U.A.C.E

CHEMISTRY

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Past Papers

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P525 / 1
CHEMISTRY
Paper 1
Nov. / Dec. 2006
2 hours 45 minutes

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

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

All *questions must be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

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

Molar volume of gas at s.t.p. is 22.4 litres.

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

Answer all questions from this section.

1. The rate equation for a certain reaction is;

Rate = K [P] $[Q]^2$ [R].

(a) State what would happen to the rate of reaction if:

(i) the concentration of P and Q are kept constant, but that of R doubled. (½ mark)

....

....

(ii) the concentration of all the species are halved. (½ mark)

....

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(iii) concentration of all the species are doubled. (½ mark)

171

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(b) The following results were obtained in a study of the reaction between peroxodisulphate and iodide ions.

Experiment No.	$[S_2O_8^{2-}]$ / mol dm^{-3}	$[I^-]$ / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.024	0.024	9.6×10^{-6}
2	0.048	0.024	1.92×10^{-5}
3	0.048	0.012	9.6×10^{-6}

(i) Write the rate equation. (01 mark)

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(ii) Calculate the rate constant for the reaction and state its units.
(1½ marks)

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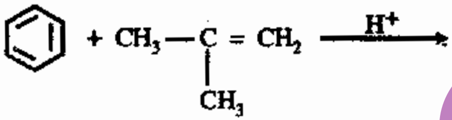
2. Complete the following equations and write the accepted mechanism for the reaction in each case.

(a)  ....

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....*(3½ marks)*

(b)  ....

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....*(03 marks)*

3. (a) Complete the following equations for the nuclear reactions.

(i) $^{35}_{17}Cl + ^{1}_{0}n \longrightarrow ^{1}_{1}H +$ ....

(01 mark)

(ii) $^{214}_{83}Bi \longrightarrow 3\beta + 2\alpha +$ ....

(01 mark)

(iii) $^{2}_{1}H + ^{10}_{5}B \longrightarrow ^{1}_{0}n +$ ....

(01 mark)

(b) When a radioactive isotope was stored for 42 days, it retained $\frac{1}{8}^{th}$ of its original activity. Calculate the half–life of the isotope. (*02 marks*)

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4. (a) State the co-ordination number and oxidation states of the central atoms / ions in the following complexes. (*03 marks*)

Complex	**Co-ordination number**	**Oxidation state.**
$[Cr(H_2O)_6Br_3]$		
$[CoCl_4]^{2-}$		
$[Ni(H_2O)_6]^{2+}$		

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(b) Briefly explain why transition elements form complexes. (*2½ marks*)

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5. Compound Q, C_7H_7Br burns with a sooty flame.

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

....

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4

(b) When Q was heated with aqueous sodium hydroxide, a primary alcohol, Z was formed.

(i) identify Q. (*½ mark*)

(ii) Write an equation and outline a mechanism for the reaction between Q and sodium hydroxide. (*1½ marks*)

(iii) Write an equation to show how Z can be converted into

 CH = N − OH. (*2½ marks*)

(a) Write the electronic configuration of copper. (*01 mark*)

(b) State two properties of copper as a transition element. (*01 mark*)

(c) Hydrated copper(II) sulphate was dissolved in water. Write equation(s) for the reaction(s) that took place. (*03 marks*)

7. 50.0 g of substance Y was dissolved in water to make 1000 cm^3 of solution. If the partition coefficient of Y between water and ether is 0.2, calculate the mass of Y extracted by shaking the 1000 cm^3 of solution with:

(a) 500 cm^3 of ether. *(02 marks)*

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(b) **two** successive portions of 250 cm^3 of ether. *(03 marks)*

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8. Draw the structures and name the shapes of the following molecules / ions. *(4½ marks)*

Molecule/ ion	Structure	Shape
CO_3^{2-}		
SiF_4		
$(CH_3)_3N$		

9. (a) The standard enthalpy change of formation of silicon(IV) chloride is $-610\ kJ\ mol^{-1}$.
The standard enthalpy changes of atomization of silicon and chlorine are $+338$ and $+122\ kJ\ mol^{-1}$ respectively.
Use these values to construct a Born – Harber cycle for the formation of silicon(IV) chloride from its elements and indicate the energy changes involved. *(02 marks)*

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(b) Calculate the average bond energy of the Si – Cl bond. *(02 marks)*

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SECTION B

Attempt six questions from this section.

10. (a) Alkenes react with bromine according to the following equation:

$$RCH=CH_2 + Br_2 \xrightarrow{CCl_4} RCH(Br)-CH_2Br$$

2.8 g of an alkene **X** reacted completely with 4.0 g of bromine.

(i) Determine the number of moles of **X** that reacted with bromine. *(01 mark)*

....

....

....

(ii) Calculate the molecular mass of **X**. *(01 mark)*

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(iii) Determine the molecular formula of **X**. *(01 mark)*

....

....

(iv) Write the structural formulae of all the possible isomers of **X**. *(1½ marks)*

....

....

(b) Ozonolysis of **X** gave only one product. Identify **X**. *(01 mark)*

....

(c) Write the mechanism of the reaction between **X** and water in the presence of sulphuric acid. *(3½ marks)*

....

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....

11. (a) State three factors that can affect molar conductivity of electrolytes. *(1½ marks)*

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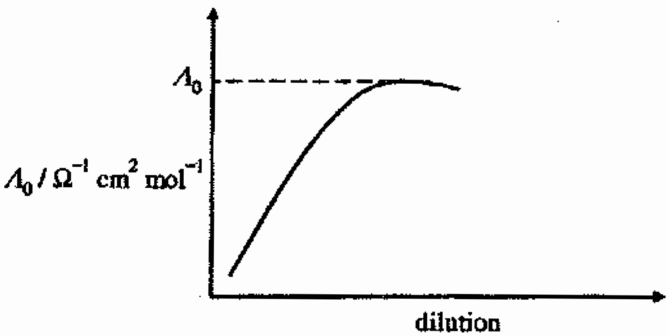
(b) The graph below shows the variation of molar conductivity of a strong electrolyte with dilution.



8

Briefly explain the shape of the graph. (*2½ marks*)

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(c) The molar conductivity of nitric acid, potassium nitrate and potassium fluoride are 421, 145 and 129 $\Omega^{-1}\ cm^2\ mol^{-1}$ respectively at infinite dilution.

Calculate the:

(i) molar conductivity of hydrofluoric acid at infinite dilution. (*02 marks*)

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(ii) dissociation constant, k_a, of a 0.1 M hydrofluoric acid solution. (The electrolytic conductivity of hydrofluoric acid is $3.15 \times 10^{-5}\ \Omega^{-1}\ cm^{-1}$). (*03 marks*)

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12. Carbon, silicon, germanium, tin and lead are in group (IV) of the Periodic Table.

(a) (i) Write the general outermost electronic configuration of the elements. (*01 mark*)

....

(ii) State the common oxidation states exhibited by the elements in their ions or compounds. (*01 mark*)

....

(b) State what would be observed and write equation for the reaction that would take place, if any, when the following compounds are treated with water.

(i) $C\,Cl_4$ *(01 mark)*

(ii) $Si\,Cl_4$ *(03 marks)*

(iii) $Sn\,Cl_4$ *(03 marks)*

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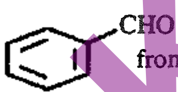
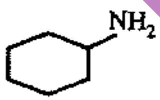
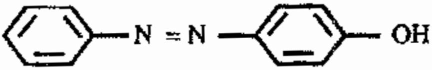
13. Write equations to show how the following compounds can be synthesized.

(a)  from benzene. *(02 marks)*

(b)  from cyclohexene. *(1½ marks)*

(c) $(CH_3CH_2)(CH_3)C=N-OH$ from but-1-ene. *(03 marks)*

(d)  from aniline. *(2½ marks)*

14. (a) Name one source of nitrogen and one source of hydrogen for use in the manufacture of ammonia.. *(01 mark)*

(b) Nitrogen and hydrogen react to form ammonia according to the following equation:

$$3H_2\,(g) + N_2\,(g) \rightleftharpoons 2NH_3\,(g), \quad \Delta H = -92\ \text{kJ mol}^{-1}.$$

State what would happen to the position of the equilibrium and in each case give a reason, if:

(i) the pressure of the system is increased. *(1½ marks)*

(ii) the temperature of the system is increased. *(1½ marks)*

(iii) iron is added to the system. *(1½ marks)*

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....

(c) At a certain temperature, the equilibrium constant for the reaction between nitrogen and hydrogen k_P, was 4.82×10^{-5} atm^{-2} and the partial pressures of nitrogen and hydrogen are 30 and 120 atmospheres respectively.

(i) Write an expression for the equilibrium constant, k_P. *(½ mark)*

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....

(ii) Calculate the partial pressure of ammonia at equilibrium. *(03 marks)*

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15. (a) A chloride of Aluminium, X, contains 20% Aluminium and 80% chlorine.

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

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(ii) Determine the molecular formula of **X**.
(The vapour density of **X** is 133.5). *(1½ marks)*

....

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(iii) Write the structural formula of **X**. *(01 mark)*

....

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....

(b) Write an equation to show how aluminium chloride can be prepared from aluminium. *(01 mark)*

....

(c) Aluminium chloride was dissolved in water.
Write the equation for the reaction that took place. *(1½ marks)*

....

(d) Sodium carbonate was added to an aqueous solution of aluminium chloride.

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

....

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

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(a) The osmotic pressure of a solution containing 4 g per litre of a polymer is 65 Nm^{-5} at 298 K. Calculate the approximate molecular mass of the polymer. *(02 marks)*

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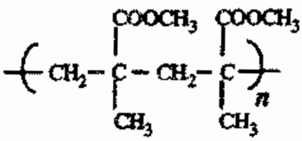
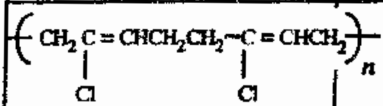
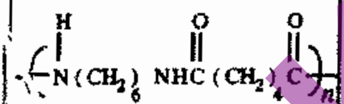
(b) The structural formulae of some polymers are given in the table below. For each polymer, write the structural formula of the monomer(s), the name(s) of the monomer(s), the type of polymerization and one use of the polymer. *(07 marks)*

Polymer	Structure of monomer(s)	Name of monomer(s)	Type of polymerization	Use of polymer
				
				
				

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17. (a) What is meant by the term common ion effect ? *(01 mark)*

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....

(b) Calcium iodate, $Ca(IO_3)_2$ is sparingly soluble in water.

Write:

(i) the equation for the solubility of calcium iodate in water. (*1½ marks*)

....

(ii) the expression for the solubility product, K_{sp} of calcium iodate.

....

(*01 mark*)

(c) If the solubility product of calcium iodate at 25^0C is 1.95×10^{-4} mol dm^3, calculate the solubility in moles per litre at 25^0C of calcium iodate in

(i) water. (*1½ marks*)

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(ii) a 0.1 M solution of sodium iodate. (*02 marks*)

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(d) Comment on your answers in (c) above. (*02 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)															

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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. $\underset{H}{1}$ — indicates Atomic number.

2. $\underset{1.0}{H}$ — indicates relative Atomic mass.

END.

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Paper 2
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2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer **five** *questions, including* **three** *questions from Section* **A** *and any* **two** *from Section* **B**.

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

 Turn Over

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SECTION A

Answer **three** *questions from this section.*

1. (a) Write:

(i) the electronic configuration of manganese atom. (Atomic number = 25). *(01 mark)*

(ii) the possible oxidation states of manganese. *(2½ marks)*

(b) (i) Write the half equation for the reduction of potassium permanganate in acidic medium. *(1½ marks)*

(ii) State the change in the oxidation state of the manganese in the reaction in (b)(i) above. *(01 mark)*

(c) State **three** advantages of using potassium permanganate in volumetric analysis. *(03 marks)*

(d) Briefly explain why hydrochloric acid and nitric acid are not used for acidifying potassium permanganate solution during volumetric analysis. *(03 marks)*

(e) Explain what would be observed if aqueous sodium hydroxide solution was added drop-wise till in excess to a solution containing manganese(II) ions. *(06 marks)*

(f) Name a reagent apart from aqueous ammonia and sodium hydroxide solution that can be used to distinguish manganese(II) ions, Mn^{2+} from Nickel ions, Ni^{2+}.

State what would be observed if each of them is separately treated with the reagent you have named. *(02 marks)*

2. (a) Explain what is meant by the term **ideal solution.** *(03 marks)*

(b) At Standard atmospheric pressure, hydrochloric acid and water form a **constant boiling point mixture** having a boiling point of 110 ^{0}C and composition 20% by mass of hydrochloric acid.

(i) Define the term **constant boiling point mixture.** *(02 marks)*

(ii) Sketch a labelled diagram of the boiling point – composition for hydrochloric acid and water system.

[The boiling points of water and hydrochloric acid are 100 ^{0}C and 85 ^{0}C respectively.] *(03 marks)*

(iii) Describe what would happen if a mixture of 10% hydrochloric acid is fractionally distilled. *(03 marks)*

(c) A constant boiling point mixture of hydrochloric acid and water has a density of $1.18\ g\ cm^{-3}$. Calculate the volume of the acid needed to prepare one litre of 2 M hydrochloric acid solution. *(03 marks)*

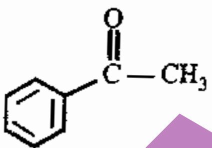
(d) The vapour pressure of ethanol at $20\ ^0C$ is 43.6 mm Hg while that of benzene at the same temperature is 75.2 mm Hg. The mole fraction of benzene is 0.09 for a mixture of benzene and ethanol at $20\ ^0C$.

Calculate:

(i) the vapour pressure of the mixture. *(04 marks)*

(ii) the mole fraction of benzene in the vapour phase. *(02 marks)*

3. For each of the following pairs of compounds:

(i)  and 

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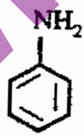
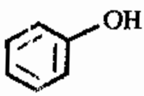
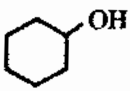
(ii)  and 

(iii) CH_3CO_2H and HCO_2H.

(iv)  and 

name one reagent which;

(a) when reacted with each member of the pair will show similar observation. *(08 marks)*

(b) can be used to distinguish between the members of each pair.

In each case state what would be observed when each member of the pair is reacted with the reagent you have named. *(12 marks)*

4. (a) (i) Define the term **enthalpy of solution.** *(01 mark)*

(ii) State the energy terms that determine the magnitude and sign of the enthalpy of solution of an ionic salt. *(02 marks)*

(iii) Describe an experiment that can be used to determine the enthalpy of solution of an ionic salt. *(09 marks)*

Your answer should include treatment of results and any assumptions used in the experiment .

(*Diagrams are* **not** *required.*)

(b) Some thermo-chemical data of copper, copper(II) chloride and chlorine are given below.

Enthalpy of formation of $CuCl_2$	$= -220\ kJ\ mol^{-1}$
Enthalpy of sublimation of Cu	$= +338.3\ kJ\ mol^{-1}$
First ionization energy of Cu	$= +745\ kJ\ mol^{-1}$
Second ionization energy of Cu	$= +1958\ kJ\ mol^{-1}$
First electron affinity of chlorine	$= -364.0\ kJ\ mol^{-1}$
Bond dissociation energy of chlorine	$= +121.1\ kJ\ mol^{-1}$

(i) Draw an energy level diagram which can be used to determine the lattice energy of copper(II) chloride. *(04 marks)*

(ii) The hydration energy of copper(II) chloride is $-2883.9\ kJ\ mol^{-1}$. Determine the enthalpy of solution of copper(II) chloride. *(03 marks)*

(iii) Comment on the solubility of copper(II) chloride. *(01 mark)*

SECTION B

Answer **two** *questions from this section.*

5. Nitrogen (II) oxide combines with oxygen at 80 ^0C and 200 atmospheres to form nitrogen (IV) oxide according to the following equation:

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}, \ \Delta H = -x\ kJ\ mol^{-1}.$$

(a) (i) Write an expression for the equilibrium constant, k_p, for the reaction. *(01 mark)*

(ii) Calculate k_p, if the mixture contained 67% nitrogen (IV) oxide at equilibrium. *(3½ marks)*

(b) State how the value of k_p will be affected if:

(i) temperature is increased. *(01 mark)*

(ii) a catalyst is added. *(½ mark)*

(c) The Kinetic data for the reaction in (a) is shown in the table below:

Initial rate / $Nm^{-2}\,s^{-1}$	6.8	27.2	61.2	108
P^2_{NO} / $N^2\,m^{-4}$	0.04	0.16	0.36	0.64

P_{NO} = the partial pressure of NO.

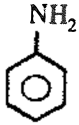
(i) Plot a graph of **initial rate** against P^2_{NO}. *(03 marks)*

(ii) Using the graph, determine the order of the reaction with

[6]

6. Explain the following observations.

(a) The basic strengths of aminobenzene, ammonia and dimethylamine are in the order.

 $< NH_3 < (CH_3)_2NH.$ (*04 marks*)

(b) The tendency of group(II) elements to form complex ions is in the order:

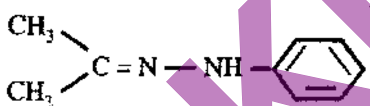
Be > Mg > Ca > Ba (*04 marks*)

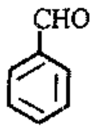
(c) The bond angle in water molecule is 104^0 whereas that in a molecule of ammonia is 107^0. (*04 marks*)

(d) The acid dissociation constant, k_a, of bromoethanoic acid is greater than that of ethanoic acid, at the same temperature. (*04 marks*)

(e) Ammonia boils at $-33\ ^0C$ whereas phosphine, pH_3, boils at $-88\ ^0C$. (*04 marks*)

7. Write equations to show how the following compounds can be synthesized.

(a)  from propene. (*05 marks*)

(b)  from benzene. (*02 marks*)

(c) $CH_3CH_2C \equiv CH$ from ethanol. (*7½ marks*)

(d) $CH_3CH_2NH_2$ from ethanal. (*03 marks*)

(e) CH_3CO_2H from ethene. (*2½ marks*)

8. (a) Outline the reactions that take place in the blast furnace during the extraction of iron from Spathic iron, $Fe\ CO_3$. *(08 marks)*

(b) Briefly describe how iron reacts with the following. (*Your answer should include equations.*)

(i) water , *(3½ marks)*

(ii) chlorine , *(2½ marks)*

(iii) dilute sulphuric acid , *(03 marks)*

(iv) concentrated sulphuric acid. *(03 marks)*

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END.

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

Signature ....

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CHEMISTRY
PAPER 1
Nov. / Dec. 2005
2 hours 45 minutes

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

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

All *questions must be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

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

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SECTION A

*Answer **all** questions from this Section.*

1. The standard electrode potentials for some half-cells are shown below:

$Fe^{3+}_{(aq)}$ / $Fe^{2+}_{(aq)}$	+0.76 V
$I_{2\,(aq)}$ / $I^{-}_{(aq)}$	+0.54 V

(a) Write:

(i) the cell convention for the combined cell. *(01 mark)*

....

....

(ii) the equation for the overall cell reaction. *(1½ marks)*

....

....

(b) Calculate the overall electrode potential for the cell. *(1½ marks)*

....

....

(c) (i) State whether the reaction is feasible or not. *(0½ mark)*

....

....

(ii) Give a reason for your answer in (c)(i). *(0½ mark)*

....

....

2. The following reagents can be used to distinguish between classes of organic compounds.

Name the **class** of organic compounds and in each case state what would be observed if the reagent is separately treated with a member of each class of the compounds you have named.

(a) **Reagent**: Copper(II) sulphate and sodium hydroxide solution. *(03 marks)*

Class: ....

Observations: ....

....

(b) **Reagent**: Anhydrous zinc chloride and concentrated hydrochloric acid. *(04 marks)*

Class: ....

Observations:..

....

....

3. (a) Compare the reactivity of the following metals with water:

(i) beryllium *(01 mark)*

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(ii) magnesium *(01 mark)*

....

....

(iii) barium *(01 mark)*

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158

(b) Write an equation for the reaction between:

(i) the oxide of phosphorus and water. *(1½ marks)*

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....

(ii) the oxide of silicon and sodium hydroxide. *(1½ marks)*

....

....

4. (a) Define the term **Osmotic pressure**. *(02 marks)*

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Turn Over

(b) The osmotic pressure of a solution containing 42.0g of a substance Y is 5.62×10^5 Nm^{-2} at 20^0C. Calculate the relative molecular mass of Y. *(2½ marks)*

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....

5. Complete the following equations and write the IUPAC name of the main organic product in each case.

(a) $CH_3CH_2CO_2H + PCl_5 \xrightarrow{\text{heat}}$ *(1½ marks)*

....

(b) $HC \equiv CH \xrightarrow{Ag(NH_3)_2^+ (aq)}$ *(1½ marks)*

....

6. Complete the following equation for the nuclear reactions:

(a) ${}^{239}_{94}Pu + {}^{1}_{0}n \longrightarrow {}^{91}_{39}Y + {}^{146}_{55}Cs +$ .... *(01 mark)*

(b) ${}^{239}_{92}U \longrightarrow {}^{239}_{93}NP +$ .... *(01 mark)*

(c) ${}^{226}_{88}Ra \longrightarrow {}^{4}_{2}He +$ .... *(01 mark)*

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

(a) $CH_3CH = CH_2 \xrightarrow{H^+/H_2O}$ *(04 marks)*

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4

(b)  $—CH_2—CH_2Br + CH_3CH_2O^-Na^+ \xrightarrow[\text{heat}]{CH_3CH_2OH}$ *(02 marks)*

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8. A dark purple crystalline solid Z, dissolves in water to give a violet solution. When aqueous sodium hydroxide was added to the solution of Z dropwise until in excess, a green precipitate was formed and it dissolved in excess sodium hydroxide to give a green solution.

(a) Identify the cation in Z. *(01 mark)*

(b) Write the formula of the species responsible for the formation of:

(i) the violet solution. *(01 mark)*

(ii) the green solution. *(01 mark)*

(c) When hydrogen peroxide was added to the green solution, a yellow solution was formed, which on treatment with ethanoate solution formed a yellow solid.

Write an equation for the reaction leading to the formation of:

(i) the green solution. *(1½ marks)*

(ii) the yellow solution. *(1½ marks)*

(iii) the yellow solid. *(1½ marks)*

9. A solution containing 0.001 mol dm^{-3} of methanoic acid is 1% ionised.

Calculate:

(i) the pH of methanoic acid solution. *(02 marks)*

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(ii) the acid dissociation constant, K_a, for methanoic acid. *(02 marks)*

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SECTION B

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

10. (a) State:

(i) **Raoult's Law.** *(02 marks)*

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....

(ii) the conditions under which Raoult's law is valid. *(01 mark)*

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(b) Briefly describe why some solutions do not obey Raoult's law. *(06 marks)*

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11. (a) A compound X, $C_8H_{10}Br$ burns with a sooty flame.
Write all the possible structural formulae of X. *(1½ marks)*

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(b) When **X** was heated under reflux with aqueous sodium hydroxide solution, a compound ***Q***, $C_8H_{10}O$ was formed.

(i) Identify ***X*** and ***Q***. *(01 mark)*

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(ii) Write an equation and indicate a mechanism for the reaction leading to the formation of ***Q*** from ***X***. *(1½ marks)*

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(c) ***Q*** was converted in a one-step reaction to an alkene. Write equation and outline a mechanism for the reaction. *(3½ marks)*

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(d) The alkene in (c) was polymerised.

(i) Write the structural formulae of the polymer. *(01 mark)*

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....

(ii) State the type of polymerisation involved. *(0½ mark)*

....

12. Write equations to show how each of fluorine and chlorine react with:

(a) water.

(i) Fluorine *(1½ marks)*

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....

(ii) Chlorine *(1½ marks)*

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....

(b) cold dilute sodium hydroxide solution:

(i) Fluorine *(1½ marks)*

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(ii) Chlorine *(1½ marks)*

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1355

(c) hot concentrated sodium hydroxide solution:

(i) Fluorine *(1½ marks)*

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....

(ii) Chlorine *(1½ marks)*

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13. The Kinetics data for the reaction between **P** and sodium hydroxide is shown in the table below:

Concentration of **P** (mol l^{-1})	0.105	0.088	0.074	0.051	0.037	0.026	0.016	0.010
Time (hours)	0.0	3.5	7.0	14.5	20.0	27.0	35.5	45.0

(a) Plot a graph of concentration of **P** against time. *(3½ marks)*

(b) Determine:

(i) the half-life of **P**. *(2½ marks)*

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(ii) the order of the reaction. *(01 mark)*

....

(iii) the rate constant for the reaction. *(02 marks)*

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14. (a) (i) State what is meant by the term **thermo-setting plastic.** *(02 marks)*

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(ii) Give **one** example of a synthetic thermo-setting plastic. *(01 mark)*

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(b) Nylon – 6, 10 can be formed by reacting 1, 6 – diamino hexane with decane dioyl dichloride, $ClOC\{CH_2\}_8COCl$.

ls4

(i) Write an equation for the formation of nylon 6, 10. *(02 marks)*

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(ii) State the type of polymerisation involved in the formation of nylon 6, 10. *(01 mark)*

....

