Names:……..……**Index No:** …...…….....……

School Exam Number:.....**Signature**:…….....

*Candidates should **NOT** write their Centre Name or Centre Number anywhere on this booklet*

P525/1
CHEMISTRY
Paper 1
25 July 2022
2 ¾ hours

ENTEBBE JOINT EXAMINATION BUREAU

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

Answer **all** *questions in* Section**A** *and* **six** *questions from* Section**B**

All *questions are to be answered in the spaces provided.*

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

Illustrate your answers with equations where applicable.

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

Illustrate your answers with equations where applicable.

Molar gas constant, $\boldsymbol{R} = 8.31 JK^{-1}mol^{-1}$.

Molar volume of gas at s.t.p=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**

SECTION A: (46 Marks)

Answer **all** *the questions in the* Section.

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

Process	$\Delta H^{\theta}(KJmol^{-1})$
(i) $Cu(s) \longrightarrow Cu(g)$	+339
(ii) $Cu(g) \longrightarrow Cu^{2+}(g) + 2e$	+2711
(iii) $Cu^{2+}(g) + (aq) \longrightarrow Cu^{2+}(aq)$	-2100
(iv) $\frac{1}{2} H_2(g) + (aq) \longrightarrow H^{+}(aq) + e$	+446

(a) Calculate the standard enthalpy change for the reaction. *(03 marks)*
$H_2(g) + Cu^{2+}(aq) \longrightarrow Cu(s) + 2H^{+}(aq)$

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(b) (i) State whether reduction of copper(II) ions by hydrogen is feasible or not. *(½mark)*

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(ii) Give a reason for your answer. *(01mark)*

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2. Write equations stating the conditions for the reaction to show how methylbenzene can be converted to;

(a) ***$CONH_2$*** *(3½ marks)*

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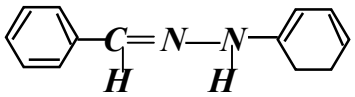
(b)  *(02 marks)*

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3. State what would be observed and write equation for the reaction that would take place when acidified hydrogen peroxide solution is added to a solution containing;

(a) Manganate(VII) ions

Observation; *(1½marks)*

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Equation;

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(b) Dichromate (VI)ions

Observation; *(01 mark)*

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Equation;

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4. (a) Define the term **freezing point constant of a substance**. *(01mark)*

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(b) (i) The freezing point of a 3.0% aqueous solution of solute ***Q*** was found to be -0.423℃ . Calculate the relative molecular mass of ***Q***.*(molar freezing point constant for water is 18.6℃ per 100g per mole)*

(2½ marks)

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(ii) State how the relative molecular mass of ***Q*** would change if it ionises in water. Give a reason for your answer. *(1½marks)*

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5. Some of the complexes formed by copper and iron are $[Cu(H_2O)_4]SO_4$ and $Fe(CO)_5$ respectively.

(a) Name the complexes; *(01 mark)*

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(b) State the;

(i) co-ordination number of copper in the complex. *(½mark)*

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(ii) oxidation state of iron in the complex. *(½ mark)*

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(c) Write equation for the reaction that takes place when;

(i) excess concentrated hydrochloric acid is treated with copper(II) nitrate solution. *(1½ marks)*

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(ii) Iron(II) sulphate solution is warmed with acidified potassium chlorate (V) solution. *(1½marks)*

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6. (a) Hydrogen gas diffuses through a porous membrane 5.477 times faster than a vapour of an alcohol ***T***, $CnH_{2n+1}OH$. Determine the;

(i) relative molecular mass of ***T***. *(1½ marks)*

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(ii) molecular formula of ***T***. *(01 mark)*

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

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(iii) ***T*** reacts with aqueous iodine solution and sodium hydroxide solution to give a pale yellow precipitate.Identify ***T***. *(½ mark)*

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7. Ammonium nitrate undergoes hydrolysis in water according to the following equation.

$NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O^+{}_{(aq)}$

(a) 0.2 $moldm^{-3}$ of ammonium nitrate solution has a pH of 5.3. Calculate the hydrolysis constant, Kh. *(1½ marks)*

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(b) $30cm^3$ of 0.2 M ammonia solution were mixed with an equal volume of 0.2M nitric acid. Calculate the pH of the resultant solution formed. *(3½ marks)*

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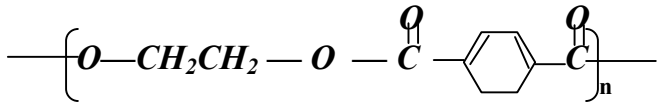
8. The structural formula of a polymer ***R*** is



(a) Write the structural formula(s) and name(s) of the monomer(s) of ***R***. *(02 marks)*

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(b) A 1.8% solution of ***R*** in benzene has an osmotic pressure of 1948Nm^{-2} at 27℃. Determine the;

(i) formula mass of ***R***. *(02 marks)*

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(ii) value of ***n***. *(01 mark)*

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9. (a) (i) Write the electronic configuration of tin atom. *(01 mark)*

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(ii) State the common oxidation states exhibited by tin in its compounds. *(01 mark)*

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

(i) tin(II) chloride and iron(III) chloride solution. *(1½marks)*

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(ii) tin(IV) chloride and water. *(1½marks)*

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SECTION B: (54Marks)

Attempt only **six** *questions from this* Section.
Additional questions answered will not be marked

10. During the manufacture of sulphuric acid by contact process, sulphur dioxide is catalytically oxidized to sulphur dioxide according to the following equation.

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \Delta H^{\theta} = {}^{-}197 KJmol^{-1}$$

(a) (i) Name **one** source of sulphur dioxide and **one** source of oxygen used in the contact process. *(02 marks)*

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(iii) State the industrial conditions used to obtain maximum yield of sulphur dioxide. *(1½marks)*

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(b) 3.0 moles of sulphur dioxide were mixed with 1.4 moles of oxygen in a 4.8-litre container. In equilibrium at 450℃, 0.8 moles of oxygen remained. Calculate the value of the equilibrium constant, K_c for the reaction at this temperature. *(3½marks)*

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(c) Concentrated sulphuric acid is 98% w/w and has a density of $1.84gcm^{-3}$. Calculate the morality of the concentrated sulphuric acid. *(02 marks)*

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11. (a) (i) State the conditions for the reaction between benzene and ethanoyl chloride. *(01 mark)*

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(ii) Outline the mechanism for the reaction that took place in (a) (i) above. *(04 marks)*

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(b) Write equations to show how the products of the reaction in (a) above can be converted to poly(phenylethane). *(04 marks)*

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12. (a) Write the formula and name of one ore of aluminium. *(01 mark)*

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(b) In the extraction of aluminum, the ore is first digested with sodium hydroxide solution. Write equation(s) for the reaction(s) that take(s) place. *(02 marks)*

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(c) Outline the steps that are carried out after digesting the ore with sodium hydroxide to form the purified ore. *(03 marks)*

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(d) Describe how pure aluminium is obtained from the purified ore. Write equation for the reaction. *(02 marks)*

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(e) State why the anodes are replaced from time to time during extraction of aluminium. *(01 mark)*

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13. (a) Define the term **solubility product**. *(01 mark)*

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(b) The pH of a saturated solution of magnesium hydroxide is 10.46 at 25℃. Calculate the concentration of the following ions in the saturated solution. ($K_w = 1.0 \times 10^{-14}$)

(i) hydroxide ions. *(1½marks)*

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(ii) magnesium ions. *(1½marks)*

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(c) Calculate the solubility product Ksp of magnesium hydroxide at 25℃. *(1½marks)*

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(d) Determine the solubility of magnesium hydroxide in a 0.1M sodium hydroxide solution. *(3½marks)*

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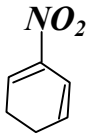
14. Complete the following equations and outline the mechanism for the reaction in each case.

(a)  + $CH_3C(CH_3)=CH_2$ $\xrightarrow{H^+}$ ..... *(03marks)*

Mechanism;

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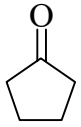
(b)  + $H_2N—NH$  $\xrightarrow{H^+}$ ..... *(04marks)*

Mechanism;

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(c) $CH_3C(CH_3)=CHCH_3 + Br_2$ $\xrightarrow{NaCl(aq)}$ ..... *(02 marks)*

Mechanism;

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15. (a) Write equation for the reaction between chlorine and;

(i) iron(II) sulphate solution. *(1½marks)*

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(ii) hot concentrated potassium hydroxide solution. *(1½marks)*

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(iii) sodium thiosulphate solution. *(1½marks)*

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(b) Some thermo-chemical data;rubidium, chlorine and rubidium chloride is given below.

