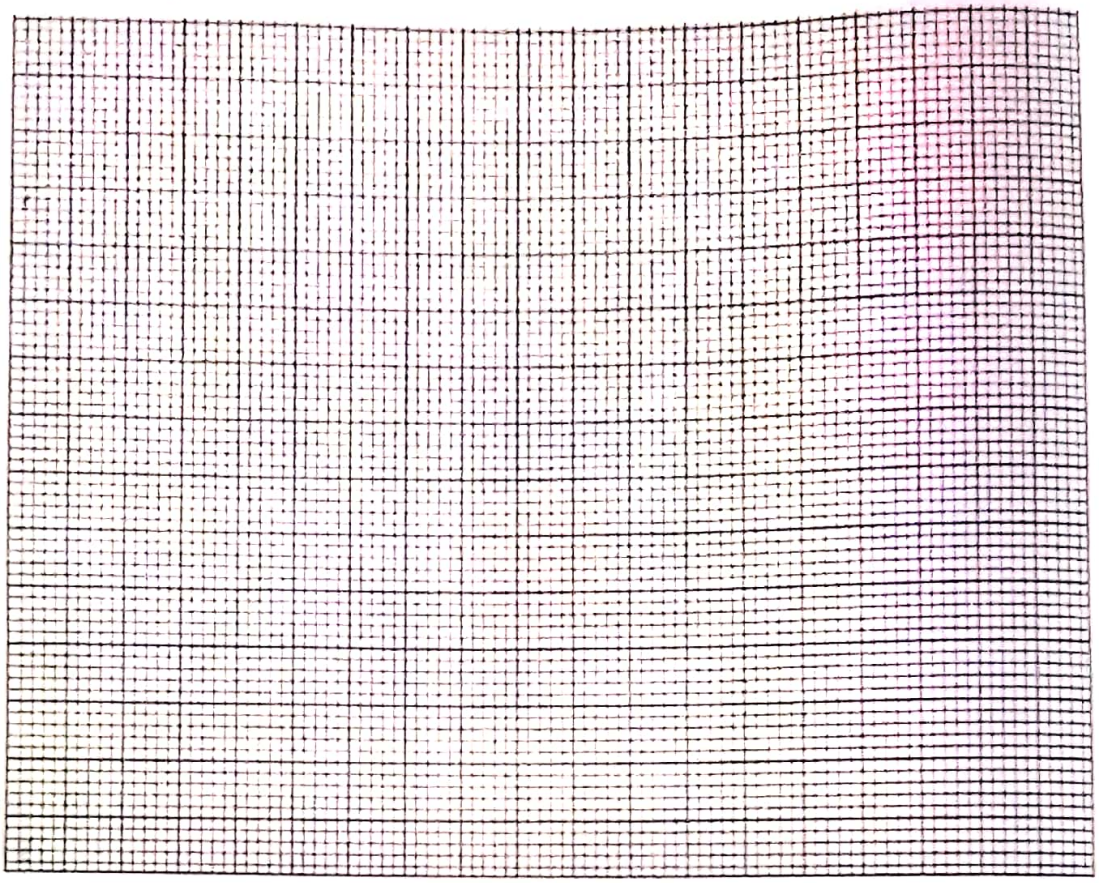
Turn Over

(b) (i) Sketch a well-labelled boiling point composition diagram for the ethanol-hexane system. (02 marks)



(ii) A mixture containing 25% liquid ethanol was fractionally distilled. Identify the substance obtained as;

- distillate..... (½ mark)
- residual liquid..... (½ mark)

(c) 50 cm^3 of the azeotrope was shaken with 100 cm^3 of choline chloride (solvent) at 25°C. Calculate the mass of ethanol extracted by choline solvent. (Partition coefficient of ethanol between choline chloride and hexane at 25°C is 15.80). (03 marks)

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THE PERIODIC TABLE

1	2											3	4	5	6	7	8
1 H 1.0																1 H 1.0	2 He 4.0
3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.4	18 Ar 40.0
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.7	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.9	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	72 Hf 178	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Tl 204	82 Pb 207	83 Bi 209	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)															

57 La 139	58 Ce 140	59 Pr 141	60 Nd 144	61 Pm (145)	62 Sm 152	63 Sm 150	64 Eu 152	65 Tb 159	66 Dy 162	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf 251	99 Es (254)	100 Fm (257)	101 Mv (256)	102 No (254)	103 Lw

1. 1 ← Indicates atomic number.
   H

2. H
   1.0 ← Indicates relative atomic mass.

END