(c) The osmotic pressure of a solution containing $2 g dm^{-3}$ of nylon 6,10 at $25\,^0C$ was 0.155 mm Hg. Calculate the relative molecular mass of nylon 6,10.
[$R = 0.0821$ atm $l^{-1}\,{}^0C\,mol^{-1}$] *(2½ marks)*

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(d) State **one** use of nylon 6, 10. *(½ mark)*

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15. (a) (i) Write the electronic configuration of copper. *(01 mark)*

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(ii) State **two** properties which show copper as a d–block element. *(01 mark)*

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(b) Excess ammonia was shaken with equal volume of trichloromethane and a 0.05 M aqueous solution of copper(II) sulphate and allowed to stand. Some ammonia reacted with copper(II) ions to form a complex, $[Cu(NH_3)_n]^{2+}$. At equilibrium, the concentrations of ammonia in the trichloromethane and in the aqueous layers were 0.725 mol l^{-1} and 0.021 mol l^{-1} respectively.
(The partition coefficient K_D, of ammonia between water and trichloromethane is 25).

Calculate:

(i) the concentration of free ammonia in the aqueous layer. *(02 marks)*

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(ii) the concentration of ammonia that formed the complex with copper. *(02 marks)*

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(iii) the value of n in the complex. *(03 marks)*

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16. A compound P contains 52.2% carbon, 13.0% hydrogen, the rest being oxygen.

(a) Determine the empirical formula of P. *(02 marks)*

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153

(b) When vaporised, 0.1 g of P occupied $78.8 cm^3$ at $157\ ^0C$ and a pressure of 740 mm Hg.

(i) Calculate the formula mass of P. *(2½ marks)*

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(ii) Determine the molecular formula of P. *(1½ marks)*

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(iii) Write the structural formulae of all the possible isomers of P. *(01 mark)*

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....

(c) P does not react with sodium metal. Identify P. *(0½ mark)*

....

(d) Write an equation to show how P can be prepared from methanol. *(1½ marks)*

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17. (a) State:

(i) how the solubility product of a sparingly soluble salt may be determined. *(02 marks)*

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....

(ii) how the solubility of a sparingly soluble salt can be affected by adding a common ion. *(01 mark)*

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(b) Calcium fluoride is a sparingly soluble salt in water.

Write:

(i) an equation for the solubility of calcium fluoride. *(01 mark)*

....

....

(ii) an expression for the solubility product, Ksp of calcium fluoride. *(01 mark)*

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....

(c) Calculate the solubility of calcium fluoride in a solution containing $0.35 \text{ mol } l^{-1}$ of fluoride ions at 25^0C.
(Ksp = 1.7×10^{-10} at $25\ ^0$C). *(03 marks)*

(d) State **one** application of solubility product. *(01 mark)*

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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. $\frac{1}{H}$ - indicates Atomic number.

2. $\frac{H}{1.0}$ - indicates relative Atomic number.

END.

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P525 / 2
CHEMISTRY
Paper 2
Nov. / Dec. 2005
2 hours 30 minutes

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions, including* **three** *questions from Section* **A** *and any* **two** *from Section* **B** .

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

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Turn Over

SECTION A

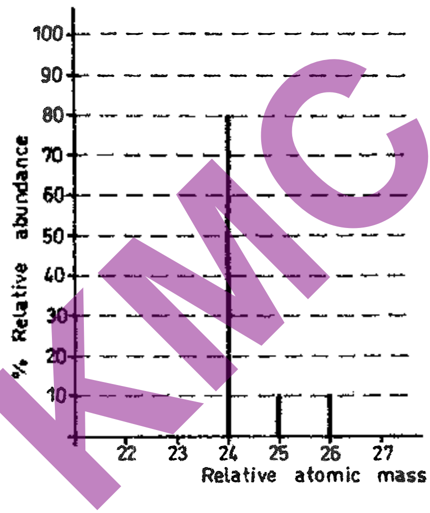
Answer **three** *questions from this Section.*

1. (a) The first, second, third and fourth ionization energies of an element Y are 736, 1451, 7740 and 10,500 respectively.

   (i) State the group in the PeriodicTable to which Y belongs and explain your answer. *(04 marks)*

   (ii) Explain why the second ionisation energy is greater than the first ionization energy. *(3½ marks)*

   (b) The mass spectrum of naturally occurring *Y* is shown in the figure below.



   (i) Briefly describe how the mass spectrum was obtained. *(08 marks)*

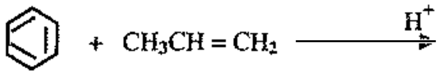
   (ii) State why the mass spectrum of *Y* shows three peaks. *(2½ marks)*

   (iii) Calculate the relative atomic mass of *Y*. *(02 marks)*

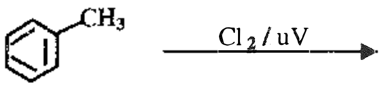
2

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

(a) $CH_3\underset{|}{\overset{Cl}{C}}H\,CH_2CH_3 \xrightarrow[\text{Heat}]{EtO^- / EtOH}$ (02 marks)

(b) 

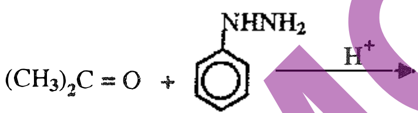
(4½ marks)

(c) 

(3½ marks)

(d) 

(02 marks)

(e) 

(05 marks)

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(f) $CH_3\overset{OH}{\overset{|}{C}}HCH_3 \xrightarrow[\text{Heat}]{\text{Conc. } H_2SO_4}$ (03 marks)

3. Carbon, silicon, tin and lead are elements in Group IV of the Periodic Table.

(a) State:

(i) the common oxidation states shown by elements in Group IV of the Periodic Table. *(01 mark)*

(ii) how the stability of the oxidation states of the Group IV elements vary down the group. (*Illustrate your answer with the chlorides of carbon and lead.*) *(03 marks)*

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

(c) Discuss the reactions of the chlorides of each element with water. *(06 marks)*

(d) Write equations for the reaction between:

(i) the oxide of each element and sodium hydroxide. (*06 marks*)

(ii) lead(IV) oxide and concentrated hydrochloric acid. (*1½ marks*)

(iii) lead(IV) oxide and warm concentrated hydrochloric acid. (*1½ marks*)

4. (a) Explain what is meant by the following terms:

(i) *molar conductivity*, (*02 marks*)
(ii) *electrolytic conductivity.* (*02 marks*)

(b) State the relationship between the **two** conductivities in (a). (*01 mark*)

(c) Draw sketch-graphs to show how molar conductivities of the following vary with concentration:

(i) a strong electrolyte. (*1½ marks*)
(ii) a weak electrolyte. (*1½ marks*)

(d) Explain the shapes of the graphs in (c). (*04 marks*)

(e) The table below shows the variation of conductivity with volume of ammonia when two inert electrodes connected to a conductivity metre were immersed in $50cm^3$ of 0.025 M Zinc nitrate solution and $2cm^3$ portions of 0.5 M ammonia, added at intervals.

Volume of ammonia solution (cm^3)	0	2	4	6	8	10	12	14
Conductivity of resultant solution (Ω^{-1} cm^{-1})	1.2	1.16	1.12	1.08	1.05	1.045	1.06	1.10

(i) Draw a graph of conductivity of solution versus volume of ammonia. (*03 marks*)

(ii) Determine the volume of ammonia solution that gave the lowest conductivity. (*01 mark*)

(iii) Determine the formula of the species present in the solution in (e)(i). (*04 marks*)

SECTION B

Answer **two** *questions from this section.*

5. Be, Mg, Ca, Sr and Ba are elements in group II of the Periodic Table.

(a) Describe and explain the trend in the reactivity of the elements with cold water down the group. *(08 marks)*

(b) Compare the solubility and basicity of the hydroxides of group II elements with the hydroxides of group I elements. *(3½ marks)*

(c) (i) Explain why beryllium and aluminium show a diagonal relationship. *(02 marks)*

(ii) Write equations to show how beryllium and aluminium each react with concentrated sodium hydroxide solution. *(03 marks)*

(d) A chloride of beryllium *Z*, contains 11.25% beryllium and 88.75% of chlorine.

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(i) Calculate the empirical formula of *Z*. *(1½ marks)*

(ii) Determine the molecular formula of *Z*. (The vapour density of $Z = 80$) *(01 mark)*

(iii) Write the structural formula of *Z*. *(01 mark)*

6. (a) (i) Describe how the molecular mass of a substance can be determined using freezing point depression method. (*Diagram* ***not*** *required.*) *(07 marks)*

(ii) Explain why the method you have described in (a)(i) is not suitable for determining the molecular mass of a polymer. *(02 marks)*

(b) Calculate the freezing point of a solution containing 4.2 g of ethane‒1 , 2 ‒ diol (molecular mass = 62) in 30 g of water. (k_f of water = 1.86 ^{0}C mol^{-1} kg^{-1}) *(04 marks)*

(c) The osmotic pressure of various concentrations of solute X in methyl benzene at 25 ^{0}C are given in the table below.

Concentration / g dm^{-3}	1.0	2.0	3.0	4.0	5.0	6.0
Osmotic pressure / Nm^{-2}	23	37	53	75	92	109

(i) Plot a graph of osmotic pressure against concentration. *(03 marks)*

(ii) Use the graph you have drawn to determine the molecular mass of X. ($R = 8.314\ JK^{-1}\ mol^{-1}$) *(04 marks)*

7. Briefly explain each of the following observations:

(a) Sodium chloride melts at 800 ^{0}C whereas Aluminium chloride sublimes at 180 ^{0}C. *(03 marks)*

(b) Graphite and copper are both conductors of electricity. *(04 marks)*

(c) Iodine is much more soluble in potassium iodide than in water. *(03 marks)*

(d) A solution of sodium thiosulphate becomes cloudy with the formation of a yellow precipitate when left standing in air. *(02 marks)*

(e) Phenylamine is a weaker base than ethylamine. *(04 marks)*

(f) Phenol is a stronger acid than cyclohexanol. *(04 marks)*

(a) (i) Write the formula and the name of one ore of copper. *(01 mark)*

(ii) Describe how pure copper can be extracted from the ore you have named in (a)(i).
(*Write equations for all reactions that take place.*) *(08 marks)*

(b) State the conditions under which copper reacts with the following acids and in each case write an equation for the reaction:

(i) sulphuric acid. *(03 marks)*

(ii) nitric acid. *(03 marks)*

(c) State what would be observed and write an equation for the reaction which will take place when the following reagents are added dropwise to a solution of copper(II) sulphate until in excess:

(i) concentrated hydrochloric acid. *(03 marks)*

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

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END.

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

Signature .. ..

P525 / 1
CHEMISTRY
PAPER 1
Nov. / Dec. 2004
2 hours 45 minutes

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

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

All *questions must be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

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 from this Section.*

1. (a) State Graham's law. *(02 marks)*

(b) A certain volume of oxygen diffused through a porous membrane in 120 s. Under the same conditions the same volume of a gas, X diffuses in 112 s. Calculate the relative molecular mass of X. *(3½ marks)*

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

(a)

$$CH_3\overset{\overset{\displaystyle O}{\|}}{C}CH_3 + NaHSO_3 \longrightarrow$$ *(2½ marks)*

(b)  + HNO_3 $\xrightarrow{\text{conc.}H_2SO_4}$ *(4½ marks)*

3. (a) Identify element X in the following equation for a nuclear reaction.

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{160}_{62}Sn + 4\,{}^{1}_{0}n + X.$$

(01 mark)

X is ....

(b) An element Y has three naturally occurring isotopes with isotopic masses and relative abundances as shown below:

Isotopic mass	Relative abundance (%)
23.98	78.60
24.98	10.11
25.98	11.29

Calculate the average atomic mass of Y. *(02 marks)*

4. (a) Complete the table below: *(4½ marks)*

Element	Formula of Oxide	Type of bonding in the oxide.	Structure of the oxide.
Al			
Si			
P			

(b) Write an equation for the reaction between the oxide of aluminium and sodium hydroxide. *(1½ marks)*

....

....

5. State what would be observed and write equation for the reactions that would take place when the following pairs of compounds are reacted.

(a) Propanol and silver nitrate in aqueous ammonia. *(02 marks)*

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Observation: ....

Equation: ....

....

(b) But–2–ene and acidified potassium permanganate solution. *(02 marks)*

Observation: ....

Equation: ....

....

6. During the extraction of aluminium, a current of 0.2 ampere was passed for one hour through aluminium sulphate solution.

(a) Write an equation for the reaction that took place at each electrode. *(03 marks)*

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(b) Calculate the mass of aluminium produced. *(03 marks)*

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7. A bromo alkane Y with molecular formula, C_4H_9Br when reacted with concentrated hydrochloric acid in the presence of anhydrous zinc chloride formed two layers of liquids immediately.

(a) Write the name and the structural formula of Y. *(01 mark)*

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(b) Write an equation and indicate a mechanism for the reaction between Y and sodium methoxide in methanol. *(03 marks)*

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8. (a) (i) State how the melting point and boiling point of group(II) metals differ from those of group (I). *(01 mark)*

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

....

(b) State reasons why beryllium differs from the rest of the elements in group(II) of the Periodic Table. (*04 marks*)

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9. (a) Write:

(i) an equation for the ionisation of methylamine in water. (*1½ marks*)

....

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

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(b) The hydrogen ion concentration of a 1 M methylamine solution is 2.5×10^{-13} mol l^{-1}. Calculate, K_b for methylamine. (*02 marks*)

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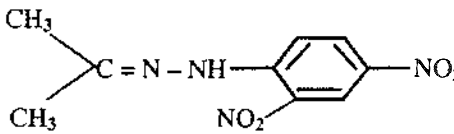
SECTION B : (54 MARKS)

Attempt **six** *questions from this Section.*

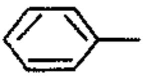
Write equations to show how the following compounds can be synthesized.

(a) *(02 marks)*



from propan–2– ol.

(b) $CH_3CH_2C \equiv C\,CH_2\,CH_3$ from but–1–ene. *(4½ marks)*

(c)  $NHCH_2CH_3$ from nitrobenzene. *(2½ marks)*

Turn Over

11. Compare the reactivity of fluorine and chlorine with the following compounds (*in each case illustrate your answer with equations.*)

(*05 marks*)

(a) water. ....

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(b) concentrated sodium hydroxide solution. (*04 marks*)

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144 ....

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12. (a) Define '**electrolytic conductivity**'. (*01 mark*)

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(b) The molar ionic conductivity at infinite dilution of some ionic species are shown below:

ion	λ^0 (Ω^{-1} cm^2 mol^{-1})
Na^+	50.1
OH^-	198.6
H^+	349.8
Cl^-	76.4

Calculate the electrolytic conductivities for:

(i) 0.01 M sodium hydroxide solution. *(02 marks)*

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(ii) a solution made by mixing 50cm^3 of 0.01 M sodium hydroxide and 50cm^3 of 0.02 M hydrochloric acid. *(05 marks)*

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(c) State **two** uses of conductivity measurements. *(01 mark)*

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Turn Over

13. 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 when the compounds are separately treated with the reagent you have named.

(a) CH_3CHO and CH_3CH_2CHO *(03 marks)*

(b) $CH_3CH_2CH_2NH_2$ and $CH_3NHCH_2CH_3$ *(03 marks)*

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(c) $CHO_3COO^-Na^+$ and $\begin{array}{l} COO^-Na^+ \\ | \\ COO^-Na^+ \end{array}$ *(03 marks)*

14. (a) The rate of a chemical reaction is given by the relationship:

$$\text{Rate} = k\,[A]^a\,[B]^b.$$

State:

(i) what each of the following stands for: *(03 marks)*

[A] ....

a ....

b ....

(ii) **one** factor that can affect the value of k. *(01 mark)*

....

(b) Write an equation for the decomposition of dinitrogen oxide. *(01 mark)*

....

(c) At 858 K, the half life of dinitrogen oxide is 75.09 hours.

Calculate:

(i) the rate constant for the decomposition of dinitrogen oxide. *(02 marks)*

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(ii) the total pressure after 75.09 hours at 858 K, if the initial pressure was one atmosphere. *(02 marks)*

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15. Write equations for the reactions which would take place and in each case, state what would be observed when:

(a) concentrated ammonia solution is added dropwise until in excess to an aqueous solution of cobalt(II) sulphate and the resulting solution allowed to stand in air. *(04 marks)*

Observation:..

....

Equation: ....

....

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....

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(b) excess concentrated hydrochloric acid is added to an aqueous solution of copper(II) sulphate. *(2½ marks)*

Observation:..

....

Equation: ....

....

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(c) sodium carbon solution is added dropwise until in excess, to an aqueous solution of chromium(III) sulphate. *(2½ marks)*

Observation:..

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Equation: ....

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16. (a) When 8.8 g of a hydrocarbon, Z was burnt in excess air, 14.4 g of water and 13.44 dm^3 of carbon dioxide were obtained at s.t.p. Determine the empirical formula of Z. *(3½ marks)*

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(b) The vapour density of Z is 22. Write the name and the molecular formula of Z. *(01 mark)*

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(c) (i) Write equations to show how Z can be synthesized from an alcohol. *(2½ marks)*

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(ii) Indicate a mechanism for the first stage of the reaction in (c)(i). *(02 marks)*

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Turn Over

17. The solubility product of Lead(II) chloride is 1.6×10^{-5} $mol^3 l^{-3}$ at 25°C.

(a) Write an expression for the solubility product of Lead(II) chloride. *(01 mark)*

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(b) Calculate:

(i) the concentration of the chloride ion in $mol\,l^{-1}$ in a saturated solution of Lead(II) chloride at 25 ^{0}C. *(3½ marks)*

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141

(ii) the solubility of Lead(II) chloride in grams per litre at 25 ^{0}C. *(2½ marks)*

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(c) (i) State what would be observed if a saturated solution of Lead(II) ethanoate was added to a solution of lead(II) chloride at 25 ^{0}C. *(01 mark)*

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

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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. $\overset{1}{\text{H}}$ - indicates Atomic number.

2. $\underset{1.0}{\text{H}}$ - indicates relative Atomic number.

END

P525 / 2
CHEMISTRY
Paper 2
Nov. / Dec. 2004
2 hours 30 minutes

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

140

INSTRUCTIONS TO CANDIDATES

Answer **five** *questions, including* **three** *questions from Section* **A** *and any* **two** *from Section* **B** .

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

 Turn Over

SECTION A

Answer **three** *questions from this Section.*

The vapour pressure (V.P.) of water and of an immissible liquid X at different temperatures are given in the table below:

Temp / ^0C	92	94	96	98	100
V.P. of X / kPa	6	8	12	15	17
V.P. of H_2O / kPa	74	80	88	94	101

(a) On the same axes, plot graphs of vapour pressure against temperature. *(04 marks)*

(b) (i) Determine the vapour pressures of the mixture of X and water at the temperatures given in the table above. *(02 marks)*

(ii) On the same axes of the graph in (a), plot a graph of the vapour pressure of the mixture versus the temperature. *(02 marks)*

(c) The distillate obtained from the mixture at 101 kPa contained 1.6 g of water and 1.1 g of X.

Calculate the relative molecular mass of X using the information from the graphs you have drawn. *(05 marks)*

(d) (i) Explain the principles in the separation of mixtures by steam distillation. *(05 marks)*

(ii) State any **two** advantages of steam distillation. *(02 marks)*

(a) The molar conductivity of sodium hydroxide solutions of different concentrations are shown in the table below:

Concentration / mol dm^{-3}	0.01	0.04	0.09	0.16	0.25	0.36
Molar conductivity, $\Lambda / \Omega^{-1} cm^2 mol^{-1}$	238	230	224	217	210	202

(i) Draw a graph of molar conductivity against the square root of concentration. *(04 marks)*

(ii) Explain the shape of the graph. *(4½ marks)*

(iii) Determine the value of molar conductivity at infinite dilution of sodium hydroxide and indicate its units. *(02 marks)*

(b) Using the same conductivity cell, the resistance of a 0.1 M potassium chloride solution and 0.1 M bromo ethanoic acid solution were found to be 24.96 and 66.50 ohms respectively at 25 ^{0}C when determined using the same conductivity cell. [The conductivity of potassium chloride at 25 ^{0}C is 0.011 64 Ω^{-1} cm^{-1} and the molar conductivity of bromo ethanoic acid at infinite dilution is 389 Ω^{-1}cm^{2}mol^{-1}.]

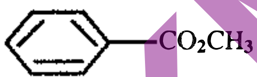
(i) Calculate the cell constant. *(02 marks)*

(ii) Calculate the molar conductivity of the 0.1 M bromo ethanoic acid. *(03 marks)*

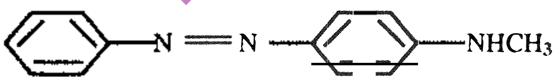
(iii) Determine the pH of 0.1 M bromo ethanoic acid. *(4½ marks)*

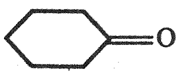
3. Write equations to show how the following compounds can be synthesized. Your answers should include reagents and conditions for the reactions.

139 (a) $CH_3CH_2OCH_2CH_3$ from ethene *(04 marks)*

(b)  from benzene *(05 marks)*

(c) $CH_3CH_2\underset{\displaystyle |\atop\displaystyle HNCH_2CH_3}{CH}CH_3$ from but-2-ene *(02 marks)*

(d)  from benzene. *(06 marks)*

(e)  from bromocyclohexane. *(03 marks)*

4. C, Si, Ge, Sn and Pb are elements in group(IV) of the Periodic Table.

(a) Explain the following trends among the group(IV) elements:

(i) electropositivity, *(04 marks)*

(ii) stability of +2 oxidation state. *(2½ marks)*

(b) State **four** properties in which carbon differs from the rest of the members of group(IV) elements. *(04 marks)*

(c) Explain why carbon tetrachloride molecule is non-polar yet the bonds in carbon tetrachloride are polar. *(03 marks)*

(d) A sample of lead(IV) oxide was treated with warm concentrated hydrochloric acid.

(i) State what was observed. *(1½ marks)*

(ii) Write an equation for the reaction. *(02 marks)*

(e) Equations for some half-cell reactions are shown below:

$$Sn^{4+}_{(aq)} + 2e^- \rightleftharpoons Sn^{2+}_{(aq)}, \ E^\theta = +0.15\ V$$

$$PbO_{2\,(s)} + 4H^+_{(aq)} + 2e^- \rightleftharpoons Pb^{2+}_{(aq)} + 2H_2O_{(l)}, \ E^\theta = +1.46\ V$$

(i) Write the overall cell equation for the spontaneously feasible reaction. *(02 marks)*

(ii) Calculate the E^θ_{cell} in (e)(i). *(01 mark)*

SECTION B

Answer **two** *questions from this Section.*

5. Explain the following observations:

(a) Although zinc belongs to the d– block elements in the Periodic Table, it does not behave as a typical transition element. *(03 marks)*

(b) The enthalpy of hydrogenation of cyclohexene to cyclohexane is $-120\ kJ\ mol^{-1}$ whereas that of benzene to cyclohexane is $-200\ kJ\ mol^{-1}$. *(04 marks)*

(c) Carbon dioxide is a gas at room temperature whereas silicon(IV) oxide is a solid with very high melting point. *(04 marks)*

(d) When sodium carbonate solution was added to a solution of aluminium chloride, a white precipitate was formed and a colourless gas evolved. *(05 marks)*

(e) When concentrated hydrochloric acid was added to a solution of copper(II) sulphate, the blue solution changed to yellow and on addition of water, the solution changed black. *(04 marks)*

6. Explain the following observations:

(a) 1 – bromobutane undergoes nucleophilic substitution reaction when heated with aqueous sodium hydroxide solution whereas bromobenzene does not react under similar conditions. *(04 marks)*

(b) Phenol (hydroxy benzene) is sparingly soluble in water but very soluble in dilute sodium hydroxide. *(2½ marks)*

(c) Iodine is sparingly soluble in water but dissolves readily in aqueous solution of potassium iodide. *(3½ marks)*

(d) Hydrogen flouride has a higher boiling point and is a weaker acid than hydrogen chloride. *(10 marks)*

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7. (a) State the distribution law. *(02 marks)*

(b) Describe how the distribution coefficient for butane –1, 4 – dioic acid (succinic acid) between water and ethoxy ethane can be determined. *(05 marks)*

(c) 100cm^3 of a solution contains 30g of substance, Z. Calculate the mass of Z that can be extracted by shaking the solution with:

(i) 100cm^3 of ethoxy ethane. *(03 marks)*

(ii) two 50cm^3 portions of ethoxy ethane. (The distribution coefficient of Z between ethoxy ethane and water is 5). *(05 marks)*

(d) Briefly describe how the distribution law can be used to determine the formula of the complex formed between copper(II) ions and ammonia. *(05 marks)*

8. (a) State what would be observed and write an equation for the reaction which takes place when:

(i) magnesium is reacted with steam. *(3½ marks)*

(ii) barium is reacted with water. *(03 marks)*

(b) Compare the reaction of berrylium and barium with sulphuric acid under various conditions. *(7½ marks)*

(c) Explain how the solubility of the hydroxides of the elements of the group(II) elements of the Periodic Table vary down the group. *(06 marks)*

END.

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

Signature ....