$Rb_{(s)} + Cl_{2(g)} \longrightarrow 2RbCl_{(s)}$	$\Delta H_1 = {}^{-}860KJmol^{-1}$
$Rb^{+}_{(g)} + Cl^{-}_{(g)} \longrightarrow RbCl_{(s)}$	$\Delta H_2 = {}^{-}665KJmol^{-1}$
$Rb_{(s)} \longrightarrow Rb_{(g)}$	$\Delta H_3 = {}^{+}84KJmol^{-1}$
$Rb_{(g)} \longrightarrow Rb^{+}_{(g)} + e$	$\Delta H_4 = {}^{+}397KJmol^{-1}$
$Cl_{2\,(g)} \longrightarrow 2Cl_{(g)}$	$\Delta H_5 = {}^{+}242KJmol^{-1}$

(i) Construct an energy cycle for the formation of rubidium chloride from its elements. *(03 marks)*

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(ii) Calculate the electron affinity of chlorine. *(1½marks)*

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16. (a) Compound ***Q*** contains 27.12% of carbon, 3.39% of hydrogen, 36.16% of oxygen and the rest being nickel.Calculate the empirical formula of ***Q***.
(02 marks)

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(b) Determine the molecular formula of ***Q****(vapour density of* ***Q*** *is 88.5)*
(01 mark)

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(c) When ***Q*** was heated with concentrated sulphuric acid, ethanoic acid vapourwere produced. Identify ***Q***. *(01 mark)*

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(d) Write equation(s) for the reaction(s) that take place when a solution of ***Q*** is treated with;

(i) iron(III) chloride on heating. *(1½marks)*

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(ii) excess ammonia solution. *(02 marks)*

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(e) State what would be observed in (d)(ii) above. *(1½marks)*

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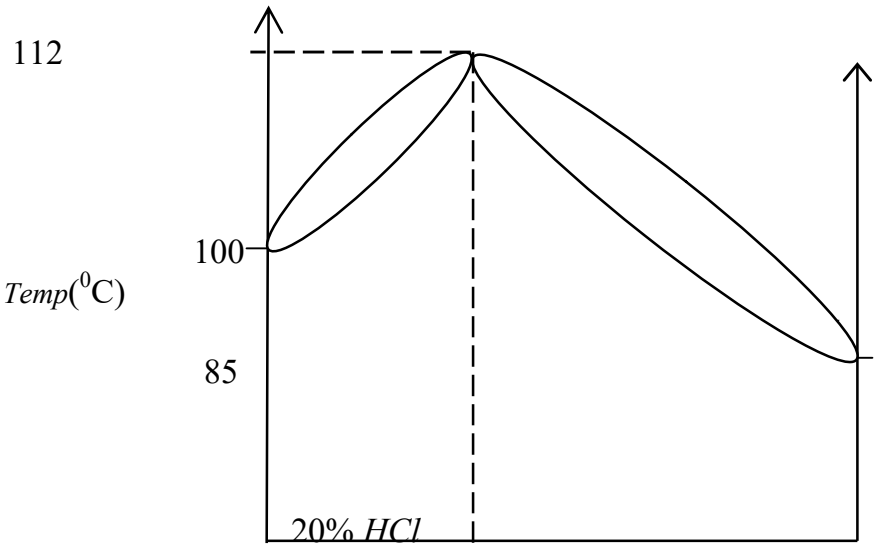
17. The phase diagram for the mixture of water and hydrochloric acid is shown below.



(a) (i) State how the mixture of hydrochloric acid and water deviates from Raoult's law. *(½mark)*

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(ii) Give a reason for your answer. *(01 mark)*

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(b) Explain the causes of the deviation you have identified in (a) above. *(03 marks)*

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(c) Describe what happens when a liquid mixture containing 50% hydrochloric acid is fractionally distilled. *(03 marks)*

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(d) State **three** reasons why azeotropic mixtures are not considered as pure substances. (*1½marks)*

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END