P525 / 1
CHEMISTRY
Paper 1
Nov. / Dec. 2003
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

137

INSTRUCTIONS TO CANDIDATES

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

All *questions must be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

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 from this Section.*

1. (a) Define the term **freezing point constant** of a substance. (*1½ marks*)

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(b) A solution containing 1.54 g of naphthalene ($C_{10}H_8$) in 18 g of camphor freezes at 148.3 ^{0}C.

Calculate the freezing point constant of camphor. (The freezing point of camphor is 175 ^{0}C.) (*3½ marks*)

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2. (a) State **three** properties in which beryllium resembles aluminium. (*03 marks*)

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(b) (i) What is the name given to the type of relationship in (a)? (*01 mark*)

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(ii) Name another pair of elements that show the type of relationship in (a). (*01 mark*)

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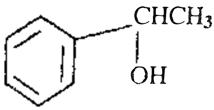
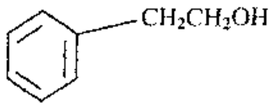
3. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with the compounds:

(a)  and 

136

(03 marks)

(b)  and $CH_3CH_2CH_2CH_2OH$

(03 marks)

4. (a) Define the term **molar enthalpy of hydration**. *(02 marks)*

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(b) The table below shows enthalpies of hydration of Mg^{2+} and Cl^- ions.

Ion	Enthalpy of hydration ΔH hyd / kJ mol^{-1}.
Mg^{2+}	1891
Cl^-	381

(i) State whether the values of enthalpies of hydration given in the table above is positive or negative. Give a reason for your answer. *(02 marks)*

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(ii) Calculate the enthalpy of hydration of magnesium chloride. *(1½ marks)*

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(a) Draw the shape of a sulphite ion, SO_3^{2-}. *(01 mark)*

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(b) Write equations to show the reaction between sulphite ions and

(i) iron(III) chloride. *(1½ marks)*

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(ii) potassium dichromate in acid solution. *(1½ marks)*

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6. A solution containing 2.3×10^{-6} mol dm^{-3} of aluminium hydroxide completely ionises in water ($K_W = 1 \times 10^{-14}$).

(a) Write equation for the reaction of aluminium hydroxide. *(1½ marks)*

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(b) Calculate the pH of the resultant solution. *(03 marks)*

135

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7. (a) When 4.90 g of an organic compound, X containing carbon and hydrogen only was burnt in oxygen, 15.78 g of carbon dioxide and 5.38 g of water were formed. Calculate the empirical formula of X. *(2½ marks)*

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(b) X was steam distilled at 80 ^{0}C and 760 mm Hg and the distillate was found to contain 90.8% by mass of X. (The vapour pressure of water at 80 ^{0}C is 240mm Hg).

(i) Calculate the formula mass of X. *(2½ marks)*

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(ii) Deduce the molecular formula of X. *(01 mark)*

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8. A crystalline solid Y dissolved in water to give a pink solution. Addition of excess aqueous sodium hydroxide produced a dirty white precipitate which rapidly turned brown on standing.

When nitric acid was added to the solution of Y followed by sodium bismuthate solution , the solution changed from pink to purple.

(a) Identify the cation in Y. *(01 mark)*

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(b) Write:

(i) the equation for the reaction that took place when sodium hydroxide was added to the solution. *(1½ marks)*

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(ii) the formula of the species responsible for the purple colour. *(01 mark)*

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(iii) equation for the reaction leading to the formation of the brown solid. *(1½ marks)*

9. Perspex is a synthetic polymer of formula: $\left[-CH_2-\underset{COOCH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}- \right]_n$

(a) (i) Write the structural formula of the monomer of perspex. *(01 mark)*

134

(ii) State the type of polymerisation involved in the formation of perspex. *(01mark)*

(b) When 1.25×10^{-3} moles of perspex was heated in the presence of silica as a catalyst, 4.85 g of monomer was produced. Determine the number of monomer molecules(n). *(03 marks)*

SECTION B

Attempt **six** *questions from this Section.*

10. (a) Name a reagent that can be used to distinguish between the following pairs of ions. In each case, state what is observed if each ion is separately treated with the reagent.

(i) Ba^{2+} and Ca^{2+} *(03 marks)*

Reagent:

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Observation:

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(ii) NO_2^- and NO_3^- *(03 marks)*

Reagent:

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Observation:

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(b) Write ionic equations for the reaction between sodium hydroxide and

(i) BeO *(1½ marks)*

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(ii) SiO_2 *(1½ marks)*

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11. Write equation to show how the following compounds can be synthesised:

(a) CH_3CHO from 1, 2 – dibromoethane. *(03 marks)*

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133

(b) CH_3CO_2H from iodomethane. *(2½ marks)*

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(c) $CH_3COOCH_2CH_3$ from chloroethane. *(3½ marks)*

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12. (a) The vapour pressure of a solution containing 108.2 g of a substance Y in 1000 g of water at 20 ^{0}C was reduced by 0.186 mm Hg.
(The vapour pressure of water at 20 ^{0}C is 17.54 mm Hg.)

Calculate the relative molecular mass of substance Y. *(04 marks)*

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(b) State **four** assumptions made in (a). *(03 marks)*

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(c) Explain why the vapour pressure of a solution containing a non – volatile solute is less than the vapour pressure of a pure solvent. *(02 marks)*

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3. Name the reagent that can be used to distinguish between the following pairs of compounds.
In each case, state what would be observed if the reagent is treated separately with each pair of compounds.

(a) HCOOH and CH_3COOH. *(03 marks)*

Reagent:

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Observation:

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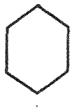
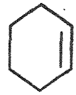
(b)  and  *(03 marks)*

Reagent:

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Observation:

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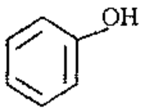
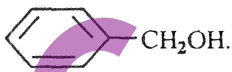
(c)  and  *(03 marks)*

Reagent:

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132 ....

Observation:

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14. 1 mole of sulphur trioxide was introduced into a 1 dm^3 vessel. The vessel was heated to 1000 K until equilibrium was attained. At equilibrium 0.35 mole of sulphur trioxide was present.

(a) Write:

(i) equation for the decomposition of sulphur trioxide. *(01 mark)*

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(ii) an expression for the equilibrium constant, k_C. *(01 mark)*

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(b) Calculate the k_c value. *(03 marks)*

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(c) 0.2 mole of SO_2, 0.1 mole of O_2 and 0.7 mole of SO_3 were introduced into the vessel in (a) at 1000K.

(i) Calculate the new k_c for the reaction value. *(03 marks)*

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(ii) Using your answers in (a)(ii) and (b)(i) above, state how the position of the equilibrium has been affected. *(01 mark)*

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15. (a) Compound X, C_3H_6O reacts with 2, 4 – dinitrophenyl hydrazine to form a yellow solid.
Write the structural formulae of all the possible isomers of X. *(01 mark)*

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(b) X does not react with Tollens reagent. Identify X. *(½ marks)*

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(c) Write equation and indicate a mechanism for the reaction between X and 2, 4 – dinitrophenyl hydrazine under acid conditions. *(4½ marks)*

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(d) Write equation to show how X can be prepared from an alkene. *(03 marks)*

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16. (a) State what is meant by the term **Order of a reaction**. *(02 marks)*

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(b) Methyl ethanoate is hydrolysed by water in the presence of an acid according to the following equation:

$$CH_3CO_2CH_3 + H_2O \overset{H^+}{\rightleftharpoons} CH_3CO_2H + CH_3OH.$$

(i) State the molecularity of the reaction. *(01 mark)*

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(ii) Determine the order of the reaction. (Assume that the acid takes part in the reaction.) *(01 mark)*

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(iii) State the conditions under which the reaction can be overall first order. *(02 marks)*

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(c) The table below shows some Kinetics data for the following reaction:
$3A + B \longrightarrow 2P$.

Experiment	**Initial concentration of A (mol dm^{-3})**	**Initial concentration of B (mol dm^{-3})**	**Initial rate (mol dm^{-3})**
1	0.20	0.20	1.2×10^{-8}
2	0.20	0.60	1.2×10^{-8}
3	0.40	0.60	4.8×10^{-8}

(i) Write the overall rate equation. *(1½ marks)*

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(ii) Calculate the rate constant and give its units. *(1½ marks)*

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17. (a) Write the equation for the:

(i) solubility of silver chromate in water. *(1½ marks)*

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(ii) solubility constant, k_p, for silver chromate. *(01 mark)*

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(b) The solubility of silver chromate at 25^0C is 3.207×10^{-2} g dm^{-3}. Calculate the solubility constant for silver chromate at 25^0C. *(03 marks)*

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130 ....

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(c) Determine the molar concentration of silver ions required to precipitate silver chromate from an aqueous solution containing 0.005 M chromate ions. *(02 marks)*

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(d) A solution containing silver ions was added to a solution containing 0.005 M chromate ions and 0.005 M chloride ions. State which of the salts AgCl or $AgCrO_4$ was precipitated first. Give a reason for your answer. [K_{sp}; for Ag Cl = 1.96×10^{-10} $mol^2 l^{-2}$]. *(1½ marks)*

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15

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 103	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. $\frac{1}{\text{H}}$ - indicates Atomic number.

2. $\frac{\text{H}}{1.0}$ - indicates relative Atomic number.

END

P525 / 2
CHEMISTRY
Paper 2
Nov. / Dec. 2003
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

129

INSTRUCTIONS TO CANDIDATES

Answer **five** *questions, including* **three** *questions from Section A and any* **two** *from Section B.*

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

 Turn Over

SECTION A

Answer **three** *questions from this Section.*

1. (a) State what is meant by the term **boiling point constant** of a liquid. *(02 marks)*

(b) Describe an experiment that can be used to determine the relative molecular mass of a compound using the method of elevation of boiling point of a liquid.

Draw a labelled diagram of the apparatus used. *(12 marks)*

(c) Explain why the method you have described in (b) is **not** suitable for the determination of the relative molecular mass of ethanoic acid in aqueous solution. *(03 marks)*

(d) A solution of 2.8 g of cadmium(II) iodide in 20 g of water boiled at 100.2 ^{0}C at normal pressure. Calculate the relative molecular mass of cadmium(II) iodide and comment on your result. [The boiling point elevation constant for water is 0.52 ^{0}C per mole per 1000g]. *(03 marks)*

2. The molarity of a sample of hydrochloric acid about 0.1 M was determined accurately by measuring the conductivity of the solution as 1.0 M sodium hydroxide was added to 50cm^3 of the acid. The results were as follows:

Conductivity / Ω^{-1} cm^{-1}	4.1	3.3	2.4	1.7	1.5	1.8	2.2	2.5
Volume of 1.0 M NaOH / cm^3	1	2	3	4	5	6	7	8

(a) (i) Plot a graph of conductivity against volume of 1.0 M sodium hydroxide. *(03 marks)*

(ii) Determine from the graph the volume of 1.0 M sodium hydroxide used to reach the end – point. *(01 mark)*

(iii) Calculate the molarity of the hydrochloric acid. *(02 marks)*

(iv) Explain the shape of the graph. *(03 marks)*

(b) Name **one** other application of conductivity measurement. *(01 mark)*

(c) Explain what is meant by the term **standard electrode potential**. *(02 marks)*

(d) Some half cells and their e.m.f.s are given below;

Half cell	e.m.f. (volts)
$I_2(aq) / 2I^-(aq)$	0.54
$Fe^{3+}(aq) / Fe^{2+}(aq)$	0.76

(i) Write the cell convention for a cell made up of the half cells. *(01 marks)*

(ii) Write equation for the cell reaction. *(1½ marks)*

(iii) Determine the e.m.f. of the cell. *(01 mark)*

(iv) Calculate the standard free energy for the reaction and indicate its unit. *(2½ marks)*

(v) State whether the reaction in (ii) is possible or not and give a reason for your answer. *(02 marks)*

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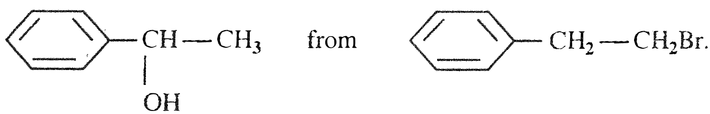
3. (a) Name the pair(s) of functional groups that can be distinguished using the following reagents. In each case, state what would be observed if each member of the pair is separately treated with the reagent.

(i) Ammonical silver nitrate. *(06 marks)*
(ii) Iron(III) chloride. *(03 marks)*

(b) Write equations to show how the following compounds can be synthesised:

(i) Propanone from ethanol. *(03 marks)*
(ii) Ethyne from ethanol. *(05 marks)*

(iii) *(03 marks)*



4. (a) Explain why flourine shows some differences in its properties from the rest of the elements (chlorine , bromine , and iodine) of the Periodic Table. *(03 marks*

(b) State the differences between the chemistry of fluorine and the rest of the elements of Group(VII) of the Periodic Table. *(08 marks*

(c) Write equations to compare the reactions of fluorine and chlorine when they react separately with

(i) water. *(1½ marks)*
(ii) cold dilute sodium hydroxide. *(03 marks)*
(iii) hot concentrated sodium hydroxide. *(03 marks)*

(d) Write equation for the reaction between hydrofluoric acid and silicon dioxide. *(1½ marks)*

SECTION B

Answer **two** *questions from this Section.*

5. (a) Draw diagrams to show the change in pH when a 0.1 M sodium hydroxide solution is added in portions to:

(i) $20 cm^3$ of a 0.1 M hydrochloric acid. *(02 marks)*
(ii) $20 cm^3$ of a 0.1 M ethanoic acid. *(02 marks)*

(b) Explain the shapes of the curves in (a). *(13 marks)*

(c) $20 cm^3$ of a 0.1 M sodium hydroxide solution was added to $100cm^3$ of a 0.1 M ethanoic acid. Calculate the pH of the resultant solution. (K_a for ethanoic acid is 1.75×10^{-5}). *(03 marks)*

(a) Complete the following equations and in each case outline a mechanism for the reaction.

(i) $CH_3CH_2OH \xrightarrow[140\,^0C]{conc.\ H_2SO_4}$ *(3½ marks)*

(ii) $(CH_3)_3CBr \xrightarrow[heat]{C_2H_5O^- K^+ / C_2H_5OH}$ *(03 marks)*

(iii) $CH_3CH = CHCH_3 \xrightarrow{conc.\ H_2SO_4 / H_2O}$ *(4½ marks)*

(iv)  $+ Br_2 \xrightarrow[heat]{Fe_{(s)}}$ *(04 marks)*

(v) $CH_3CHO + NaHSO_3 \xrightarrow{H^+}$ *(03 marks)*

(b) Write the IUPAC names of the products in (a)(i) and (a)(ii) above. *(02 marks)*

7. (a) Write the name and formula of one ore from which aluminium can be extracted and describe how aluminium is extracted from the ore. *(08 marks)*

(b) Write equations and state the conditions under which aluminium reacts with:

(i) air , *(2½ marks)*

(ii) sodium hydroxide , *(2½ marks)*

(iii) hydrochloric acid. *(2½ marks)*

(c) State what is observed and write equation for the reaction which takes place when aqueous ammonia is added drop – wise to a solution containing aluminium ions. *(2½ marks)*

(d) Write equation for the reaction that takes place when aluminium chloride is dissolved in water. *(1½ marks)*

8. (a) Describe how nitric acid:

(i) is manufactured , *(09 marks)*

(ii) can react with copper (Your answer should include equations for the reactions.) *(05 marks)*

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(b) State why nitric acid is **not** used to acidify potassium manganate(VII) in volumetric analysis. *(02 marks)*

(c) 1.07 g of a nitrogen containing compound was boiled with excess sodium hydroxide solution to produce ammonia.
The ammonia produced neutralised $200cm^3$ of a 0.1 M monobasic acid.

Calculate the percentage by mass of nitrogen in the compound.

[N = 14 , H = 1] *(03 marks)*

(d) State **two** industrial uses of nitric acid. *(01 mark)*

END

Name ....

Centre / Index No. ..../......... .....

Signature ....

P525 / 1
CHEMISTRY
Paper 1
Nov. / Dec. 2002
2hrs 45 min

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

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

All *questions must be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

For Examiner's Use Only																	
	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. Write an ionic equation for the reaction between sodium hydroxide and

(a) silicon(IV) oxide, *(1½ mark)*

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....

(b) lead (II) oxide , *(1½ marks)*

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....

(c) aluminium (III) oxide, *(1½ marks)*

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2. The mass spectrum of chlorine shows peaks at masses 70, 72 and 74. The heights of the peaks respectively are in the ratio of 9:6:1

Calculate:

(a) the average atomic mass of chlorine. *(2 marks)*

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(b) the relative abundance of ^{35}Cl and ^{37}Cl. *(3 marks)*

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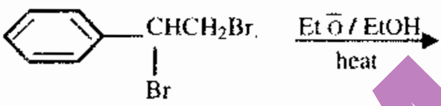
3. Complete the following equations and in each case write a mechanism for the reaction.

(a) $CH_3CH_2CH_2OH \xrightarrow[180^0C]{\text{conc. } H_3PO_4}$ (*3 marks*)

(b) 

(*2 marks*)

4. The table below shows the ionisation energies (in k mol^{-1}) of five elements lettered A, B, C, D and E.

Element	**1st ionisation energy**	**2nd ionisation energy**	**3rd ionisation energy**	**4th ionisation energy**
A	500	4600	6900	9500
B	740	1500	7700	10500
C	630	1600	3000	4800
D	900	1800	14800	21000
E	580	1800	2700	11600

(a) Which one of these elements is most likely to form an ion with a charge of +1 ? Give a reason for your answer. *(1½ marks)*

....

....

(b) State:

(i) **two** elements which belong to the same group in the Periodic Table.

....

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(½ marks)

(ii) the group to which the elements you have stated in b(i) belong.

....

....

(½ marks)

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(c) (i) Write the formula of the chloride of element E. *(1 mark)*

....

(ii) Write equation for the reactions between the chloride of element E and water. *(1½ marks)*

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....

5. (a) Derive the expression for the half-life for a first order reaction:

$2.303 \log\left(\frac{a_0}{a_0 - x}\right) = kt$; where a_0 is the initial concentration of the reactant and $(a_0 - x)$ is the concentration at time, t. *(2 marks)*

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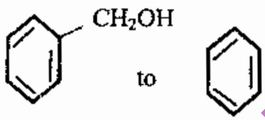
(b) The half-life of a first order reaction is 100s.

(i) Calculate the rate constant. *(1 mark)*

(ii) Determine the percentage of the reactant that reacted after 250s.

(2 marks)

6. Show how the following conversions could be carried out. *(2½ marks)*

(a) 

(b) $CH_3CH_2CH_2OH$ to $CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_3$. *(3 marks)*

7. (a) One of the properties of transition metals is complex ion formation

(i) define the term '**complex ion**'. (2 marks)

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....

(ii) Explain why transition metals form many complexes. (2 marks)

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(b) $Fe(CN)_6^{3-}$ and $(CuCl_4)^{2-}$ are complexes formed by iron and copper respectively.

State:

124 (i) the oxidation state of:

iron ....

copper .... (1 mark)

(ii) the co-ordination number of:

iron ....

copper .... (1 mark)

8. (a) Define the term '**partial pressure**'. (1½ marks)

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(b) The vapour pressures of pure chloroform and carbon tetrachloride are 199.1 and 114.5mmHg respectively at 25^{0}C.

(Assume that a mixture of the two liquids behave as an ideal gas and that it contains 0.96 mole of each pure liquid.)

Calculate:

(i) the partial pressure of each component in the mixture. *(2½ marks)*

(ii) the total pressure. *(½ mark)*

(c) Calculate the percentage of carbon tetrachloride in the vapour in equilibrium with the liquid mixture. *(1 mark)*

9 Complete the following equations and write the IUPAC name of the major organic product.

(1½ marks)

(a)  $\xrightarrow[\text{U.V. light}]{Cl_2}$

(b)  $\xrightarrow[\text{dil. HCl, } 0^{0}\text{C}]{NaNO_2}$ *(1½ marks*

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....

(c) $n\ CH_3CH = CH_2 \xrightarrow[\text{heat}]{\text{catalyst}}$ *(1½ marks*

....

....

....

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SECTION B

Answer only six questions from this Section.

10. State what would be observed and write equations for the reactions that take place when the following compounds are reacted.

(a) Aqueous potassium dichromate(VI) with hydrogen sulphide. *(3 marks*

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(b) Aqueous iron(III) chloride with sodium carbonate. *(3½ marks*

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(c) Aqueous copper(II) sulphate with potassium iodide. *(2½ marks)*

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(a) An organic compound A contains carbon, hydrogen and oxygen only. On combustion, 0.463g of A gave 1.1g carbon dioxide and 0.565g of water. Determine the empirical formula of A.

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(2½ marks)

(b) When vaporised, 0.1g of A occupies $54.5cm^3$ at 208^0C and 98.3 kPa. Determine the molecular formula of A.

(2½ marks)

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(c) A reacts with sodium metal with evolution of a gas. Write the structural formulae of all the possible isomers of A. (½ marks)

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(d) A reacts with anhydrous zinc chloride and concentrated hydrochloric acid to give a cloudy solution in about 5 minutes.

(i) Identify A. (½ mark)

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(ii) Show how A could be synthesised from but-2-nE. (1 mark)

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....

....

12. (a) A piece of clean magnesium ribbon was added to a solution of iron(III) chloride solution.

(i) State what was observed. (1½ marks)

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(ii) Explain your observation in (a)(i) above. (*2 marks*)

(iii) Write stepwise equations for the reactions that took place.

(*4 marks*)

(b) State what would be observed if a few drops of iron(III) chloride was added to the solution of the following:

(i) sodium acetate. (*1 mark*)

(ii) phenol (*½ mark*)

13. Complete the table below about the properties of different types of crystals.

Type of crystal	Force holding the crystals	Melting point (state whether low, moderate, high or very high)	Form in which electricity is conducted if any.
Metallic			
Ionic			
Network covalent			

(09 marks)

12|

14. (a) Write equation to show how ethanol can be formed from glucose.

....

.... (1 mark)

(b) Write equations to show how ethyne can be:

(i) prepared from ethanol. *(4 marks)*

....

....

....

(ii) converted to methylpropyne *(1½ marks)*

....

....

(c) (i) Name **one** reagent that can be used to confirm the formation of methylpropyne. *(1 mark)*

....

....

(ii) State what would be observed if methylpropyne was reacted with the reagent you have named in (c)(i) and write equation for the reaction. *(1½ marks)*

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15. (a) The table below shows the atomic numbers of some elements and their electron affinities.

Atomic No.	11	12	13	14	15	16	17
Electron affinity ($kJ\ mol^{-1}$)	2.0	-6.7	3.0	13.5	6.0	20.0	36.4

(i) Draw a graph of electron affinity versus atomic number. *(03 marks)*

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(ii) Explain the shape of the graph. *(3 marks)*

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....

(b) List **three** factors which affect the size of the first ionisation energy of an element. *(3 marks)*

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14

16. Write equations to show how the following compounds can be synthesised.

(a) CH_3CHO (from 1, 2 – dibromoethane) *(3 marks)*

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(b) CH_3CO_2H (from iodomethane) *(2½ marks)*

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(c) $CH_3CO_2CH_3$ (from ethene) *(3½ marks)*

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17. (a) Name **two** plants from which vegetable oil can be obtained. *(1 mark)*

....

(b) Soap was prepared from 9.5g of an oil containing mainly hexadecanoic acid $CH_3(CH_2)_{14}CO_2H$ as the main component of the oil.

(i) Explain briefly how pure soap was obtained from the oil. *(3 marks)*

....

....

....

(ii) Write equation for the reaction leading to the formation of the soap. *(1 mark)*

....

(iii) Calculate the mass of the soap formed. *(3 marks)*

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(c) Name **one** use of the residue left after the oil has been extracted. *(1 mark)*

....

....

THE PERIODIC TABLE

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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 65·4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$—indicates Atomic number.
2. $\underset{1\cdot0}{H}$ —indicates relative Atomic mass.

END.

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P525 / 2
CHEMISTRY
Paper 2
Nov. / Dec. 2002
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

NSTRUCTIONS TO CANDIDATES

.nswer **five** *questions, including* **three** *questions from Section* **A** *and any* **two** *from uestions in section* **B**.

egin each question on a fresh page.

'athematical tables and graph papers are provided.

lustrate your answers with equations where applicable.

Turn Over

SECTION A

*Answer **three** questions from this section.*

1. (a) A compound X, vapour density 58, contains carbon 62.07%, hydrogen 10.34%, the rest being oxygen.

X does not burn with a sooty flame.

(i) Calculate the empirical formula of X. (C=12, H=1, O=16) *(3 marks)*

(ii) Determine the molecular formula of X. *(2 marks)*

(b) Hydrolysis of X yielded compounds, Y, $C_4H_{10}O$ and Z, $C_2H_4O_2$.

Both Y and Z react with metallic sodium. Z reacted with sodium carbonate but Y did not.

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(i) Identify Z. *(1 mark)*

(ii) Write the names and the structural formulae of all the possible isomers of Y. *(4 marks)*

(iii) Name a reagent that can be used to distinguish between the isomers in (b)(ii) and state what would be observed if the reagent is reacted separately with each of the isomers. *(4 marks)*

(c) When Y was warmed with acidified potassium dichromate solution, there was no observable change.

(i) identify Y, *(1 mark)*

(ii) write the structural formula of X. *(1 mark)*

(d) (i) Write equation and outline a mechanism for the reaction between Y and concentrated phosphoric acid. *(3½ marks)*

(ii) Write the IUPAC name of the product in (d)(i). *(½ mark)*

2. (a) State **Raoult's Law**. *(3 marks)*

(b) A mixture of ethanoic acid (b.p. 118^0C) and pyridine (b.p. 123^0C) show negative deviation from Raoult's law.

(i) Draw the vapour pressure / composition curve for the mixture of ethanoic acid and pyridine and indicate the line for ideal behaviour. *(4 marks)*

(ii) Explain the shape of the curve in relation to Raoult's law. *(6 marks)*

(c) (i) Explain what is meant by the term; '**steam distillation**'. *(3 marks)*

(ii) When a compound Y, was steam distilled at standard atmospheric pressure, the temperature of distillation was 96^0C. The vapour pressure of water at this temperature was 730mm Hg and the distillate contained 74% of water.

Calculate the relative molar mass of Y. *(4 marks)*

3. (a) The atomic numbers and the atomic radii of some transition metals are given in the table below.

Element	Si	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic number	21	22	23	24	25	26	27	28	29	30
Atomic radii (Å)	1.44	1.32	1.22	1.17	1.17	1.16	1.16	1.15	1.17	1.25

(i) Plot a graph of atomic number versus atomic radii. *(4 marks)*

(ii) Explain the shape of your graph. *(7 marks)*

(b) (i) Write the outer electronic configuration of manganese. *(1 mark)*

(ii) State the possible oxidation states of manganese. *(2½ marks)*

(iii) How does the acidity of the oxides of manganese vary with increasing oxidation state? *(½ mark)*

(iv) What is the change in the oxidation state of manganese when potassium manganate (VII) is reduced under alkaline conditions? *(1 mark)*

(c) State **four** applications of potassium manganate(VII) in the laboratory as an oxidising agent. *(4 marks)*

4. (a) (i) Define 'Standard Electrode potential'. (2 marks)

(ii) Why is it not possible to measure standard electrode potential absolutely? (2 marks)

(iii) Discuss the factors which affect the value of standard electrode potentials. (5½ marks)

(b) Describe a standard hydrogen half cell. (2 marks)

(c) How would you measure standard electrode potential of a metal in a solution of its ions? (3 marks)

(d) $Ca^{2+} + 2e^- \longrightarrow Ca_{(s)}$ $E^0 = -2.87$

$Mg^{2+} + 2e^- \longrightarrow Mg_{(s)}$ $E^0 = -2.37$

A cell was set up as below:

$Mg_{(s)} / Mg^{2+}_{(aq)} // Ca^{2+}_{(aq)} / Ca_{(s)}$

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(i) Calculate the e.m.f. of the cell. (2 marks)

(ii) What conclusion can you draw from your e.m.f. value in (d)(i) above? (3 marks)

SECTION B

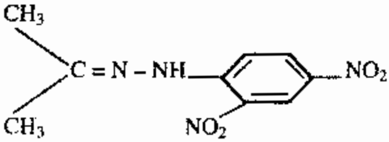
Answer **two** *questions from this section.*

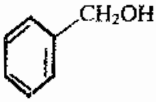
5. Write equations to show how the following compounds can be synthesised.

(a) $CH_3CH_2CH_2CO_2H$ from propan-1-ol. (4 marks)

(b) $CH_3CH_2CH_3$ from 1-bromobutane. (4 marks)

(c)  $-C\equiv CCH_3$ from  $-CH_2CH_2OH$ (6 marks)

(d)  from propane. (3½ marks)

(e)  from benzene (2½ marks)

6. Discuss the reactivity of the Group IV elements (carbon, silicon, germanium, tin and lead) of the Periodic Table with:

(a) water, (4 marks)

(b) dilute acids, (6 marks)

(c) concentrated acids. (10 marks)

7. (a) Explain what is meant by the following terms:

(i) "Osmosis" (3 marks)

(ii) "Osmotic pressure" (3 marks)

(b) State the significance of Osmosis. (1 mark)

(c) Describe a method which can be used to determine the osmotic pressure of a solution. (7 marks)

(d) State the conditions under which solutions do not obey the laws of osmotic pressure. (3 marks)

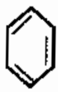
(e) The osmotic pressure of a solution containing 1.24% of a polymer is 3.1×10^{-3} atmosphere, at $25^{0}C$.

Determine the relative molecular mass of the polymer, (R = 0.0821) (3 marks)

 Turn Over

8. Complete the following equations and in each case outline a mechanism for the reaction:

(a) $CH_3CH_2CH_2Br + CH_3CH_2\bar{O}\,Na^+ \xrightarrow[\text{heat}]{CH_3CH_2OH}$ .... *(2 marks)*

(b)  $+\ CH_3CH=CH_2 \xrightarrow{H_2SO_4}$ .... *(4 marks)*

(c) $CH_3CH_2CHO + H_2N—NH—$  $\xrightarrow{H^+}$ .... *(4½ marks)*

(d)  $—CH_2Br + OH^-_{(aq)} \xrightarrow{\text{heat}}$ .... *(2 marks)*

(e) $\underset{\displaystyle CH_3\,CH\,CH_3}{\overset{\displaystyle OH}{|}} + \text{conc. } H_3PO_4 \xrightarrow{\text{heat}}$ ....*(3½ marks)*

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(f) $CH_3CH=CHCH_3 \xrightarrow{Cl_2\,/\,H_2O}$ .... *(4 marks)*

END.

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

Signature ....

P525 / 1
CHEMISTRY
Paper 1
Nov. / Dec. 2001
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

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 in section* **B**.

All *questions* **must** *be answered in the spaces provided.*

The Periodic Table, with relative atomic masses, is supplied 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 equations where applicable.

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)

1. The osmotic pressure of a solution containing 1.40 g of a polymer X per $100cm^3$ of a solution is $1200 Nm^{-2}$ at 25^0C.

   (a) Calculate the relative molecular mass of X

   ....

   ....

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   ....

   ....

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   ....

   (4 marks)

   (b) Determine the number of monomers in X (The molecular mass of the monomer of X is 28).

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   ....

   (1 mark)

2. (a) Complete the following equation for the decay of bismuth.

   $^{214}_{83}Bi \longrightarrow {}^{0}_{-1}e$ + ... *(1 mark)*

   (b) The half life of bismuth is 19.7 minutes. Determine the time taken for 43% by mass of bismuth to decay.

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   (3 marks)

3. The solubility of calcium phosphate is 0.0011 g per 100g of water at 25 ^{0}C
Calculate the solubility product of calcium phosphate at 25 ^{0}C

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(5 marks)

4. (a) A gaseous compound X contains 44.4% carbon, 51.9% nitrogen and hydrogen. Determine the empirical formular of X.

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(2 marks)

(b) 50 ml of X diffused through a porous plug in 25 seconds. Under similar conditions, the same volume of hydrogen gas diffused in 6.8 seconds.

Calculate:

(i) the molecular mass of X.

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(1½ marks)

Turn Over.

(ii) the molecular formular of X.

(1½ marks)

5. Name one reagent that can be used to distinguish between each of the following pairs of compounds and in each case state what would be observed if each member of the pair is treated with the reagent.

(a) $CH_3\overset{\overset{\displaystyle O}{\|}}{C}CH_3$ and $CH_3\overset{\overset{\displaystyle O}{\|}}{C}-H$

(3 marks)

(b) CH_6H_5COOH and C_6H_5OH

(3 marks)

6. The results of the hydrolysis of 2-bromo-2-methylpropane by aqueous sodium hydroxide at 25^0C is shown in the table below.

Concentration of $(CH_3)_3CBr$ / mol dm^{-3}	Concentration of OH^- ions / mol dm^{-3}	Rate of hydrolysis / mol dm^{-3}
0.100	0.500	0.0020
0.100	0.250	0.0020
0.050	0.250	0.0010
0.025	0.250	0.0005

(a) Deduce the order of reaction with respect to:

(i) 2-bromo-2-methylpropane

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.... (*1 mark*)

(ii) the hydroxide ion

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.... (*1 mark*)

(b) Write the rate equation for the reaction.

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.... (*1 mark*)

(c) Calculate the rate constant, K, for the reaction and state its units.

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.... (*2 marks*)

 Turn Over.

7. $100cm^3$ of an aqueous solution containing 20 g of W was shaken once with $50cm^3$ of ether.

(a) Calculate the mass of W extracted by ether.
(The distribution coefficient, K_D of W between ether and water is 4).

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(2 marks)

(b) Calculate the mass of W that would be extracted by shaking the solution twice with $25cm^3$ of ether.

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(4 marks)

113

8. When 142 cm^3 of a hydro carbon Q, of molecular mass 58 was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was 694 cm^3.
After addition of concentrated potassium hydroxide, the volume decreased to $126cm^3$.

(a) Determine the molecular formula of Q.

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(4 marks)

(b) Write the names and the structural formulae of all isomers of Q.

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(2 marks)

9. An acid HA ionises in water to give a 0.1 M acidic solution with pH = 3.0

(a) Write the equation for the ionisation of HA.

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(1 mark)

(b) Calculate the ionisation constant, K_a of the acid.

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(3 marks)

SECTION B

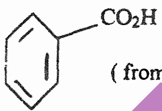
Answer only **six** *questions in this section.*

10. Write equations to show how the following compounds can be synthesised.

(a) CH_3CO_2H (from ethene).

(3 marks)

(b)



(from benzene)

112

(3 marks)

(c) $CH_3CH_2CH = CH_2$ (from ethyne).

(3 marks)

11. (a) State:

(i) the Distribution (Partition) law

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($3\frac{1}{2}$ marks)

(ii) the conditions under which the Distribution law is valid.

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($1\frac{1}{2}$ marks)

(b) 100cm^3 of an aqueous solution containing 10 g of a compound Q was shaken with 100cm^3 of benzene. Q is more soluble in benzene and the partition coefficient of Q between benzene and water is 12.2 Calculate the mass of Q left in the aqueous layer

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(3 marks)

(c) State **one** application of partition of solutes.

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(1 mark)

12. The bond energies and the atomic numbers of the elements in group VII in the Periodic Table are given in the table below:

Element	F	Cl	Br	I
Bond energy($kJ\,mol^{-1}$)	158	242	193	151
Atomic number	9	17	35	53

(a) Define the term bond energy.

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(2 marks)

(b) (i) Draw a graph of bond energy versus atomic number of the halogens. *(3 marks)*

(ii) Explain the shape of the graph you have drawn in (b)(i).

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(4 marks)

13. Complete the following equations and in each case write the accepted mechanism for the reaction.

(a) $CH_3 - CH = CHCH_3 \xrightarrow{H^+ / H_2O}$

(3 marks)

(b)

 $+ \; CH_3COCl \xrightarrow{AlCl_3}$

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(3 marks)

(c) $(CH_3)_3C-Br \; + \; CH_3O^-Na \xrightarrow[\text{heat}]{CH_3OH}$

(3 marks)

14. (a) Iron(II) sulphate is normally used to standardise a solution of potassium manganate(VII) acidified using sulphuric acid.

(i) Write equation for the reaction between potassium manganate(VII) and Iron(II) sulphate.

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(1½ marks)

(ii) State why hydrochloric acid is not used to acidify potassium manganate(VII) solution.

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(2½ marks)

(b) 25cm^3 of an acidified solution of 0.02 M potassium manganate (VII) reacted exactly with 25cm^3 of sodium nitrite. Potassium manganate(VII) reacts with sodium nitrite according to the following equation.

$$2MnO_4^-(aq) + 5NO_2^-(aq) + 6H^+(aq) \longrightarrow 2Mn^{2+}(aq) + 5NO_3^-(aq) + 3H_2O(l)$$

Calculate the concentration of the sodium nitrite in moles per litre.

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(4 marks)

15. (a) Define the term a 'buffer solution'.

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(2 marks)

(b) Calculate the mass of sodium ethanoate that should be added to 1 litre of a 0.1 M ethanoic acid solution in order to produce a solution of pH = 4.0 (Ka for ethanoic acid = 1.8×10^{-5})

(*5 marks*)

(c) State what would happen to the pH of the solution in (b), if a small amount of the following were added

(i) sodium hydroxide solution

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(*½ mark*)

(ii) hydrochloric acid.

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(*½ mark*)

(d) State **one** biological application of a buffer solution.

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(*1 mark*)

Turn Over.

16. (a) (i) Write an equation for the solubility of silver sulphate in water.

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(*1 mark*)

(ii) Determine the molar concentrations of silver and sulphate ions in a saturated solution of silver sulphate at 25^0C. (The solubility product, K_{sp} of silver sulphate is 1.7×10^{-5} mol dm^{-3} at 25^0C)

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(*3 mark*)

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(b) State how the solubility of silver sulphate would be affected if the following substances were added.

(i) Sodium sulphate solution.

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(*1 mark*)

(ii) ammonia solution.

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(*1 mark*)

(c) Explain your answer in (b).

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(*3 marks*)

17. State the type of polymerization leading to the formation of the polymers given in the table below. In each case, write the name, and the structural formulae of the monomers.

Polymer	Type of polymerisation	Structural formula of monomers	Name of monomers
Polyester			
Polyamide			
Polysterene			

(9 marks)

THE PERIODIC TABLE

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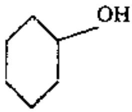
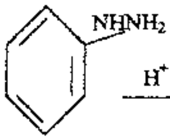
1	2											3	4	5	6	7	8
1 H 1·0																1 H 1·0	2 He 4·0
3 Li 6·9	4 Be 9·0											5 B 10·8	6 C 12·0	7 N 14·0	8 O 16·0	9 F 19·0	10 Ne 20·2
11 Na 23·0	12 Mg 24·3											13 Al 27·0	14 Si 28·1	15 P 31·0	16 S 32·1	17 Cl 35·4	18 Ar 40·0
19 K 39·1	20 Ca 40·1	21 Sc 45·0	22 Ti 47·9	23 V 50·9	24 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 65·4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{\mathrm{H}}$ —indicates Atomic number.
2. $\underset{1\cdot 0}{\mathrm{H}}$ —indicates relative Atomic mass.

(c)  $\xrightarrow[\text{heat}]{\text{Conc } H_3PO_4}$ .... *(3½ marks)*

(d) $CH_3\overset{\overset{O}{||}}{C}CH_2CH_3$ +  $\xrightarrow{H^+}$ .... *(5½ marks)*

(e) $(CH_3)_2C=CH_2 + I_2 \xrightarrow{CCl_4}$ .... *(3 marks)*

3\. (a) Define the term *eutectic mixture*. *(3 marks)*

(b) The table below shows the melting points of various mixtures of lead and tin.

% Tin	0	20	40	70	80	100
Melting Point / ^{0}C	327	280	234	193	206	232

(i) Draw a fully labelled diagram for the tin-lead system. *(5 marks)*

(ii) Determine the eutectic temperature and the composition of the eutectic mixture. *(3 marks)*

(c) Describe the changes that would take place when a liquid mixture of the above system containing 40% tin is cooled from 400^0c to 100^0C. *(6 marks)*

(d) (i) State **one** application of the tin-lead eutectic mixture. *(1 mark)*

(ii) Name **one** other pair of metals which can give a similar phase diagram as in (b)(i). *(1 mark)*

(iii) State **one** similarity between a eutectic mixture and a pure metal. *(1 mark)*

 Turn Over.

4. (a) Describe how sodium hydroxide can be prepared on a large scale. *(6 marks)*

(b) Sodium hydroxide solution was added to $25cm^3$ of 0.1M ethanoic acid and the pH of the solution was measured at intervals. The results are given in the table below.

Volume of NaOH (cm^3)	0	4	8	12	16	20	22	22.5	23	24	28
pH of the mixture	2.8	3.5	4.0	4.5	5.1	5.8	7.0	9.0	10.5	11.4	12.3

(i) Plot a graph of pH against volume of sodium hydroxide. *(3 marks)*

(ii) Explain the shape of the curve. *(4 marks)*

(iii) Determine the pH at the end point. *(1 mark)*

(iv) Calculate the molarity of the sodium hydroxide solution. *(3 marks)*

(c) Determine the dissociation constant, K_a, of the ethanoic acid used. *(3 marks)*

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SECTION B

Answer two questions from this Section.

5. Write equations to show how the following compounds can be synthesized.

(a) benzoic acid from benzene. *(2½ marks)*

(b) hexane from 1-bromo propane. *(1 mark)*

(c) ethyne from ethanol. *(4½ marks)*

(d) propanoic acid from bromoethane. *(2 marks)*

(e) aminomethane from ethene. *(5½ marks)*

(f) methyl ethanoate from bromo ethane. *(4½ marks)*

6. (a) Define the following terms:

(i) *hydration energy,*
(ii) *lattice energy,*
(iii) *enthalphy of solution.*

(*6 marks*)

(b) State **two** factors which can affect the magnitude of lattice energy and explain how they affect the lattice energy. (*4 marks*)

(c) Some thermochemical data are given below.

The standard enthalpy of formation of $CaCl_{2(s)}$ is -795 kJ mol^{-1}
The standard energy of atomization of calicum is $+177$ kJ mol^{-1}.
The first ionisation energy of calcium is $+590$ kJ mol^{-1}.
The second ionisation energy of calcium is $+1100$ kJ mol^{-1}
The standard enthalpy of atomization of chlorine is $+121$ kJ mol^{-1}
The first electron affinity of chlorine is -364 kJ mol^{-1}.

Calculate the lattice energy of calcium chloride. (*2 marks*)

(d) The lattice and hydration energies of salts AX and BX are given in the table below.

	Lattice energy / kJ mol^{-1}	Hydration energy / kJ mol^{-1}
AX	+880	−860
BX	+790	−800

(i) Calculate the enthalpy of solution of each salt. (*3 marks*)

(ii) Which of the **two** salts is more soluble in water at a given temperature ? Give a reason. (*2 marks*)

(e) Explain why hydrated copper(II) sulphate crystals dissolve endothermically whereas anhydrous copper(II) sulphate dissolve exothermically.

(*3 marks*)

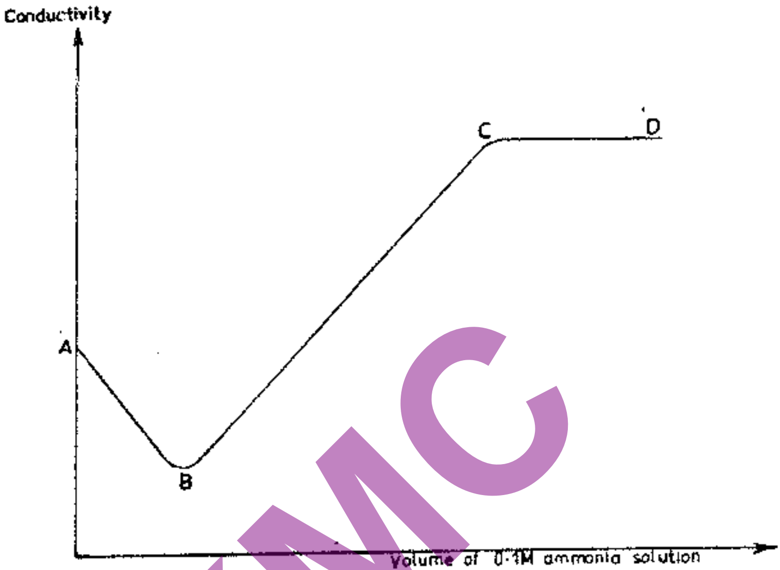
7. (a) Define the following terms:

(i) *conductivity,*
(ii) *molar conductivity.*

(*3 marks*)

Turn Over.

(b) The graph below shows the change in conductivity when 0.01 M methanoic acid is titrated with 0.1M ammonia solution.



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Explain the shape of the graph. (*7 marks*)

(c) At 25^{0}C, the molar conductivity of silver nitrate, potassium nitrate and potassium chloride are 133.4, 145.0 and 149.9 $\Omega^{-1}cm^2\ mol^{-1}$ respectively.

At the same temperature, the conductivity of a saturated solution of silver chloride is $3.41 \times 10^{-6}\ \Omega^{-1}cm^{-1}$ while that of pure water is $1.6 \times 10^{-6}\ \Omega^{-1}cm^{-1}$.

(i) Calculate the solubility of silver chloride in moles per dm^3 at 25^{0}C. (*4 marks*)

(ii) Determine the solubility product of silver chloride at 25^{0}C. (*3 marks*)

(d) The ionic conductivities of rubidium and sodium ions are 78.3 and 50.1 $\Omega^{-1}cm^{-2}\ mol^{-1}$ respectively. Explain why the ionic conductivity of rubidium ion is higher than that of sodium ion. (*3 marks*)

8. (a) With reference to transition metals, explain what is meant by the following:

(i) complex-ion formation, *(5 marks)*

(ii) catalytic activity, *(3 marks)*

(iii) coloured-iron formation. *(5 marks)*

(b) State what would be observed when dioxovanadium(V) ion, VO_2^+ is reacted with:

(i) sodium hydroxide solution. *(1 mark)*
(ii) sulphuric acid. *(1 mark)*

(c) The standard electrode potentials for some systems are given below:

$Mn^{3+}(aq)$ / $Mn^{2+}(aq)$ $+1.5$ E^0/V

$V^{3+}(aq)$ / $V^{2+}(aq)$ -0.26 E^0/V

(i) Write the convention for the cell formed by combining the two systems. *(1 mark)*

(ii) Write the overall equation for the cell reaction. *(1½ marks)*

(iii) Calculate the e.m.f. of the cell. State whether the reaction is possible or not and give a reason for your answer. *(2½ marks)*

END.

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

Signature ....

P 525/ 1
CHEMISTRY
Paper 1
Nov./Dec. 2000
(2¾ HOURS)

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

(2 hours 45 minutes)

INSTRUCTIONS TO CANDIDATES:

104

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

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

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

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

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

1. Complete the following equations:

(a) $CH_3CHOH\,CH_3 \xrightarrow{CrO_3 / H^+}$

....

....

(1 mark)

(b) $CH_3CH_2Br \xrightarrow[\text{ethanol}]{\text{Zn – Cu couple}}$

....

....

(1 mark)

(c) $C_6H_6 + CH_3Cl \xrightarrow{AlCl_3}$

....

....

(1 mark)

(d) $(CH_3)_2\,CHOH \xrightarrow[\text{heat}]{\text{Conc. } H_2SO_4}$

....

....

(1 mark)

2. (a) (i) What is meant by the term **ionisation energy of** an element ?

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(2 marks)

(ii) Write equation to show the first ionisation of magnesium.

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(1 mark)

(b) The second and third ionisation energies of magnesium are 1450 kJ mol^{-1} and 7730 kJ mol^{-1} respectively.
Give a reason for the large difference between the second and the third ionisation energies of magnesium.

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(2 marks)

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3. The second dissociation constant of a dibasic acid is 4.39×10^{-5} mol^2 dm^{-6} at 25^0C.

(a) Calculate the degree of a 0.01 M solution of the acid.

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(2½ marks)

(b) Sketch a diagram to show how the degree of dissociation varies with dilution.

(2 marks)

4. (a) (i) Write the electronic configuration of aluminium.

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(1 ½ marks)

(ii) State the type of bonding that exists in aluminium flouride.

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(1 mark)

(b) By using equations only, explain why aqueous solution of aluminium chloride is acidic.

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(1 ½ marks)

5. (a) Draw and name the structure of the following compounds.

Structure	Name
(i) NCl_3.	
	(1 ½ marks)
(ii) PCl_5	
	(1 ½ marks)

4

(b) Write equation for the reaction between nitrogen trichloride and boron trichloride.

.... (1 ½ marks)

6. Name **one** reagent that can be used to distinguish between each of the following pairs of compounds and in each case, state what would be observed if each member of the pair is treated with the reagent.

(a) $CH_3CH_2CH(OH)CH_3$ and $CH_3CH_2CH_2OH$ (3 marks)

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(b) $(CH_3CH_2)_2NH$ and $CH_3CH_2NH_2$ (3 marks)

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5

7. Ethanol decomposes according to the equation :

$$CH_3CHO_{(g)} \rightleftharpoons CH_{4(g)} + CO_{(g)} \qquad \Delta H = -ve$$

(a) Write an expression for the equilibrium constant, k_p for the reaction.

....

....

(1 mark)

(b) Explain how k_p would be affected if :

(i) the temperature is increased.

....

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(2 marks)

(ii) pressure is increased.

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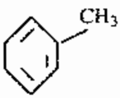
(2 marks)

8. Write equation to show how benzene can be converted to

(a) 

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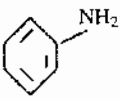
(2 marks)

(b) 

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(4 marks)

9. $1.00\ dm^3$ of aqueous solution contains 5.00g of butanoic acid. Calculate the mass of butanoic extracted when the solution was shaken:

(a) with $50\ cm^3$ of a solvent Q.

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(3 marks)

(b) twice with $25\ cm^3$ of solvent Q.

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(4 marks)

10/

SECTION B

Answer **six** *questions in this section.*

10. (a) Name **two** types of polymerisation reactions. (*2 marks*)

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(b) State the structural requirements for the formation of polymers by each of the two reactions you have named in (a).

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(*2 marks*)

(c) Write the names and structural formulae of :

(i) two naturally occuring polymers. (*3 marks*)

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(ii) the monomers of the polymers named in c(i) above. (*2 marks*)

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11. (a) Write the formula of an ore of aluminium.

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(*1 mark*)

(b) During the extraction of aluminium, the ore is first treated with sodium hydroxide, followed by aluminium hydroxide.

(i) State the purpose of adding sodium hydroxide.

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(*1 mark*)

(ii) Write equation for the reaction between the ore and sodium hydroxide.

....

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(*1½ marks*)

(iii) What is the purpose of adding aluminium hydroxide ?

100

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(*1 mark*)

(c) Briefly explain how aluminium can be obtained after the ore has been treated as in (b).

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(*3 marks*)

(d) Carbon dioxide was used instead of aluminium hydroxide in (b). Write equation for the reaction that took place.

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(*1 ½ marks*)

12. (a) Write equation for the solubility of silver bromide in water at 25^0C.

....

(1 mark)

(b) If the solubility product of silver bromide at 25^0C is 5.0×10^{-13} $mol^2\ dm^{-6}$, Calculate the solubility in $g\ dm^{-3}$ at 25^0C of silver bromide in :

(i) water.

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(3 marks)

(ii) 0.1 M hydrobromic acid. (State any assumptions made.)

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(3 marks)

(c) State two methods that can be used to determine solubility product.

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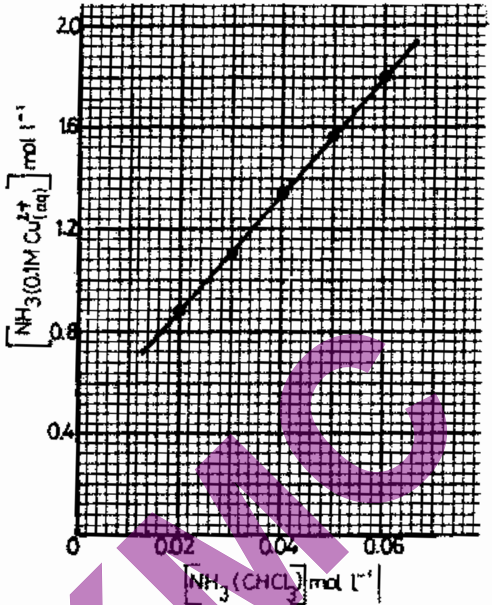
(2 marks)

99

13. The graph below shows the distribution of ammonia between aqueous layer of 0.1 M copper (II) ions and chloroform.



(a) (i) Determine the distribution coefficient, K_D of ammonia between aqueous copper (II) ions and chloroform.

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(3 marks)

(ii) State what the value of K_D you have determined indicates about the distribution of ammonia.

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(2 marks)

(b) The graph does not pass through the origin because ammonia reacts with copper(II) ions:

(i) Determine the number of moles of ammonia that reacts with copper(II) ions.

....

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(2 ½ marks)

(ii) Write equation for the reaction between ammonia and copper(II) ions.

....

....

....

(1 ½ marks)

14. (a) Write the structural formulae and names of all possible isomers of an organic compound having the molecular formula C_3H_8O.

....

....

(3 marks)

(b) When one of the isomers, P, in (a) above was reacted with acidified potassium dichromate compound Q was formed. Q reacted with phosphorus pentachloride to form compound R and hydrogen chloride gas.
Identify:

P ....

Q ....

R ....

(3 marks)

(c) Write equation and indicate a mechanism for the reaction between **P** and concentrated sulphuric acid.

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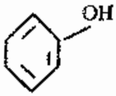
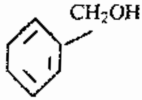
(3 marks)

15. Name a reagent that can be used to distinguish between each of the following pairs of compounds. State what would be observed if the compounds are treated with the reagent:

(a)  and 

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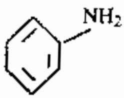
(3 marks)

(b)  and $CH_3CH_2CH_2CH_2CH_2CH_2NH_2$

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....

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(3 marks)

98

(c) $CH_3CH_2CH = CH_2$ and $CH_3CH_2C \equiv CH$.

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(3 marks)

16. (a) State **three** characteristics of chromium as a transition metal.

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(3 marks)

(b) A solution of potassium dichromate(VI) was added to an acidified solution of iron(II) sulphate.

(i) State what was observed.

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(1 mark)

(ii) Write the ionic equation for the reaction that took place.

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(1½ marks)

(c) (i) Write the structural formulae of the isomers of chromium (III) chloride, $CrCl_3 \cdot 6H_2O$.

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(3 marks)

(ii) State **one** way of distinguishing the isomers.

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(½ mark)

17. When 0.155g of an organic compound **T** was burned in oxygen 0.220g of carbon dioxide and 0.135g of water were formed.

(a) Determine the empirical formula of **T**.

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(3½ mark)

(b) When 0.225g of **T** was vaporised at 127 ^{0}C and 760 mmHg it occupied a volume of 119.11 cm^3. (Molar volume of gas at s.t.p. is 22.4 dm^3)

(i) Calculate the molecular mass of **T**.

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(2½ mark)

(ii) Determine the molecular formula of **T**.

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(1½ mark)

97

(c) **T** reacts with acidified potassium dichromate to form ethane-1, 2-dioc acid. Write the formula and the IUPAC name of **T**.

....

....

(1½ mark)

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 65.4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$ —indicates Atomic number.
2. $\underset{1.0}{H}$ —indicates relative Atomic mass.

END.

16

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

Signature ....

P 525/2
CHEMISTRY
Paper 2
Nov./Dec. 2000
(2½ HOURS)

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

(2 hours 30 minutes)

96

INSTRUCTIONS TO CANDIDATES:

Attempt **five** *questions, including* **three** *questions from Section* **A** *and any* **two** *from Section* **B**.

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Turn Over.

SECTION A

Answer **three** *questions from this Section.*

1. Explain each of the following observations:

(a) dimethylamine is a stronger base than phenylamine. *(5 marks)*

(b) the first ionisation energy of aluminium is less than that of magnesium. *(5 marks)*

(c) the pH of a solution of chromium (III) sulphate in water is less than 7. *(3 marks)*

(d) 1-bromohexane undergoes nucleophilic substitution reaction whereas bromobenzene does not. *(5 marks)*

(e) When solid lead(IV) chloride is added to water, white fumes are observed and a brown precipitate is formed. *(2 marks)*

2. (a) Describe the spectrum of a hydrogen atom. Use a diagram to illustrate your answer. *(7 marks)*

(b) Explain how the spectrum of a hydrogen atom:

(i) is formed. *(4 marks)*
(ii) provides evidence for the existence of energy levels in atoms. *(7 marks)*

(c) The frequency of hydrogen at the point of ionisation is 32.8×10^{14} Hz. Calculate the ionisation energy of hydrogen.

(Planks constant = 6.6×10^{-34} Js) *(2 marks)*

3. (a) Write equations to show how the following compounds can be prepared:

(i) phenylamine (aniline)
(ii) aminoethane (ethylamine) *(4 marks)*

(b) Which **one** of phenylamine and ethyalamine is a stronger base ? Explain your answer. *(3 marks)*

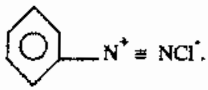
(c) Write equations for **each** of the compounds, phenylamine and ethylamine reacting with :

(i) ethanoyl chloride (CH_3COCl). *(2 marks)*
(ii) acidified solutions of sodium nitrite at 5 ^{0}C. *(2 marks)*

(d) (i) Write a mechanism for the reaction of ethanoyl chloride with ethylamine. *(3 marks)*

(ii) How can the reaction in c(ii) above be used to distinguish between phenylamine and ethylamine ? *(1 mark)*

(e) Phenylamine can be converted to benzene diazonium chloride.



Write equations (reagents and conditions to be given) for the conversion of diozonium salt into :

(i) iodo benzene *(1 mark)*

(ii) benzoic acid *(4 marks)*

95

4. (a) The melting point of 4-nitrophenol is much higher than that of 2-nitrophenol. The two compounds can be separated by steam distillation

(i) Explain why the melting point of 4-nitrophenol is higher than that of 2-nitrophenol. *(5 marks)*

(ii) Explain the principles of steam distillation. *(5 marks)*

(iii) Describe how a mixture of 2-nitrophenol and 4-nitrophenol can be separated by steam distillation. *(6 marks)*

(b) When a substance Y was distilled at 93 ^{0}C and 750 mm Hg, the distillate contained 55% of Y by mass. Calculate the relative molecular mass of Y. (The partial vapour pressure of water at 93 ^{0}C is 654 mm Hg). *(4 marks)*

SECTION B

Answer **two** *questions from this Section.*

5. The atomic numbers and the melting points of some elements in Period 3 of the Periodic Table are shown below:

Element	Na	Mg	Al	Si	P
Atomic number	11	12	13	14	15
Melting point (^{0}C)	98	650	660	1410	44

(a) (i) Plot a graph of melting points against atomic number. *(3 marks)*

(ii) Explain the shape of the graph in (i). *(6 marks)*

(b) Describe and explain how the oxides of magnesium, aluminium and silicon react with:

(i) sodium hydroxide.

(ii) hydrochloric acid. *(9 marks)*

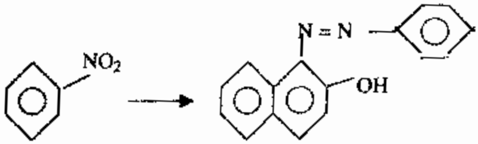
(c) State the type of bonding in the oxides of sodium and phosphorus. *(2 marks)*

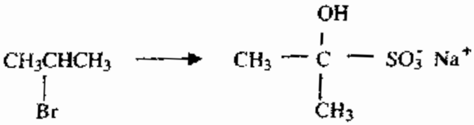
6. Write equations to show how each of the following conversions can be effected and indicate the reagents and the conditions for the reactions.

(a) $CH_3CH_2I \longrightarrow CH_3CH_2COOH$ *(3 marks)*

(b) $CH_3CH_2CH_2OH \longrightarrow CH_3\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$ *(5 marks)*

(c) $C_6H_5CH_2OH \longrightarrow C_6H_6$ *(3 marks)*

(d)  *(5 marks)*

(e)  *(4 marks)*

7. (a) Explain what is meant by the term ore. *(2 marks)*

(b) Describe **two** ways in which ores can be concentrated by:

(i) physical method.

(ii) chemical method.

(Illustrate your answers with suitable examples)

(12 marks)

92

(c) A copper ore was dissolved in excess concentrated ammonia and the solution made up to 1 dm^3. The resultant solution was shaken with trichloromethane and left to settle. 50 cm^3 of the organic layer needed 25.0cm^3 of 0.05 M hydrochloric acid for neutralisation. 25 cm^3 of the aqueous layer was neutralised by 40 cm^3 of 0.5 M hydrochloric acid.

Calculate the concentration of copper(II) ions in moles dm^{-3}.
(The distribution coefficient of ammonia between water and trichloromethane is 25). *(6 marks)*

8. (a) Explain what is meant by the term **melting point**. *(1 mark)*

(b) State the factors which affect the melting point of :

(i) metals, *(1 mark)*
(ii) molecular substances. *(1 mark)*

(c) Explain the trend in the melting points of the elements in group (II) and group (VII) of the periodic table. *(8 marks)*

(d) Explain why the transition metals of period 4 tend to have higher melting points than non-transition metals of the same period. *(2 marks)*

(e) The table below shows the melting points of some compounds:

Compound	**Melting point / k**
Aluminium oxide	2290
Aluminium chloride	451
Calcium oxide	2850
Calcium chloride	1051

Explain why:

(i) the melting point of aluminium chloride is abnormally low compared to that of aluminium oxide. *(2 marks)*

(ii) the melting point of calcium oxide is much higher than that of calcium chloride. *(2 marks)*

(f) Determine the freezing point depression for a solution containing 0.025 g of sodium chloride in 200 g of water. [molar freezing point constant of water, $K_{fp} = 1.86\ ^0C\ mol^{-1}\ kg^{-1}$, Na = 23, Cl = 35.5]. *(3 marks)*

END.

Name .... Centre and Index No ..../................

Signature ....

P525/1
CHEMISTRY
Paper 1
Nov./Dec. 1999
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

93

INSTRUCTIONS TO CANDIDATES:

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

All questions are to be answered in the spaces provided.

The periodic table, with relative atomic masses, is supplied at the end of the paper.

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

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

1. (a) Determine the oxidation number of

(i) nitrogen in HNO_3 *(1 mark)*

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(ii) Sulphur in S_2O_8 *(1 mark)*

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(b) Write half equation for the conversion of $S_2O_8^{2-}$ to SO_4^{2-} ion. *(1 mark)*

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(c) Complete the following and balance the equations

(i) $S_2O_8^{2-} + I^- \longrightarrow$ .... *(1½ mark)*

....

....

(ii) $Sn^{2+}(aq) + S_2O_8^{2-}(aq) \longrightarrow$ .... *(1½ mark)*

....

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2. The Standard electrode potentials E^θ of lead and magnesium are shown below:

		E^θ / Volt.
$Pb^{2+} + 2e \longrightarrow$	Pb	- 0.13
$Mg^{2+} + 2e \longrightarrow$	Mg	- 2.40

(a) Write the cell convention for the cell that can be formed. *(1½ marks)*

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(b) Write the equation for the:

(i) reaction taking place at each electrode. *(2 marks)*

(ii) overall reaction. *(1 mark)*

(c) Calculate the e.m.f. of the cell. *(1 mark)*

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

(a)  + $CH_3CH_2Br \xrightarrow{Al\,Br_3}$ .... *(4 marks)*

92

(b) $CH_3CH_2Cl + HC \equiv CNa \xrightarrow{\text{liq } NH_3}$ .... *(2 marks)*

4. 1.455g of a compound Y was dissolved in 80g of ethanol. The boiling point of the solution was 78.97^0C while that of pure ethanol was 78.8^0C (K_b for ethanol is 1.15^0C for 1 mole in 1000 g).

Calculate the molecular mass of Y in ethanol. *(4 marks)*

Turn Over

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5. (a) Methane reacts with chlorine in the presence of sunlight to form chloromethane. Write equation for the reaction and outline mechanism for the reaction.

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(2 marks)

(b) Some bond energies are given below:

Bond	**Energy / kJ mol^{-1}**
Cl - Cl	242
C - H	435
Cl - H	431
C - Cl	339

Determine the enthalpy change for the reaction in (a). *(3 marks)*

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6. State the conditions and write equations for the reaction between hydrogen peroxide and

(a) Iron (II) ions *(2 marks)*

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(b) Iron(III)ions (2 marks)

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(c) Iodide ions (2 marks)

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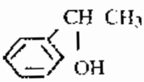
7. Write equations to show how the following compounds can be synthesised!

(a) 

(from benzene) (3½ marks)

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91

(b) CH_3CO_2H (from ethene) (2½ marks)

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8. The table below shows how the initial rate of the reaction

$$X + Y \longrightarrow Z$$

varies with different starting concentrations of X and Y.

[X] mol.	[Y] mol.	Initial rate mol sec^{-1}
0.200	0.200	4.0×10^{-5}
0.200	0.400	4.0×10^{-5}
0.400	0.200	16.0×10^{-5}

 Turn Over

(a) Determine the order of the reaction with respect to

(i) X .... *(1 mark)*

(ii) Y .... *(1 mark)*

(b) Write the rate equation for the reaction. *(1 mark)*

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(c) Calculate the:

(i) rate constant *(1 mark)*

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(ii) the rate of the reaction when [X] = 0.100 M and [Y] = 0.200 M.

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(1 mark)

9. Lithium is in group I and magnesium is in group II of the Periodic Table but the two elements show some common chemical properties.

(a) State the name given to this type of relationship. *(1 mark)*

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(b) Give **four** examples of the properties in which the two elements show similarities. *(4 marks)*

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(c) Name **two** other pairs of elements that show similar type of relation as lithium and magnesium.

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(1 mark)

SECTION B

Answer **six** *questions from this section*

10. (a) What is meant by bond energy? *(2 marks)*

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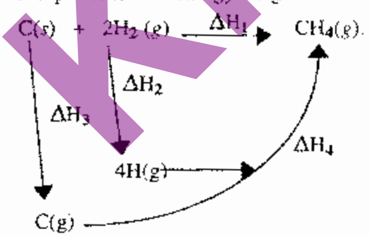
90

(b) Figure 1 represents the energy diagram for the formation of methane.



Identify the following energy changes: *(3 marks)*

ΔH_1 ....

ΔH_2 ....

ΔH_3 ....

(c) Given that ΔH_1 = -75kJ /mole.

ΔH_2 = +218 kJ /mole of hydrogen atom.

ΔH_3 = + 715kJ/mole.

Turn Over

Calculate the value of :

(i) ΔH_4. *(2 marks)*

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(ii) the bond energy for C-H bond. *(2 marks)*

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11. (a) Chromium (III) sulphate was dissolved in water and a few drops of concentrated sodium carbonate solution added to the solution.

(i) state what was observed. *(2 marks)*

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(ii) Give a reason for your answer and write equations for the reactions. *(2½ marks)*

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(b) Potassium chromate was dissolved in water. State the shape of the chromate ion. *(1 mark)*

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(c) To the solution in (b) was added few drops of dilute sulphuric acid followed by aqueous sodium hydroxide dropwise until in excess.

(i) State what was observed. *(1 mark)*

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(ii) Write equations for the reactions that took place. *(2½ marks)*

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12. A buffer solution of pH 4.5 was prepared from ethanoic acid ($Ka = 1.8 \times 10^{-5}$) and sodium ethanoate. The concentration of sodium ethanoate was 0.2 mole $litre^{-1}$.

89

(a) (i) Write equation for the reaction that can take place on add'tion of a small amount of the following to the solution:

dilute hydrochloric acid; *(1½ marks)*

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dilute sodium hydroxide. *(1½ marks)*

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(ii) Calculate the concentration of ethanoic acid in the buffer solution.

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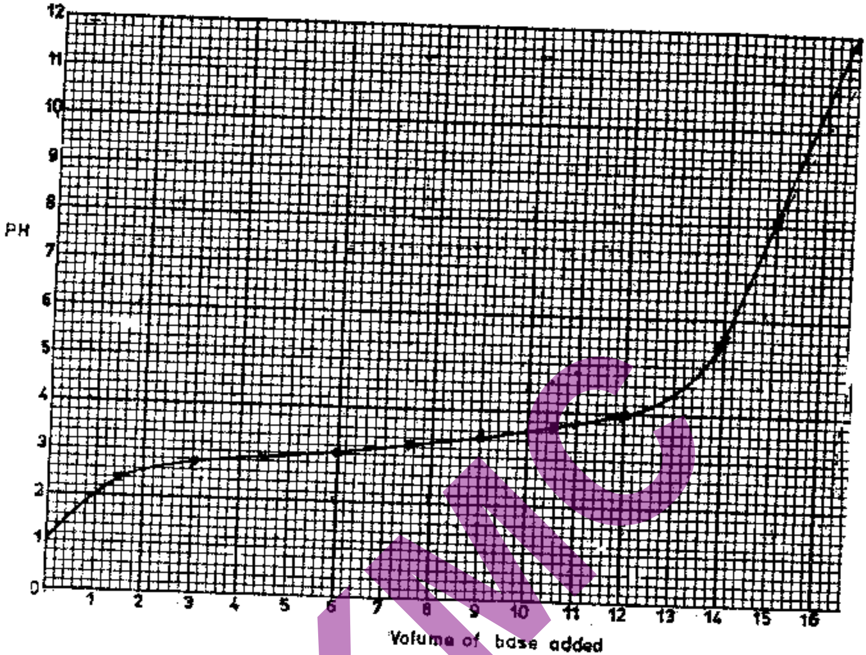
(3 marks)

(b) The graph below shows the pH changes during an acid base titration.



(i) State whether the acid and the base are strong or weak electrolytes. *(2 marks)*

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(ii) Determine the pH and the volume of the base used at neutralisation point. *(1 mark)*

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13. (a) Write an expression for the:

(i) acid dissociation constant, Ka, for ethanoic acid. *(2 marks)*

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(ii) relationship between acid dissociation , Ka, and the degree of ionisation of an acid, α . *(1 mark)*

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88

(b) The electrolytic conductivity of a 1.6×10^{-2} M CH_3COOH : 20^0C is 1.96×10^{-2} S m^{-1} and its molar conductivity at infinite dilution is 3.5×10^{-2} S m^2 mol^{-1}

Calculate:

(i) the molar conductivity of the ethanoic acid at 20^0C. *(2 marks)*

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(ii) the degree of ionisation of the acid at 20^0C. *(1 mark)*

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(iii) the pH of the acid. *(2 marks)*

(c) Besides concentration, state **one** other factor that can affect the pH of the acid.

(2 marks)

14. 2-Bromo-2-Methylpropane reacts with aqueous sodium hydroxide to form 2-methylpropan-2-ol.

(a) Write the rate equation for the reaction. *(1 mark)*

(b) Draw the energy diagram for the reaction. *(3½ marks)*

(c) Write a mechanism for the reaction. *(3 marks)*

(d) State the: *(1½ marks)*

(i) rate determining step of the reaction

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....

(ii) technique which was used to study the reaction.

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15. A compound, **B** has an empirical formula of C_3H_6O. Oxygen gas diffuses 1.345 times faster than **B**.

(a) (i) Determine the molecular formula of **B**. *(2 marks)*
($O = 16$).

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87

(ii) Write the structural formulae of all the possible isomers of **B**. *(1 mark)*

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(iii) **B** has no effect on silver nitrate in ammonia. Identify **B**. *(1 mark)*

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(b) (i) Using equations, show how **B** can be formed from propene. *(2½ marks)*

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(ii) Write an equation for the reaction of **B** with sodium hydrogen sulphite and write the mechanism. *(2½ marks)*

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16. (a) The molecular formula of a hydrocarbon **X** is C_4H_8.
Write the names and molecular formulae of all the possible isomers of **X**. *(1 mark)*

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(b) Ozonolysis of **X** followed by hydrolysis gave only one compound. Identify the compound. *(1 mark)*

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(c) Write equation to show how **X** can be converted to an alkyne. Your answer should include the conditions for the reaction. *(4 marks)*

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(d) Write the name and structural formula of an alkyl halide which can be used as a starting material for the synthesis of **X**. *(1 mark)*

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17. Figure 2 is a phase diagram for a certain substance.

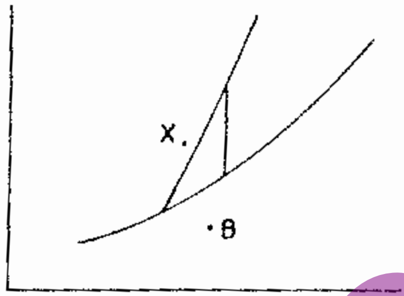

Fig.2

86

(a) Label the following on the diagram:

(i) the axes ,
(ii) the phases present ,
(iii) the critical temperature ,
(iv) the triple point. *(4 marks)*

(b) Define the terms:

(i) critical point ,

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....

(ii) triple point. *(2 marks)*

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(c) Explain what would happen when the substance in point **X** changes to point **B**.

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(3 marks)

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 65·4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$ -indicates Atomic number.

2. $\underset{1\cdot 0}{H}$ -indicates relative Atomic mass.

END.

P525/2
CHEMISTRY
Paper 2
Nov./Dec.1999
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

85

INSTRUCTIONS TO CANDIDATES:

Attempt **five** *questions, including* **three** *questions from section* **A** *and any* **two** *from section* **B**.

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Turn over

SECTION A

Answer **three** *questions from this section.*

1. (a) The first eight ionisation energies of an element **B** are shown below:

Ionisation Energies / kJ mol^{-1}

1st	2nd	3rd	4th	5th	6th	7th	8th
786	1580	3230	4360	16000	20000	23600	29100

(i) Explain what is meant by the term **First ionisation energy**.

(ii) State the factors that determine the value of the first ionisation energy.

(iii) To which group in the Periodic Table does element B belong ? Give a reason for your answer.

(b) Explain what is meant by the term **eletronegativity**.

State the factors that determine the value of electronegativity of an element.

(c) Explain how the following factors affect the value of electronegativity of an element:

(i) atomic radius,
(ii) nuclear charge,
(iii) the screening effect of the inner electrons.

(d) Explain the difference between electronegativity and electron affinity.

2. (a) (i) Explain the term, **Colligative Property**.
(ii) State four colligative properties of a solution.

(b) (i) Describe how the molecular mass of a substance can be determined using the depression of freezing point method.
(ii) State **two** limitations of the method.

(c) (i) Calculate the boiling point of an aqueous solution of Urea, $CO(NH_2)_2$ of concentration 12.0g dm^{-3} at a pressure of 101.3 kPa. Assume that the volume of the solute is negligible compared to that of the solution.
(The boiling point elevation constant for water = 0.52^0 C mol^{-1} kg^{-1}, C = 12, H= 1, O =16, N= 14)

(d) (i) Explain the term, **mole fraction**.

(ii) Calculate the mole fraction of sodium chloride in an aqueous solution containing 10g of sodium chloride per 100g of water.
(Na = 23.0 , Cl = 35.5)

3. Write equations to show the reaction that can take place between the following pairs of compounds and indicate mechanisms for the reactions.

(a) but-2-ene and hydrogen chloride,

(b) ethene and iodine.

(c) methylbenzene and chlorine in the presence of sunlight.

(d) benzene and propene.

(e) cyclohexanone and hydroxylamine in the presence of an acid.

4. (a) Describe how sulphuric acid can be manufactured from Iron(II) disulphide (iron pyrites).

(b) Outline how iron can be extracted from iron (III) oxide.

SECTION B

Answer two *questions from this section.*

84

5. (a) Heptane and Octane form an Ideal solution.

(i) State Raonit's Law
(ii) Explain what is meant by an ideal solution ?
(iii) Calculate the vapour pressure of a solution containing 50g heptane and 38g of Octane at 20^0 C. (H=1, C=12.)

The vapour pressure of heptane at 20^0C = 473.2 Pa
The vapour pressure of Octane at 20^0C = 139.8 Pa

(b) Compound A (bp 372^0C) and Compound B (bp 399^0C) form an ideal solution.

(i) Sketch a labelled boiling / composition diagram for the mixture
(ii) Using the diagram describe and explain how pure B can be obtained from a mixture containing 50% B.

6. Write notes on the following:

(Your answer should include suitable examples and mechanisms for reactions in each case.)

(a) Elimination reaction ,

(b) Electrophilic substitution reaction

(c) Electrophilic addition reaction.

7. The elements Be, Mg, Ca, Sr, Ba, are in Group-II of the Periodic Table.

(a) Explain how the following factors vary within the Group:

(i) atomic radius
(ii) Ionisation energy
(iii) electropositivity

(b) Beryllium, like aluminium can react with Sodium hydroxide solution. Other Group II elements do not.

(i) Write ionic equations for the reactions of beryllium and aluminium with a solution of Sodium hydroxide.

(ii) List **three** other properties in which beryllium shows similarity to aluminium.

(iii) Explain why beryllium behaves differently from the other Group-II elements.

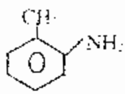
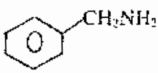
(iv) Name **two** other elements which have similar relationships like beryllium and aluminium.

8. Name a reagent that can be used to distinguish between each of the following pairs of compounds. In each case state what is observed when the reagent named is used.

(i) $CH_3CH_2COCH_2CH_3$ and $CH_3COCH_2CH_2CH_3$

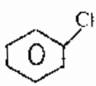
(ii) C_6H_5CHO and $C_6H_5CH_2COCH_3$

(iii) $CH_3C\equiv CCH_3$ and $CH\equiv CCH_2CH_3$

(iv)  and 

(v) $CH_3-\underset{\displaystyle OH}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3$ and $CH_3CH_2CH_2CH_2OH$

(vi) CH_3OH and CH_3CH_2OH

(vii)  and $CH_3CH_2CH_2Cl$

END.

Name .... Centre and Index No............/..............

Signature ....

P525/1
CHEMISTRY
Paper 1
March 1998
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

83

INSTRUCTIONS:

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

All questions are to be answered in the spaces provided.

The periodic table, with relative atomic masses, is supplied at the end of the paper.

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

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

Answer all the questions in this section.

1. RCO_2H is a weak acid.

(a) Write the equation for the ionisation of the weak acid RCO_2H in water. *(1 mark)*

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(b) Write the expression for the ionisation constant K_a for the acid. *(1 mark)*

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(c) Calculate the hydrogen ion concentration of a 0.25 M solution of the acid. *(4 marks)*

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2. Name one 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 is treated with the reagent.

(a) *(3 marks)*

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(b) $CH_3CH_2NH_2$ and $(CH_3CH_2)_2NH$ *(3 marks)*

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82

3. The table below shows the rates of the reaction between substances A and B at different concentrations.

Experiment	Initial concentration in mol dm^{-3} of		Initial rate of reaction in mol dm^{-3} s^{-1}
	A	**B**	
1	0.50	0.50	2.0×10^{-2}
2	1.00	0.50	8.0×10^{-2}
3	1.00	1.00	16.0×10^{-2}

(a) Determine

(i) the order of reaction with respect to A and B.

A ....

.... (1 mark)

B ....

.... (1 mark)

(ii) the overall order of the reaction. (1 mark)

....

....

(b) (i) Write an expression for the rate of the reaction. (1 mark)

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(ii) Calculate the rate constant for the reaction and state the units. (2 marks)

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4. Equations for some half-cell reactions are given below:

$Hg_2Cl_2 + 2e \longrightarrow 2Hg_{(l)} + 2Cl^-(aq)$ E = +0.334 V

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e \longrightarrow 2Cr^{3+}(aq) + 7H_2O_{(l)}$ E = +1.33 V

(a) Write the convention for the cell. *(1 mark)*

....

....

(b) Write equation for the overall reaction. *(1½ marks)*

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(c) Calculate the cell voltage. *(1½ marks)*

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5. Draw the molecular structures of the following compounds and in each case name the shape of the molecule.

(a) Sulphurtrioxide, SO_3. *(1 mark)*

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(b) Trichloromethane, $CHCL_3$. *(1 mark)*

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(c) Hydrogen sulphide H_2S. (1 mark)

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(d) Phosphite, PH_3. (1 mark)

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6. (a) Write an expression for pH. (1 mark)

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81

(b) (i) Calculate the pH of a 0.05 M solution of sodium hydroxide. (2 marks)
(K_w = 1×10^{-14} M)

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(c) (ii) State the effect of dilution on the pH of sodium hydroxide solution. (1 mark)

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Give a reason for your answer. (1 mark)

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7. When 0.13 g of a chloride of iron was vaporised at 600K and I atmosphere pressure, 20 cm^3 of vapour was formed.

(a) Calculate the relative mass of iron chloride. (3 *marks*)

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(b) (i) Determine the molecular and formula of the iron chloride. (*2 marks*)

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(ii) Write the structural formula of the iron chloride. (*1 mark*)

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8. (a) But-2-ene can be prepared from butan-2-ol and phosphoric acid.

(i) State the conditions for the reaction. (*1 mark*)

....

(ii) Write a mechanism for the reaction. (*3 marks*)

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(b) But-2-ene was passed through acidified potassium permanganate solution.

(i) State what was observed. *(1 mark)*

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(ii) Write equation for the reaction. *(1 mark)*

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(iii) State the change in the oxidation state of manganese *(1 mark)*

80

....

9. (a) In the complex Co $(NH_3)_5(H_2O)$ Cl_3

(i) State the oxidation state of cobalt. *(1 mark)*

....

(ii) Give the name of the complex. *(1 mark)*

....

(b) State **three** factors that affect of complex formation in transition metals. *(3 marks)*

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Turn Over

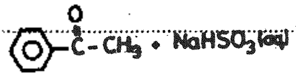
SECTION B

Answer six questions from this section.

10. Complete each of the following equation and in each case write a mechanism for the reaction.

(a) $CH_3CH_2I + KOH_{(aq)} \xrightarrow{heat}$

(2 marks)

(b) 

(3 marks)

(c) 

(4 marks)

11. Explain briefly the following characteristics:

(a) Ice has a lower density than water. (3 marks)

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(b) The boiling point of HF is higher than that of HCl. *(3 marks)*

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(c) Methylamine (CH_3NH_2) is a stronger base than ammonia (NH_3). *(3 marks)*

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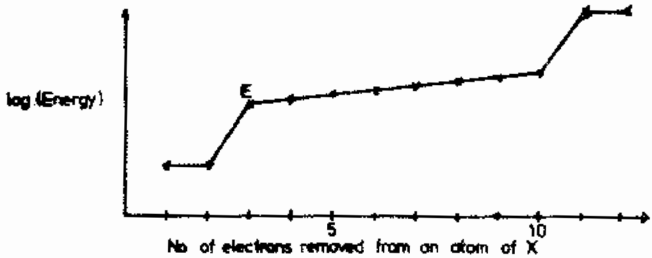
12. The diagram below shows successive ionisation energies for an element X, showing removal of all electrons.



(a) Giving reasons state

(i) the group of element **X**. *(1½ mark)*

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(ii) the period of element **X**. *(1½ marks)*

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(iii) Identify element **X**. *(1 mark)*

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(b) Explain the sudden increase in the energy required to remove electron **E**. *(2 marks)*

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(c) Explain how the size of **X** will change as electrons are removed. *(1 mark)*

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(d) (i) Explain what would be the sign of energy change if an electron was added to **X** to give X^-. (*1 mark*)

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(ii) How would you expect it to affect the size of **X** ? (*1 mark*)

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(e) Explain giving reasons whether you would predict **X** to form compounds in the +1 oxidation state. (*1 mark*)

78

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13. 1 mole of hydrogen iodide gas at 25^0 C was introduced into a container of volume 20.0 litres.

(a) Calculate the pressure of the gas, assuming ideal behaviour (1 mole of an ideal gas occupies 22.4 litres under standard conditions). (1½ marks)

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(b) The sample of hydrogen iodide, considered above was raised to a temperature of 300^0 C and it partially decomposed into hydrogen and iodine gases. At equilibrium, 1 mole of iodine was found to be present.

(i) Write an equation for the decomposition. *(1 mark)*

....

(ii) Calculate the pressure of the equilibrium mixture at 300^0 C, assuming no change in volume. *(1½ marks)*

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(iii) Calculate the eqilibrium constant at 300^0 C. *(3 marks)*

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(c) $\Delta H^0_f(HI_{(g)}) = +26.5 kJ\ mol^{-1}$. Explain giving reasons how you would expect the equilibrium constant to change with temperature. *(2 marks)*

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14. (a) Rubber is a natural polymer whose monomer is 2-methylbutan-1, 3-diene.

Write the structure of

(i) the monomer of rubber. *(1 mark)*

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(ii) the structural formula of rubber. *(1 mark)*

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(b) (i) Briefly describe how rubber is vulcanised. *(2 marks)*

....

....

(ii) State the purpose of vulcanising rubber. *(3 marks)*

....

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(c) Name one substance that is added to prolong the life of rubber. *(1 mark)*

....

77

(d) Name one other natural polymer. *(1 mark)*

....

15. The table below shows the temperature rise when various volumes of 2 M sulphuric acid were added to $60\ cm^3$ of about 2 M sodium hydroxide and in each case the total volume made up to $120\ cm^3$ with water.

Experiment	1	2	3	4	5	6
Volume of NaOH (cm^3)	60	60	60	60	60	60
Volume of 2M H_2SO_4 (cm^3)	5	10	20	25	30	40
Volume of water (cm^3)	55	50	40	35	30	20
Temperature rise (^0C)	4.8	6.9	9.1	10.1	10.1	10.0

(a) Plot a graph of temperature rise against volume of sulphuric acid added. (*3 marks*)

(b) From the graph determine the highest temperature rise. (*2 marks*)

(c) Calculate the heat of neutralisation of sulphuric acid and give its units (the density of solution is 1 kg dm^{-3} and specific heat4.2 kJ/kg/K). (*4 marks*)

16. (a) When red lead, Pb_3O_4 was reacted with nitric acid a solid was formed. Write the equation for the reaction. *(2 marks)*

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(b) The mixture from (a) was filtered and the residue warmed with concentrated hydrochloric acid.

(i) What was observed? Explain your answer. *(1 mark)*

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(ii) Write the equation for the reaction. *(1½ mark)*

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(c) The filtrate from (a) was divided into two parts.

(i) To the first part was added aqueous potassium iodide. State what was observed and write the equation for the reaction. *(2 marks)*

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(ii) The second part was evaporated to dryness and heated strongly. Explain what was observed and write the equation for the reaction that took place. *(2½ marks)*

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17. The elements contained in the third short period of the Periodic Table, given in the alphabetical order, are aluminium, argon, chlorine, magnesium, phosphorus, silicon, sodium and sulphur.

(a) In the table given below, write the formula of the hydrides formed by the elements listed, state the oxidation state (or valency) of the elements in these hydrides and classify the bonding in the hydrides as ionic or covalent.

(*6 marks*)

Elements	Formula of hydride	Oxidation (or valency) of the elements in the hydride	Type of bonding
Aluminium			
Chlorine			
Magnesium			
Phosphorous			
Silcon			

(b) The hydrides formed by sodium and sulphur were separately shaken with water.

Write the equation to show the reaction which took place, if any, with

(i) sodium hydride

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....

(ii) sulphur hydride

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(*3 marks*)

END.

P525/2
CHEMISTRY
Paper 2
March 1998
2½ hours

75

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt **five** *questions, including* **three** *questions from section* **A** *and any* **two** *from section* **B**:

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

 Turn Over

SECTION A

Answer **three** *questions from this section.*

1. (a) Describe using equations the reactions of zinc with

   (i) air.
   (ii) water.
   (iii) sodium hydroxide. *(10 marks)*

   (b) (i) Explain why zinc is not considered a typical transition metal. *(3 marks)*
   (ii) State three ways in which the chemistry of zinc is similar to that of magnesium. *(3 marks)*

   (c) (i) State what is observed when dilute aqueous ammonia is added dropwise to a solution containing zinc ions. *(2 marks)*
   (ii) Write the equation(s) for the reaction that takes place in (c) (i). *(2 marks)*

2. The boiling points of the hydrides of group (VII) elements are given in the table below.

Compound	HF	HCl	HBr	HI
B.P (^{0}C)	+19.9	-85.0	-66.7	-35.4

   (a) Explain the trend in the boiling points of the hydrides. *(5 marks)*

   (b) Giving reasons suggest the trend in acid strength of the hydrides. *(4 marks)*

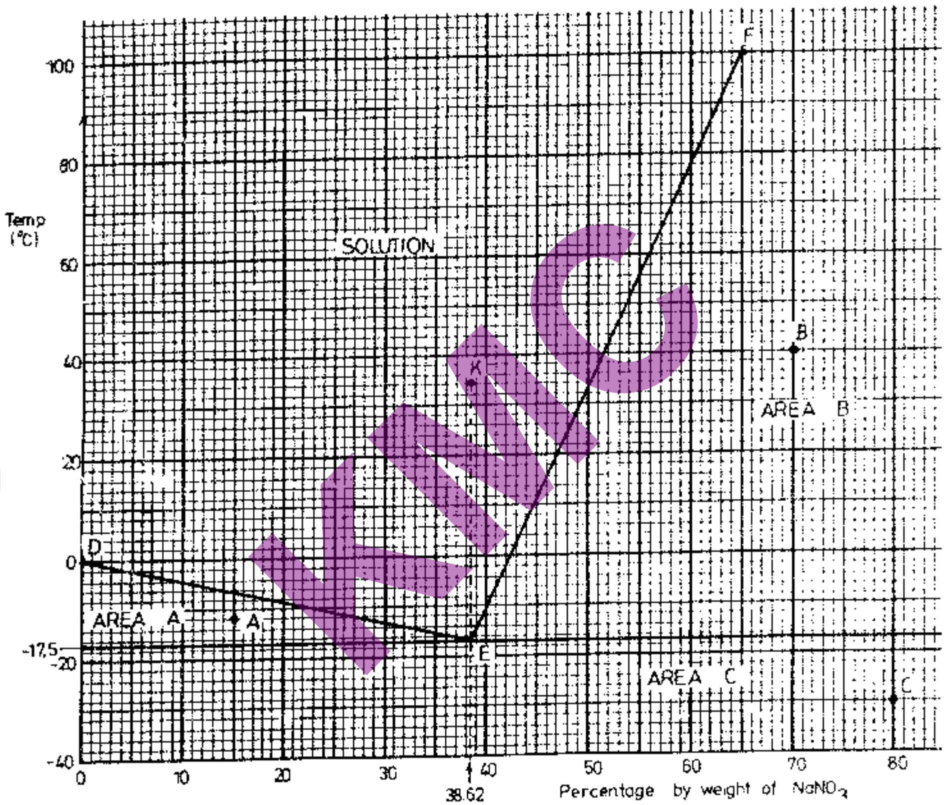
   (c) Using equations where possible explain what happens when concentrated sulphuric acid is mixed with each of the hydrides. *(6 marks)*

   (d) (i) Arrange the following compounds in order of their increasing acid strength. $HClO$, $HClO_2$, $HClO_3$, $HClO_4$ *(1 mark)*
   (ii) Explain your answer in d(i) *(4 mark)*

3. (a) Explain the following terms:

   (i) Solubility. *(3 marks)*
   (ii) Eutectic mixture. *(3 marks)*

(b) The equilibrium diagram for the sodium nitrate-water system is shown below.



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(i) State what lines **DE** and **EF** represent. *(2 marks)*

(ii) Determine the percentages of sodium nitrate at points **A**, **B** and **C**. *(3 marks)*

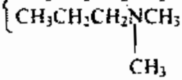
(iii) Name the substances present at **A**, **B**, **C** and **E**. *(4½ marks)*

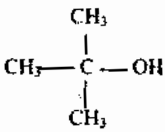
(c) (i) What would be observed if a solution having the composition **K** was cooled slowly? *(1½ marks)*

(ii) State two reasons why eutectic mixtures are not compounds. *(3 marks)*

4. Name the class of compounds to which each pair of the following substances belong and name each substance.

A (i) CH_3CH_2CHO
(ii) $CH_3CH_2COCH_2CH_3$

B (iii) $CH_3CH_2CH_2NH_2$
(iv) 

C (v) $CH_3CH_2CH_2CH_2OH$
(vi) 

D (vii) $CH_3CH_2CH_2COOH$
(viii) $CH_3CH_2COOCH_3$ *(8 marks)*

For each pair of compounds give one test to distinguish them. In each case describe the observations expected and name the products. *(12 marks)*

SECTION B

*Answer **two** questions from this section.*

5. (a) (i) What is structural isomerism?
(ii) Describe the three types of structural isomerism giving a suitable example in each case. *(10 marks)*

(b) A compound has the following formula $C_3H_6Cl_2$. Write down the three possible structures for the compound. *(3 marks)*

(c) Describe the reaction of one of the isomers of $C_3H_6Cl_2$ with sodium hydroxide and write the mechanism of the reaction. *(7 marks)*

6. (a) (i) What is the chemical nature of all soaps? *(1 mark)*
(ii) Give the chemical name of an example of soap. *(1 mark)*
(iii) What do you understand by the term synthetic detergent? *(1 mark)*
(iv) Explain clearly how soaps or detergents remove grease particles during the process of washing. *(4 marks)*
(v) Give one advantage and one disadvantage of detergents. *(2 marks)*
(vi) Give the chemical processes that occur during the manufacture of

- soaps. *(2 marks)*
- detergents. *(2 marks)*

Indicate clearly which raw materials are used in each case

(b) (i) What are the constituents of crude oil? *(2 marks)*
(ii) How are these separated? *(2 marks)*
(iii) Briefly explain cracking and state its use in petroleum industry. *(3 marks)*

7. (a) Explain what is meant by the term **ideal solution**. *(3 marks)*

(b) Propanone was mixed with trichloromethane.

(i) State what was observed. Explain your answer. *(4 marks)*
(ii) Sketch a labelled diagram for the vapour pressure - composition for the mixture of propanone and trichloromethane. (The boiling point of propanone is lower than that of trichloromethane). *(3 marks)*
(iii) Describe what would happen if a mixture of trichloromethane and propanone was fractionally distilled. *(4 marks)*

(c) The boiling point of a solution containing 2.8g of a compound **Z** in 20 g of water is 100.2^0C at standard pressure (b.p of water is 100^0C at standard pressure).

(i) Explain how the solute affects the boiling point of water. *(3 marks)*
(ii) Calculate the relative molecular mass of **Z**.
($K = 0.52^oC\ mol^{-1}$ per 1000g) *(3 marks)*

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8. Explain each of the following observations. (Use equations to illustrate your answer where necessary).

(a) When aqueous sodium carbonate is added to zinc chloride solution a precipitate is formed whereas when the carbonate solution is added to acidified zinc chloride solution, no precipitate is formed. *(5 marks)*

(b) A mixture of water (boiling point 100^0C) and benzene (boiling point 80^0C) boils at 70^0C at 1 atmosphere pressure. *(4 marks)*

(c) When alpha particles are directed at a thin gold foil most of them pass through undeflected. *(3 marks)*

(d) Methanoic acid reacts with ammoniacal silver nitrate solution whereas ethanoic acid does not. *(4 marks)*

(e) When dilute hydrochloric acid is added to a solution of lead (II) ethanoate, a white precipitate is formed. The precipitate is soluble in excess concentrated hydrochloric acid. *(4 marks)*

END

P525/1
CHEMISTRY
Paper 1
April 1997
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

INSTRUCTIONS:

*Answer **all** questions in part A and six questions in Part B.*

All questions are to be answered in the spaces provided.

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

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

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

PART A

Answer all the questions in this part

1. Explain the following observations.

When ammonia solution is added to a solution containing aluminium ions, a white precipitate is formed. In the presence of ammonium chloride, aluminium ions do not form a precipitate with ammonia solution.

72

(5 marks)

2. a) The pH of a 0.10M solution of a weak acid HX is 3.30. Calculate the acid dissociation constant of HX.

(4 marks)

(b) When 50ml of 0.10M solution of ammonium hydroxide solution was added to 50ml of 0.10M solution of hydrochloric acid, the resulting solution had a pH less than 7. Explain the observation.

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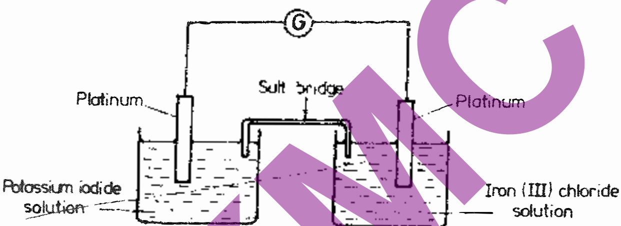
(2 marks)

3. The diagram below shows the e.m.f. cell for the reaction between iron(III) chloride and potassium iodide solution



(a) Indicate on the diagram the direction of flow of current. *(1/2 mark)*

(b) State what is observed at the :

(i) anode, *(1 mark)*

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(ii) cathode. *(1 mark)*

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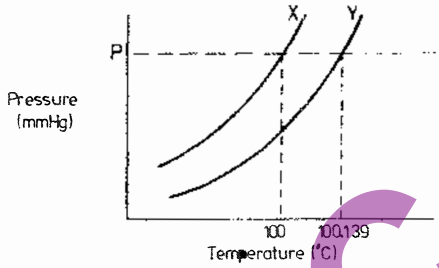
(c) Write equation for the reaction.

....

($1^1/2$ marks)

4. 5.5g of a non-volatile substance **B** was dissolved in 125g of a solvent. The vapour pressure curves for the solution and pure solvent at constant pressure **P** are shown below.



(a) Identify the curve for the solution.

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(1 mark)

(b) Calculate the molecular mass of **B**.
(The boiling point elevation constant for the solvent, K= 0.52°C per mole^{-1} kg^{-1}.)

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(3 marks)

71

(c) State **two** limitations of your calculations in (b).

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(2 marks)

5. Ethanol (bp 78.5°C) and tetrachloromethane (bp 76.8°C) form an azeotropic mixture of boiling point 65.0°C.

(i) What is meant by **azeotropic mixture**?

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(2 marks)

(ii) Draw a boiling point diagram for the ethanol-tetrachloromethane mixture.

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(2 marks)

(iii) Explain why ethanol and tetrachloromethane form an azeotropic mixture.

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(*2 marks*)

6. (a) Write the expression for the distribution of ammonia between water and trichloromethane.

....

(*1 mark*)

70

(b) $100cm^3$ of a solution containing 0.171g of ammonia in trichloromethane was shaken with $10cm^3$ of water until equilibrium was attained at room temperature. Calculate the number of moles of ammonia in the trichloromethane layer. (The distribution Coefficient of ammonia between water and trichloromethane at room temperature is 27.5)

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(*4 marks*)

7. A solution contains 50g of ethane-1, 2-diol and 40.0g of water.

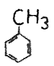
(a) Calculate the boiling point of the solution.
($H=1$, $O=16$, $C=12$, K_b[water] $= 0.52 Kmol^{-1} kg^{-1}$)

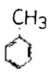
(4 marks)

(b) State any assumptions you made in the calculation.

(2 marks)

8. Complete each of the following equations.

(a)  $+ Cl_2 \xrightarrow[\text{reflux dark}]{AlCl_3}$ (2 marks)

(b)  $+ Cl_2 \xrightarrow{\text{UV light}}$ (2 marks)

9 2.8g of an alkene, C_nH_{2n}, reacted completely with 8.0g of bromine.

(a) Calculate the number of moles of bromine molecules that reacted with the alkene.

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(1½ marks)

(ii) Deduce the number of moles of the alkene that reacted. (1 mole of bromine molecules reacts with 1 mole of alkene.)

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(½ marks)

69

(b) (i) Calculate the formula mass of the alkene.

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(2 marks)

(ii) Determine the molecular formula of the alkene.

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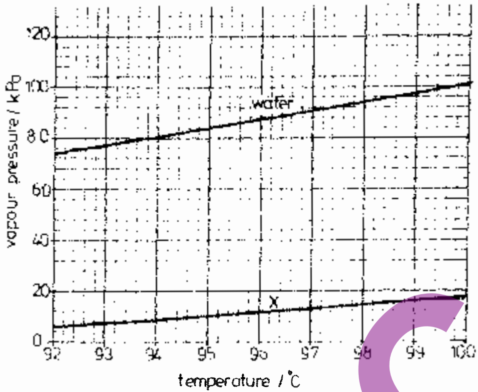
(2 marks)

SECTION B

Answer six questions from this part.

10 The vapour pressures of water and of an immiscible liquid **X** at different temperatures are given below.

figure 1



(a) (i) Construct on Fig. 1 the vapour pressure curve for a mixture of water and **X**. (*1 mark*)

(ii) At what temperatures will the mixture boil at the following pressures

....

(*1 mark*)

(b) (i) After distilling at 101kPa pressure for sometime the distillate was found to consist of 1.00g of water and 0.480g of **X**. By using the graphs in the figure, calculate the relative molecular mass of **X**.

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(*3 marks*)

(ii) How will the composition of the distillate change (if at all) during the distillation :

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(*1 mark*)

(c) In the space below draw a labelled diagram showing the arrangement of the apparatus for steam distillation.

(3 marks)

11. At 25°C ammonia has a base ionisation constant, Kb, of 1.8×10^{-5} mole dm^{-3}.

(a) Write an expression for Kb of ammonia

(1 mark)

68

(b) Calculate the concentration of OH^- in 0.1M ammonia solution at 25° C. State any assumptions made.

(3 marks)

(c) Calculate the change in OH^- concentration which occurs when 0.01 mole of ammonium chloride is added to $1.0 dm^3$ of the solution in (b). State any assumptions made.

(3 marks)

(d) Explain the change in OH^- concentration in (c).

(2 marks)

12. (a) Write an equation for the hydrolysis of sodium ethanoate in water.

($1\frac{1}{2}$ marks)

(b) Write an expression for the hydrolysis constant, Kh of sodium ethanoate.

(1 mark)

(c) Calculate:

(i) the value of Kh for sodium ethanoate and indicate its units.
(Ka for CH_3COOH is 1.8×10^{-5}; $Kw = 1 \times 10^{-14}$)

($2\frac{1}{2}$ marks)

(ii) the pH of a 0.1 M Sodium ethanoate solution.

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(*3 marks*)

(d) State what would be the effect on the pH of the solution in c(ii) if 1 cm^3 of 0.1M ethanoic acid was added to it.

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(*1 mark*)

67

13. A gaseous hydrocarbon **P** consists of 92.3% carbon.

(a) Calculate the empirical formula of **P**.

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(*3 marks*)

(b) 0.13g of **P** occupies 112 cm^3 at s.t.p.
Calculate:

(i) the formula mass of **P**.

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(*3 marks*)

(ii) the molecular formula of **P**.

(3 marks)

14. (a) Write a general outer electronic configuration for elements in the group II of the Periodic Table.

(1 mark)

(b) Describe the reaction, if any, between each of the following elements, beryllium, magnesium and calcium with

(i) warm dilute sulphuric acid

(5marks)

(ii) warm concentrated sodium hydroxide solution.

(4 marks)

(In each case illustrate your answer with equation.)

15. Lead(II) sulphate is sparingly soluble in water ,

(a) Write an expression for the solubility product of lead(II)sulphate

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(b) 5g of lead(II) sulphate was shaken with $1dm^3$ of water

Determine the percentage of lead(II)sulphate that dissolved .
Ksp figures = 1.6×10^{-8} , Pb = 207, S = 32, 0=16)

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(4 marks)

66

(c) If 0.05M sulphuric acid was used instead of water in (b), calculate the percentage of lead(II)sulphate that dissolved and state any assumption you make .

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(4 marks)

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 ● 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 65.4	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 150	63 Eu 152	64 Gd 157	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 H — indicates Atomic number.
1.0 — indicates relative Atomic mass.

END

17

P525/2
CHEMISTRY
Paper 2
April 1997
$2^1/2$ hours

64

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS

Attempt **five** questions including three questions from Section **A** and any two questions from Section **B** .

Begin each question on a fresh page .

Mathematical tables and graph papers are provided .

Non-programmable scientific electronic calculators may be used .

Where necessary use the following values :

C = 12 ; Cl = 17; H = 1; K = 39; N = 14; O = 16; Na = 23; I = 127 .

1 mole of gas occupies 22.4 dm^3 at s.t.p.

1 mole of gas occupies 24dm^3 at room temperature .

Faraday's constant , F = 96500 C

 Turn Over

SECTION A

Answer three questions from this section.

1. (a) A compound **B** contains 92.31% carbon and 7.69% hydrogen. Determine the empirical formula of **B**. (2 marks)

(b) **B** burns with a sooty flame and has a vapour density of 39.

(i) Determine the molecular formula of **B** and write its molecular structure. (3 marks)

(c) Write equation and indicate a mechanism for the reaction between **B** and

(i) nitric acid (5 marks)
(ii) ethanoyl chloride (4 marks)
(iii) propene. (4 marks)

In each case indicate the other reagents necessary and the conditions for the reactions.

(d) Write eqation to show how **B** can be synthesised. (2 marks)

2. (a) A solution contains a mixture of sodium hydroxide and sodium carbonate in 1 litre. Briefly describe how the percentage of sodium hydroxide in the mixture can be determined using a standard hydrochloric acid. (8 marks)

(b) Sketch a graph to show the variation of pH during the titration of hydrochloric acid with

(i) sodium hydroxide
(ii) ammonia solution. (2 marks)

Explain the shape of the graph in each case. (5 marks)

(c) Calculate the pH of the resultant solution when 10 cm^3 of 0.1M sodium hydroxide was added to 25 cm^3 of 0.1M ethanoic acid.

(K_a of ethanoic acid = 1.8×10^{-5}) (5 marks)

3. Discuss the chemistry of zinc and iron showing
(a) similarities. ($8\frac{1}{2}$ marks)
(b) differences. ($11\frac{1}{2}$ marks)

Illustrate your answers with equations.
(Your answer in (a) should include reactions with water, acids and non-metals)

4. (a) With the aid of a diagram, briefly describe how the standard electrode potential of an emf cell can be measured. (7 marks)

(b) The standard electrode potentials of copper and zinc are given below:

$Cu^{2+}(aq) + 2e$	$Cu(s)$	$E^{\theta} = +0.34V$
$Zn^{2+}(aq) + 2e$	$Zn(s)$	$E^{\theta} = -0.76V$

Write the cell diagram for a zinc/copper cell and calculate the emf of the cell (3 marks)

(c) State two ways by which an electrolytic cell differs from an emf cell (2 marks)

(d) During the electrolysis of dilute sulphuric acid using platinum electrodes, a current of 2 amperes was passed for 6.7 minutes at room temperature. Calculate the volume of the gas evolved at

(i) the anode.

(ii) the cathode ([illegible] marks)

(1Faraday = 96500 coulombs; 1 mole of gas occupies 24 dm³ at room conditions)

63

(e) Name one application of

(i) electrolysis (1 mark)

(ii) standard electrode potential (1 mark)

SECTION B

Answer two questions from this section.

5. (a) (i) State Rault's Law. (2 marks)

(ii) Draw the vapour pressure composition curve for mixtures of methanol and cyclohexane and explain the shape of the curve with reference to Rault's Law (8 marks)

(b) (i) Explain the process of steam distillation. (Diagram not required) (5 marks)

(ii) Name one compound that can be isolated by steam distillation. (1mark)

(c) When a compound **Y** was steam distilled at standard atmospheric pressure, the distillation temperature was 86°C. The vapour pressure of water at 86°C is 740mm Hg. The distillate contained 85% by mass of water. Calculate the relative molecular mass of **Y**. (4 marks)

Turn Over

6. (a) (i) Explain what is meant by the term **distribution co-efficient**. (3 marks)

(ii) Describe how the distribution coefficient of ethanoic acid between water and butan-1-ol can be determined. (8 marks)

(b) When $100cm^3$ of aqueous solution containing 30g of ethanoic acid was shaken with $50cm^3$ of butan-1-ol, 12g of ethanoic acid remained in the aqueous later. Calculate the distribution coefficient of ethanoic acid between water and butan-1-ol. (3 marks)

(c) The aqueous solution of ethanoic acid in (b) was shaken twice with $25cm^3$ portions of butan-1-ol. Calculate the mass of ethanoic acid extracted. (4 marks)

(d) State two applications of the partition law. (2 marks)

(a) Describe briefly how chlorine is produced on a large scale. (5 marks)

(b) Describe briefly how chlorine can be converted to potassium chlorate(V) crystals in the laboratory (5 marks)

(c) 2.0 g of a mixture of potassium chloride and potassium chlorate were dissolved in $250cm^3$ of water. $10.0\ cm^3$ of the solution was mixed with excess potassium iodide. The iodine liberated required $8.00\ cm^3$ of a 0.2 M sodium thiosulphate solution for complete reaction. Potassium chlorate and potassium iodide react according to the equation :

$ClO_3^-(aq) + 6H^+(aq) + 6I^-(aq) \rightarrow 3I_2(aq) + Cl^-(aq) + 3H_2O(l)$

Calculate the percentage of potassium chlorate in the mixture (6marks)

(d) Explain why chlorine is more soluble in dilute sodium hydroxide than in water (4 marks)

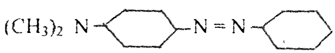
8 Write equation to show how the following compounds can be synthesised.

(a) 

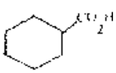
(from benzene) (4 marks)

(b) $CH_3C \equiv CCH_3$ (from $CH_3CHBrCH_2CH_3$) (5 marks)

(c) CH_3CONH_2 (from ethene) (4 marks)

(d) 

(from nitrobenzene) ($4^1/2$ marks)

(e) 

(from benzene) ($2^1/2$ marks)

END.

4

Name .... Centre and Index No...../.. ...

P525/1
CHEMISTRY
Paper 1
April 1996
2¾hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

62

INSTRUCTIONS TO CANDIDATES:

Answer **all** *questions in Part A and* **six** *questions in Part B.*

All questions are to be answered in the spaces provided.

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

1 mole of gas occupies 22.4ℓ at s.t.p.

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

For Examiner's Use Only

 Turn over

PART A

Answer **all** *the questions in this part*

1. The atomic number of element *A* is 33.

(a) Write the electronic configuration of *A*. (1 mark)

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(b) Write the formula of the oxide of *A*. (1 mark)

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(c) State whether the oxide of *A* you have given in (b) is acidic, neutral, basic or amphoteric. Write an equation to illustrate your answer. (2 marks)

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2. (a) Dilute sodium hydroxide solution was added dropwise until in excess to aqueous chromium(III) chloride.

(i) State what was observed. (1½ marks)

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(ii) Write the equation for the reaction. (2 marks)

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(b) To the product in (a) was added a few drops of hydrogen peroxide and the mixture boiled.

(i) State what was observed. (½ mark)

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(ii) Write the equation for the reaction. (1½ mark)

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3 Given the following electrode potentials

$Na^+(aq) + e \longrightarrow Na(s) \quad E^o = -2.71$ volts

$Cu^{2+}(aq) + 2e \longrightarrow Cu(s) \quad E^o = +0.337$ volts

$Zn^{2+}(aq) + 2e \longrightarrow Zn(s) \quad E^o = -0.763$ volts

$Ag^+(aq) + e \longrightarrow Ag(s) \quad E^o = +0.799$ volts

61

(a) Arrange the electrodes in order of reducing power starting with the least reducing. (1 mark)

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(b) (i) Which **two** electrodes will form a cell of maximum e.m.f.? (½mark)

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(ii) Write the cell notation for the cell you give in (i) (1½ marks)

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(iii) Write the overall cell reaction for the cell in (i) (1½ marks)

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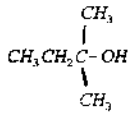
4. 8.0g of a copper ore was leached with dilute sulphuric acid and the resulting solution diluted to $250cm^3$. To $30.0cm^3$ of this solution was added excess 10% potassium iodide solution. The liberated iodine required $23.5cm^3$ of 0.05M sodium thiosulphate solution for complete reaction. Calculate the percentage of Copper in the ore. The reactions that take place are

$$2Cu^{2+}(aq) + 4I^-(aq) \longrightarrow Cu_2I_2(s) + I_2(S)$$

$$I_2(s) + 2S_2O_3^{2-}(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

(4 marks)

5. Name a reagent that can be used to distinguish between each member of the following pairs of compounds. In each case state what would be observed when the reagent is added to each compound. (6 marks)

(a) $CH_3CH_2CH_2CH_2OH$ and 

Reagent: ....

Observations: ....

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60

(b) $CH_3CH_2CH_2NH_2$ and $CH_3CH_2CH_2NHCH_3$

Reagent: ....

Observations: ....

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6. Ammonium chloride undergoes hydrolysis when dissolved in water according to the equation

$$NH_4^+(aq) + aq \rightleftharpoons NH_3(aq) + H^+(aq)$$

If the hydrolysis constant for ammonium chloride, K_h, at 25°C is 5.6×10^{-10}, calculate

(i) the *pH* of a 0.1M solution of ammonium chloride. (3 marks)

(ii) the percentage hydrolysis of 0.1M solution of ammonium chloride. (2 marks)

7. The general formula of a polymer *A* is

$$-[-CH_2-\overset{\displaystyle CO_2CH_3}{\overset{|}{C}}CH_3-]_n-$$

(a) Write the formula of the monomer of *A*. (1 mark)

(b) Name the type of poylymerisation by which *A* is formed. (1 mark)

(c) State **one** method by which the molecular mass of *A* can be determined. Give a reason for your answer. (2 marks)

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8. (a) Define the term '**heat of precipitation**'. (2 marks)

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59

(b) $25.0cm^3$ of 0.5M silver nitrate solution was added to $25.0cm^3$ of 0.5M sodium chloride solution in an insulated container. The temperature of the resulting mixture rose by 3°C. Assuming that the container had negligible heat capacity and the heat capacity of the resulting mixture is $4.2Jg^{-1}°C^{-1}$, calculate the heat of precipitation of silver chloride. (4 marks)

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9. (a) A solution containing 4.50g of a solute *B* dissolved in 125g of water freezes at -0.372°C. Calculate the formula mass of *B*. (K_f for water is 1.86°Cmol^{-1} per 1000g).
(4 marks)

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(b) How do you expect the formula mass of *B* to change if it ionised in water? Explain your answer. (2 marks)

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PART B

10. (a) Name the type of crystal lattice formed by the following substances. (3 marks)

(i) Iodine

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(ii) Caesium chloride

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(iii) Silicon dioxide

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(b) Arrange the substances given in (a) in order of increasing melting points. (1 mark)

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(c) Explain how the bonding in each of the compounds in (a) affect their melting points. (5 marks)

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(a) An organic compound *M* contains *C*, 80%, *H*, 6.7% the rest being oxygen. Calculate the empirical formula of *M*. (4 marks)

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(b) 0.5g when vapourised at 150°C and 760mmHg occupies $144.6cm^3$. Determine the molecular mass of *M*. (3 marks)

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(c) *M* burns with a yellow sooty flame, forms a yellow-orange solid with Brady's reagent and reacts with a solution of iodine in sodium hydroxide to form a yellow solid. Write the formula of *M*. (1 mark)

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(d) Write the equation for the reaction between *M* and Brady's reagent. (2 marks)

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12. In the extraction of aluminium from bauxite, the crude ore is purified by first digesting with sodium hydroxide solution.

(a) Describe what takes place when bauxite is digested with sodium hydroxide and write equations for the reactions taking place. (4 marks)

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S7

(b) Name the steps that are carried out after digesting the bauxite with sodium hydroxide. (3 marks)

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(c) Describe how pure aluminium is obtained from the purified ore. (2 marks)

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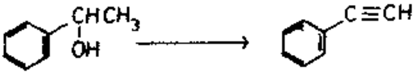
13. Using equations only show how the following conversions could be carried out. (3 marks each)

(a) 

(b) $CH_3CH_2CH_2COOH \rightarrow CH_3CH_2CH_2NH_2$

(c) $CH_3CH_2CH_2Br$ [illegible]

14. Sulphur dioxide is oxidised to sulphur trioxide according to the equation $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$. The enthalpy of the forward reaction at 25°C is $-96kJmol^{-1}$.

(a) Describe, giving reasons the effect on the position of equilibrium of

(i) increasing the temperature from 25°C to 100°C. (2 marks)

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(ii) excess oxygen

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(b) At 700°C and total pressure of one atmosphere the partial pressures at equilibrium for sulphur dioxide and oxygen are 0.27 and 0.41 atmospheres respectively. Calculate the equilibrium constant, *Kp*, for the reaction. (4 marks)

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(c) How is sulphuric acid obtained from sulphur trioxide? (1 mark)

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15. (a) Explain the term '**molar conductivity**' of an electrolyte. (2 marks)

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(b) Sketch a graph to show how the molar conductivity of barium hydroxide varies with concentration in aqueous solution. (3 marks)

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(c) Given the following molar conductivities at infinite dilution, Λo, calculate Λo for ammonia solution.

$Ba(OH)_2$ $\Lambda o = 457.6\ ohm^{-1}cm^2mol^{-1}$

$Ba\ Cl_2$ $\Lambda o = 240.6\ ohm^{-1}cm^2mol^{-1}$

NH_4Cl $\Lambda o = 129.8\ ohm^{-1}cm^2mol^{-1}$ (4 marks)

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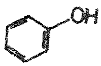
16\. (a) Write equations to show how each of the following compounds can be synthesised.

(i)  (X) from benzene sulphonic acid

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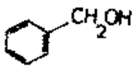
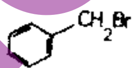
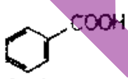
(ii)  (Y) from 

(iii)  (Z) from methyl benzene

(4 marks)

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(b) Arrange the Compounds X, Y and Z (in (a) above) in order of increasing acidity. (1 mark)

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(c) Describe how the compounds X, Y and Z can be distinguished. (4 marks)

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54 17 (a) Sketch the shapes of the following molecules: (3 marks)

(i) NH_3

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(ii) BF_3

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(iii) H_2S

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(b) Explain why each molecule adapts the shape you give in (a) above.

NH_3

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BF_3

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H_2S

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END

P525/2
CHEMISTRY
Paper 2
April 1996
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

S3

Attempt **five** *questions including* **three** *questions from Section A and any* **two** *questions from Section B.*

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Where necessary use the following values:

$C = 12;\ H = 1;\ O = 16;\ Na = 23.$

1 *mole of gas ocupies 22.4 dm^3 at s.t.p.*

1 *1mole of gas occupies 24dm^3 at room temperature.*

Gas constant, $R = 8.3 Jmol^{-1}K^{-1}$

Faraday's constant , $F = 96500C$

 Turn over

SECTION A

Answer **three** *questions from this Section*

1\. (a) (i) Define the term '**Partition Coefficient**' and state the conditions under which it is valid. (3 marks)

(ii) Briefly describe how the partition coefficient for the distribution of iodine between water and trichloromethane can be determined. (5 marks)

(b) (i) 60 cm^3 of an aqueous solution containing 0.3g of compound **Y** was shaken with 30cm^3 of ethoxyethane and the mixture allowed to stand. Calculate the mass of Y which was extracted into the ethoxyethane layer. (The partition coefficient of **Y** between ethoxyethane and water is 4.7).

(ii) The aqueous solution in (i) was extracted with two successive 15cm^3 of **ether**. Calculate the mass of **Y** that was extracted by **ether**. (6 marks)

(c) The **Table** below shows the result of partition of aminomethane between trichloromethane and 0.1M copper(II) sulphate solution.

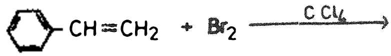
$[CH_3NH_2$ (0.1M $CuSO_4$)]	0.87	1.10	1.33	1.57	1.80
$[CH_3NH_2$ ($CHCl_3$)]	0.02	0.03	0.04	0.05	0.06

(i) Plot a graph of $[CH_3NH_2$ (0.1M $CuSO_4$] versus $[CH_3NH_2$ ($CHCl_3$)]

(ii) Determine the number of moles of aminomethane that has formed a complex with copper(II) ion

(iii) Write equation for the reaction between copper(II) ions and aminomethane. (6 marks)

2. Complete the following equations and in each case outline a mechanism for the reaction:

(a)  (3marks)

(b)  (2marks)

(c) $CH_3CH_2CH_2Br + CH_3CH_2\bar{O}Na^+ \xrightarrow[heat]{CH_3CH_2OH}$ (2marks)

(d) $CH_3CH_2CHO + NaHSO_3 \longrightarrow$ (3marks)

(e)  (6 marks)

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(f)  (4marks)

3. (a) State what would be observed and write equation for the reaction which takes place when dilute sodium hydroxide is added dropwise until in excess to

(i) Ni^{2+} (aq)

(ii) Mn^{2+} (aq)

(iii) Sn^{4+} (aq)

(8 marks)

(b) Discuss the reaction between the elements of group VII of the Periodic Table (fluorine, chlorine, bromine and iodine) and

(i) water (5 marks)

(ii) sodium hydroxide solution (7 marks)

4. (a) Ethanoic acid is a weak acid.

(i) Explain what is meant by a 'weak acid'. (2 marks)

(ii) Calculate the *pH* of a 0.05M ethanoic acid solution (*Ka* of ethanoic acid = $1.8 \times 10^{-5} moldm^{-3}$). State any assumptions you make. (4 marks)

(b) (i) Explain what is meant by a 'buffer solution' (4 marks)

(ii) Discuss the action of a buffer solution (5 marks)

(c) A solution was made by dissolving 7.2g of ethanoic acid and 12.0g of sodium ethanoate to make 1ℓ solution. To the solution was added $0.8cm^3$ of 1M hydrochloric acid. Calculate the *pH* of the solution. State any assumptions you make. (4 marks)

SECTION B

5. (a) A compound *A*, $C_7H_{14}O_2$ reacted with sulphuric acid on heating to form compounds *B*, $C_4H_{10}O$ and $C_3H_6O_2$. *B* reacted with sodium with effervescence but had no effect on litmus paper.

(i) Write the names and structural formulae of all the possible isomers of *B*. (4 marks)

(ii) Name a reagent that can be used to distinguish between the isomers in (i) and state what would be observed if the isomers are reacted with the reagent. (4 marks)

(b) *B* reacted with acidified dichromate solution to give *D* which formed a yellow solid when reacted with alkaline iodine solution.

(i) Identify *B*, *D* and the yellow solid. (3 marks)

(ii) Name one reagent that can be used to identify the functional group in *D*. (1 mark)

(c) Write equations and indicate a mechanism for the reaction between *B* and

(i) concentrated orthophosphoric acid. (4marks)

(ii) ethanoyl chloride. (3 marks)

(d) *C* reacts with sodium carbonate with evolution of a gas. Write the structural formula of *A*. (1 mark)

6. (a) What is meant by the term **'atomic radius'**? (4 marks)

(b) Explain how atomic radii vary

(i) along a short period of a Periodic Table

(ii) down the group in the Periodic Table (8 marks)

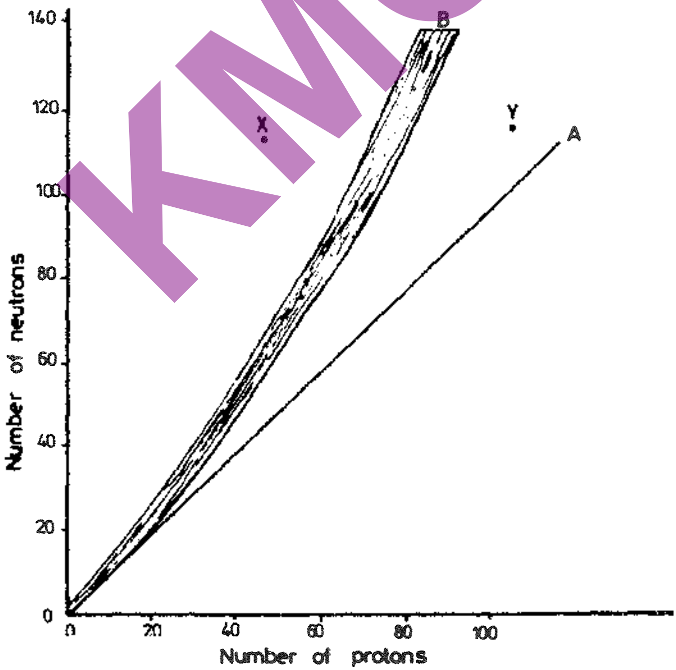
(c) Explain how the sizes of ionic radii of group II ions affects the properties of their compounds compared to those formed by group I metals. (8 marks)

7. (a) (i) What is meant by '**stability of nucleus**'? (6 marks)

(ii) Explain the factors that determine the stability of a nucleus. (7 marks)

(b) The graphs below show a plot of the number of neutrons versus the number of protons in stable nuclei.

S1



(i) State what lines *A* and *B* represent. (2 marks)

(ii) Describe briefly how nuclei *X* and *Y* can gain stability. (5 marks)

8. (a) Explain the following processes as used in the extraction of metals:

(i) Flotation

(ii) Roasting

(iii) Smelting (15 marks)

(b) Describe briefly how the percentage purity of an iron ore can be determined in the laboratory. (5 marks)

END

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

P525/1
CHEMISTRY
Paper 1
March 1995
2¾ hours

SD

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

INSTRUCTIONS:

Answer **all** *questions in Part A and* **six** *questions in Part B.*

All questions are to be answered in the spaces provided.

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

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

For Examiner's Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

PART A

Answer **all** *the questions in this part.*

1. (a) Explain the term *molar enthalpy of solution*. (2 marks)

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(b) Draw a diagram to show the energy changes that take place when a salt, MX, is dissolved in water. (3 marks)

2. Chlorine can be manufactured by electrolysis of saturated sodium chloride solution.

(a) Name (i) the cathode. .... (½ mark)

(ii) the anode. .... (½ mark)

(b) Write an equation for the reaction that takes place at the anode. (1 mark)

(c) (i) Write an equation for the reaction between chlorine and dilute sodium hydroxide at room temperature. (1½ marks)

(ii) State what would happen if the resultant mixture in (i) is heated. (1½ marks)

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3. (a) The diagram in figure 1 shows isotherms of a gas.

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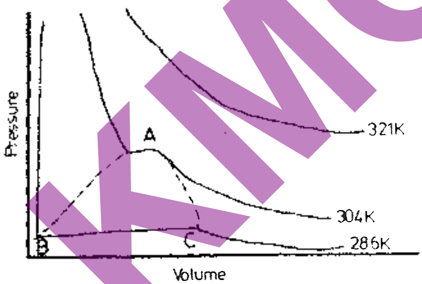

Fig. 1

(i) What is the critical temperature of the gas? (1 mark)

....

(ii) Which isotherm almost represents the behaviour of an ideal gas? (1 mark)

....

(iii) What does the region ABC represent? (1 mark)

....

(b) State one condition necessary for liquefying a gas. (1 mark)

....

4. (a) Write equation(s) and state the conditions for the reaction between sodium dichromate and

(i) propan-2-ol. (2 marks)

(ii) phenylmethanol. (2½ marks)

(b) Name one reagent that can be used to differentiate between propan-2-ol and phenylmethanol. (1 mark)

....

5. (a) Write an expression to show the relationship between acid dissociation constant, K_a, and the degree of dissociation, α, of a weak acid. (1 mark)

(b) Calculate the K_a value for 0.1 M ethanoic acid and state its units.

($\Lambda_{0.1} = 0.00052\ \Omega^{-1} m^2 mol^{-1}$, $\Lambda_\infty = 0.039\ \Omega^{-1} m^2 mol^{-1}$)

(3 marks)

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6. The table below shows the tests carried out on a solution of substance Z and the observations that were made.

	Test	Observations
I	To a solution of Z was added dilute sodium hydroxide solution dropwise until in excess.	Green precipitate insoluble in excess alkali.
II	To a solution of Z was added aqueous ammonia dropwise until in excess.	Green precipitate dissolves in excess ammonia to form solution.
III	To a solution of Z was added dilute nitric acid followed by silver nitrate solution then ammonia solution dropwise until in excess.	White precipitate dissolves in excess ammonia to form a colourless solution.

(a) Identify

(i) the cation in Z. .... (1 mark)

(ii) the anion in Z. .... (1 mark)

(b) Write an ionic equation for the reaction leading to the formation of the white precipitate. (1½ marks)

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(c) Write the formula of the final product in test II. (½ marks)

(d) Name one reagent that can be used to confirm the presence of the cation in Z and state what would be observed if a solution of Z is reacted with the reagent. (2 marks)

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7. 1.18 g of compound *P* on vapourisation occupied 300 cm^3 at s.t.p.

(a) Calculate the relative molecular mass of *P*. (2 marks)

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(b) The empirical formula of *P* is C_2H_4O Determine its molecular formula. (2 marks)

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(c) Compound *P* reacts with sodium carbonate to produce a gas that turns lime water milky. Write the structural formula of *P*. (1 mark)

8. Complete the following equations and write a mechanism for each of the reactions. (3 marks each)

(a) $Cl_2 + CH_2 = CH_2 \xrightarrow{CCl_4}$

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(b) $(CH_3)_3CBr \xrightarrow[heat]{OH^-(aq)}$

 Turn Over

9. State what would be observed and write an ionic equation for the reaction that takes place when

(a) aqueous copper (II) sulphate is added to a solution of potassium iodide. (2½ marks)

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(b) dilute sulphuric acid is added to a solution of sodium chromate followed by aqueous sodium hydroxide. (3 marks)

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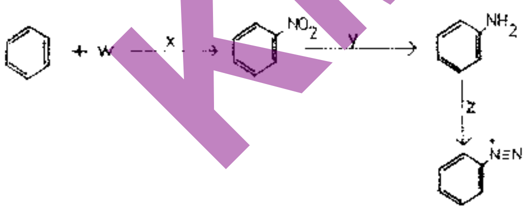
PART B

Answer six questions from this apart.

10. (a) Consider the following reaction scheme:



(i) Identify substance (1 mark)

w ....

x ....

(ii) Name reagent(s) (1½ marks)

y ....

z ....

(iii) State the condition for the reaction between aminobenzene and z. (½ mark)

....

(iv) Write a mechanism for the recation leading to the formation of nitrobenzene. (4 marks)

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(b) Benzene diazonium salt was reacted with phenol in the presence of sodium hydroxide.

(i) State what was observed. (1 mark)

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(ii) Write the structural formula of the product. (1 mark)

11. Name one reagent that can be used to distinguish between the following pairs of ions. In each case state what would be observed if each of the ions is treated with the reagent you have named.

(3 marks each)

(a) $Fe^{3+}(aq)$ and $Cr^{3+}(aq)$

(b) $Al^{3+}(aq)$ and $Zn^{2+}(aq)$

(c) $CH_3COO^-(aq)$ and $\begin{matrix} COO^- \\ | \\ COO^- \end{matrix}(aq)$

12. The table below shows the kinetic data for the decomposition of a compound *Y*.

Time (min)	Concentration of *Y* (mol dm^{-3}) x 10^{-4}
0.0	2.90
18.0	2.30
30.0	2.00
54.0	1.60
80.0	1.30
120.0	1.00

(a) Plot a graph of concentration of Y against time. (3 marks)

45

(b) Determine the rate of reaction at 100 minutes. (2 marks)

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(c) Show how the rate at 10 minutes compares with that at 100 minutes. Explain your answer. (4 marks)

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13. (a) Manganese sulphide reacts with acids according to the following equation:

$$MnS\,(s) + 2H_3O^+(aq) \rightleftharpoons Mn^{2+}(aq) + 2H_2O\,(l) + H_2S\,(aq)$$

State, giving a reason, what would happen to the equilibrium if

(i) water is added to the equilibrium mixture. (2 marks)

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(ii) hydrogen chloride is bubbled into the equilibrium mixture. (2 marks)

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(iii) the pH of the equilibrium mixture is increased. (2 marks)

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(b) Hydrogen reacts with iodine according to the following equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

A mixture of 0.8 mole of hydrogen and 0.6 mole of iodine was allowed to react in a sealed tube at 450°C. At equilibrium, 0.2 mole of iodine had reacted.

(i) Write the expression for the equilibrium constant, K_c, for the reaction. (1 mark)

(ii) Calculate the value of K_c at 450°C. (2 marks)

44

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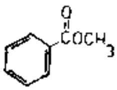
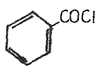
14. Write equations to show how each of the following convertions can be effected. Indicate the reagents and conditions for the reaction in each case.

(3 marks each)

(a) CH_3CHO to $CH_3COOCH_2CH_3$

(b) 

to 

(c)  to 

43

15. The graph in figure 2 shows the variation of the first ionisation energies of the elements in the first row of the Periodic Table:

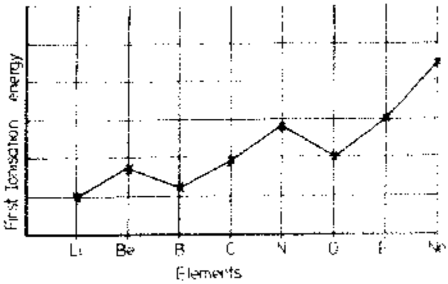


Fig. 2

Explain the following observations:

(i) There is a general increase in first ionisation energy from lithium to neon. (5 marks)

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(ii) The first ionisation energy of beryllium is higher than that of boron. (3 marks)

(iii) The first ionisation energy of oxygen is lower than that of nitrogen. (3 marks)

16. (a) State Raoult's Law. (2 marks)

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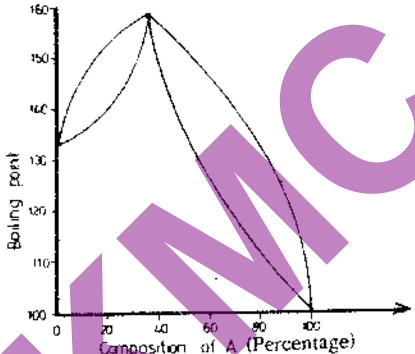
(b) The boiling point-composition diagram of a mixture of water and substance X (which is miscible with water) is given below.



(i) State how the mixture deviates from Raoult's Law. (1 mark)

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(ii) Explain how pure X can be obtained from a mixture containing 50% of water. (4 marks)

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Turn over

42

(iii) What name is given to the mixture containing 36% of X ? (1 mark)

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(iv) Name one substance that would behave in a different way from X. (1 mark)

....

17. (a) Distinguish between addition and condensation polymerisation. (2½ marks)

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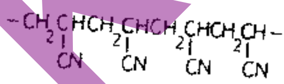
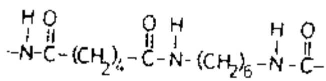
(b) The structural formulae of polymers P, Q and R are shown below:

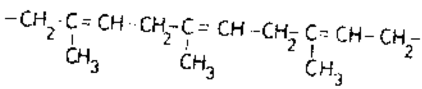
P:



Q:



R:



In the table below, write the structural formula of the monomer(s) in each case and name the type of polymerisation that leads to the formation of each polymer. (5½ marks)

	Structural formula of monomer	Type of polymerisation
P:		
Q:		
R:		

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(c) Give one use of *Q* and one use of *R*. (1 mark)

....

....

END

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 65.4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$ —indicates Atomic number.
2. $\underset{1.0}{H}$ —indicates relative Atomic mass.

P525/2
CHEMISTRY
Paper 2
March 1995
2½ hours

40

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt **five** *questions including* **three** *questions from Section A and any* **two** *questions from Section B.*

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Where necessary use the following values:

Ag = 108; C = 12; H = 1; N = 14; O = 16.

1 mole of gas occupies 22.4 dm^3 at s.t.p.

1 mole of gas occupies 24 dm^3 at room temperature.

Faraday's constant, F = 96500 C

SECTION A

Answer **three** *questions from this section*

1. (a) Explain the variations in the electropositivity of the following elements:

(i) C, Ge and Sn

(ii) Mg, Al, P and Cl_2 (8 marks)

(b) State the common oxidation states of chromium and lead. (2 marks)

(c) Discuss the similarities in the chemistry of chromium and lead.

Your answer should include:

(i) reactions leading to the formation of complexes.

(ii) reactions with aqueous sodium hydroxide. (10 marks)

2. (a) Differentiate between *order* and *molecularity* of a reaction. (5 marks)

(b) The table below shows some data for the reaction:

$$A + 2B \longrightarrow C \qquad \Delta H = +Q \text{ kJ mol}^{-1}$$

Experiment No.	Concentration of A (mol dm^{-3})	Concentration of B (mol dm^{-3})	Rate (mol dm^{-3}s^{-1})
I	1.00×10^{-2}	2.80×10^{-3}	2.1
II	5.00×10^{-3}	2.80×10^{-3}	1.7
III	1.00×10^{-2}	5.60×10^{-3}	4.3

(i) Determine the order of the reaction with respect to A and B. (2 marks)

(ii) Write the rate equation for the reaction. (1 mark)

(iii) Calculate the rate constant for the reaction and give its units. (3 marks)

(iv) Calculate the rate of the reaction when the concentrations of A and B are 8.50×10^{-3} mol dm^{-3} and 3.83×10^{-3} mol dm^{-3} respectively. (2 marks)

(c) State what would happen to the order of the reaction in (b) if B was in large excess. Explain your answer. (3 marks)

(d) Draw a fully labelled energy diagram for the reaction in (b). (4 marks)

3. Discuss the reactions of

(a) amines with nitrous acid.

(b) ethanol with sulphuric acid.

(c) methylbenzene with chlorine.

Your answer should include:

(i) suitable examples for the reactions in (a).
(ii) equations for the reactions in (b).
(iii) mechanisms for the reactions in (c). (20 marks)

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4 (a) A solution containing 20 g of a polymer X in 1 *l* of a solvent exerts an osmotic pressure of 1.4 mm Hg at 25°C.

(i) Explain what is meant by the term *osmosis*. (2 marks)

(ii) Calculate the molecular mass of X. (4 marks)

(iii) The molecular formula of the monometer of X is $(CH_2 = CHCN)$. Determine the number of monomer units in X. (2 marks)

(iv) Draw the general structural formula of X. (1 mark)

(v) Explain why the freezing point depression method is not suitable for determining the molecular mass of a polymer. (2 marks)

(b) (i) Describe how the molecular mass of a substance can be determined by the freezing point depression method. (6 marks)

(ii) Calculate the freezing point depression of the solvent in (a). (The freezing point constant of the solvent is 5° C per litre). (3 marks)

SECTION B

Answer two questions from this section

5. Potassium manganate (VII) is not used as a primary standard in volumetric analysis and has to be standardised.

(a) (i) What is meant by the term *primary standard*? (2 marks)

(ii) State three characteristics of a primary standard. (3 marks)

(iii) Explain why potassium manganate (VII) is not used as a primary standard. (2 marks)

(iv) Name one substance, other than ethanedioc acid, which can be used as a primary standard for potassium manganate (VII). (1 mark)

(b) Explain why hydrochloric acid is not usually used to acidify solutions of potassium manganate (VII). (2 marks)

(c) Acidified potassium manganate (VII) reacts with ethanedioc acid.

Write

(i) the half equations for the reaction. (2 marks)

(ii) the overall equation for the reaction. (2 marks)

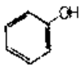
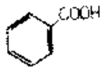
(d) 20.00 cm^3 of a 0.01 M manganate(VII) ion solution required exactly 16.65 cm^3 of a solution containing 4.8 g l^{-1} of an oxalate ($(COO^-X^+)_2 . 2H_2O$). Calculate the atomic mass of X. (6 marks)

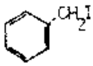
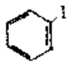
6. (a) Write equations to show how each of the following compounds can be synthesized. In each case, indicate a mechanism for the reaction. (4 marks each)

(i) $(CH_3)_2C = CH_2$ from 2-bromo-2 methylpropane.

(ii) $(CH_3)_2C = N\text{–}OH$ from propanone.

(b) Name the reagent(s) that can be used to differentiate between the compounds in each of the following pairs. In each case, state what would be observed if each member of the pairs is treated with the reagent(s).
(3 marks each)

(i)  and 

(ii)  and 

(c) When 400 cm^3 of a mixture of ethene and ethyne, measured at room temperature, was bubbled into excess ammoniacal silver nitrate solution, 2.4 g of a white precipitate was formed.

(i) Write an equation for the reaction which took place and name the white precipitate. (2 marks)

(ii) Calculate the percentage, by volume, of ethene in the mixture. (4 marks)

38

7. (a) State two factors which determine the magnitude of electrode potential of a metal. (2 marks)

(b) Draw a well labelled diagram to show how the standard electrode potential of zinc can be determined. (4 marks)

(c) The equations below show the standard electrode potentials for some half reactions.

$Cu^{+}(aq) + e \longrightarrow Cu(s)$ $\quad E^{\theta} = +0.52\ V$

$Cu^{2+}(aq) + e \longrightarrow Cu^{+}(aq)$ $\quad E^{\theta} = 0.15\ V$

Which one of the two ions, Cu^{+} and Cu^{2+}, is a stronger oxidising agent? Give a reason for your answer. (2 marks)

 Turn over

(d) The ionic radii and the molar ionic conductivities, at infinite dilution at 18°C of lithium and ceasium ions are given in the table below.

	Li^+	Cs^+
Ionic radius (nm)	0.06	0.17
Molar ionic conductivity (Ω^{-1} $cm^2 mol^{-1}$)	33.5	68.0

Explain why the molar ionic conductivity of lithium ions is lower than that of ceasium ions.
(4 marks)

(e) A current of 40.5 A was passed through molten lead (II) bromide for 4 hours and the bromine liberated reacted with 94.0 g of hydroxybenzene. Calculate the number of moles of

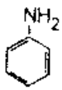
(i) bromine liberated.

(ii) hydroxybenzene that reacted.
(6 marks)

(f) Write an equation for the reaction that took place between bromine and hydroxybenzene in (e) and name the product.
(2 marks)

8. Explain each of the following observations:

(a) The basic strengths of aminobenzene, ammonia and dimethylamine are in the order



$< NH_3 < (CH_3)_2NH$

(6 marks)

(b) Beryllium belongs to group II in the Periodic Table and yet its chemistry and that of its compounds resembles that of aluminium.
(4 marks)

(c) Calcium phosphate is insoluble in water but dissolves in dilute hydrochloric acid.
(5 marks)

(d) Ethene reacts with bromine to form 1,2-dibromoethane. But when the reaction is carried out in the presence of sodium chloride solution, 1-bromo-2-chloroethane is formed.
(5 marks)

END

P525/1
CHEMISTRY
Paper 1
March 1994
2¾ hours

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UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

Answer **all** *questions in Part A and six questions in Part B.*

All questions are to be answered in the spaces provided.

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

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

For Examiners's Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

Turn Over

PART A

*Answer **all** questions from this part.*

1. Complete the following equations: (3 marks)

(a) $^{234}_{91}Pa \longrightarrow\ ^{234}_{92}U +$ ....

(b) $^{6}_{3}Li + ^{1}_{0}n \longrightarrow\ ^{3}_{1}H +$ ....

(c) $^{107}_{47}Ag + ^{1}_{0}n \longrightarrow$ ....

2. (a) Oxygen diffuses 1.19 times faster than an amine Q.

(i) Determine the relative molecular mass of Q. (3 marks)

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(ii) Write the structural formulae of all possible isomers of Q. (1 mark)

(b) When Q was reacted with sodium nitrite and hydrochloric acid at 0^oC, nitrogen gas was evolved and a colourless solution was formed.
Identify Q.

(1 mark)

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3. Substance **X** dissolved in water to form a yellow solution. When aqueous sodium hydroxide was added dropwise to the solution, a brown solid insoluble in excess alkali was formed.

(a) (i) Identify the cation in **X**. (1 mark)

....

(ii) Name one reagent that can be used to confirm the cation you have identified in (i) (1 mark)

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(b) The pH of the solution of **X** was less than 7.
Explain this observation and write an equation to illustrate your answer. (3 marks)

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4. A 0.01 M solution of ammonia is 4.0% ionised.

(a) Calculate the pH of the solution.
($K_w = 1 \times 10^{-14}$) (3 marks)

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(b) Determine the base dissociation constant, K_b, for the ammonia solution. (3 marks)

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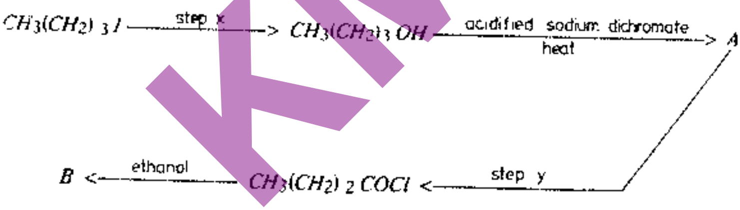
5. Compound *B* was synthesized according to the reaction scheme shown below:



(a) Identify the reagents in

(i) step *x*. .... (1 mark)

(ii) step *y*. .... (1 mark)

(b) State the condition for the reaction in

(i) step *x*. .... (1 mark)

(ii) step *y*. .... (1 mark)

(c) Write the name and structural formula of compound

(i) *A*. (1 mark)

(ii) *B*. (1 mark)

6. When excess zinc was added to 100 cm^3 of 0.25 M copper (II) sulphate solution, the temperature of the solution rose by 12.9°C.
(The specific heat capacity and density of the solution are 4.2 J g^{-1} K^{-1} and 1.0 g cm^{-3} respectively.)

(a) Write an equation for the reaction. (1½ marks)

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(b) Calculate the enthalpy change for the reaction. (4½ marks)

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7. (a) Write the electronic configuration of strontium. (1 mark)

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(b) What is the principal oxidation state of strontium? (1 mark)

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(c) State whether the first ionisation energy of strontium is greater or less than that of barium.
Explain your answer. (2 marks)

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8. (a) Explain what is meant by *steam distillation*. (2 marks)

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(b) A mixture of naphthalene ($C_{10}H_8$) and water distils at 98.3°C and 753 mm Hg. Calculate the percentage, by mass, of naphthalene in the distillate
(The vapour pressure of water at 98.3°C is 715 mm Hg)

(3 marks)

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9. Name one reagent that can be used to distinguish between each of the following compounds. In each case state what would be observed if each member of the pairs is treated with the reagent.

(3 marks each)

(a) CH_3COOH and $HCOOH$

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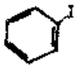
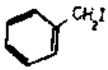
(b)  and 

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PART B

Answer **six** *questions from this part.*

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

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Write the expression for the equilibrium constant for the reaction in terms of partial pressure and indicate its units. (2 marks)

(b) Stoichiometric amounts of nitrogen and hydrogen were reacted at 50 atmospheres and at equilibrium, 0.8 moles of ammonia was formed.

Calculate

(i) the amount of hydrogen at equilibrium. (2½ marks)

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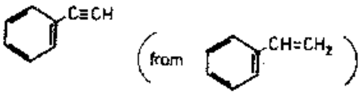
(ii) the value of the equilibrium constant for the reaction. (4½ marks)

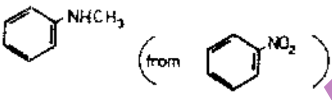
33

11. Write equations to show how each of the following can be synthesized. In each case indicate the conditions for the reaction. (3 marks each)

(a) $CH_3CH_2NH_2$ (from CH_3CH_2COOH)

Turn Over

(b) 

(c) 

12. Name one reagent that can be used to distinguish between each of the following pairs of ions and in each case state what would be observed. (3 marks each)

(a) Mg^{2+} and Ca^{2+}

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(b) Cl^- and I^-

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(c) CO_3^{2-} and HCO_3^-

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13. The data in the table below was obtained for the reaction:

$$2A \longrightarrow Products.$$

Time (hours)	0	1.3	2.0	4.0	5.3
$Log_{10}[A]$	-0.07	-0.24	-0.33	-0.57	-0.74

(a) Plot a graph of $\log_{10}[A]$ against time. (3 marks)

Turn Over

(b) From the graph, determine the order of the reaction. (1 mark)

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(c) Calculate

(i) the rate constant for the reaction. (2 marks)

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(ii) the half-life of the reaction. (3 marks)

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14. Complete each of the following equations and write a mechanism for the reaction.
(3 marks each)

(a) $CH_3COCH_2CH_3 + NaHSO_3 \longrightarrow$

Mechanism:

(b) $CH_3CH_2CH_2OH \xrightarrow[\text{heat}]{\text{conc } H_2SO_4}$

Mechanism:

(c) $CH_3CH_2CH_2Cl + CH_3CH_2O^-Na^+ \longrightarrow$

Mechanism:

15. 1.55 g of an acid, $C_nH_{2n}(COOH)_2$ was dissolved in water and the solution made up to 250 cm^3. 25.0 cm^3 of the solution required 23.5 cm^3 of a 0.1 M aqueous sodium hydroxide for complete neutralization.

30

(a) Calculate

(i) the molar concentration of the acid. (3 marks)

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(ii) the molecular mass of the acid.

(3 marks)

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(b) Determine the value of n.

(2 marks)

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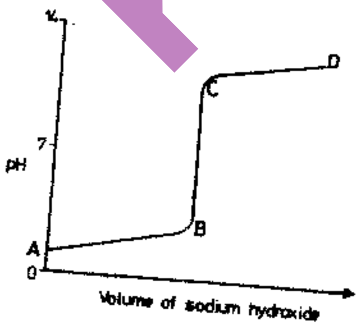
(c) Write the structural formula of the acid.

(1 mark)

16. (a) The curve below was obtained when hydrochloric acid was titrated with sodium hydroxide.



Explain what happens to the pH in the region: (6 marks)

(i) AB

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(ii) BC

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29

(iii) CD

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(b) Name one indicator that can be used in the titration in (a) (1 mark)

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(c) Using the axes above, sketch a graph that would be obtained if hydrochloric acid is titrated with ammonia solution. (2 marks)

17. (a) In volumetric estimation of reducing agents, potassium dichromate (VI) is preferred to potassium manganate (VII) as an oxidant.
Explain why potassium dichromate (VI) is preferred as an oxidant. (2 marks)

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(b) 3.8 g of solder containing tin was dissolved in excess hydrochloric acid. The solution was made up to 250 cm^3. 25.0 cm^3 of this solution required 23.5 cm^3 of a 0.01 M potassium dichromate (VI) solution for complete reaction.

(i) Write the half equation for potassium dichromate (VI) acting as an oxidizing agent in acid medium. (1½ marks)

(ii) Calculate the number of moles of potassium dichromate (VI) used. (1½ marks)

(iii) Calculate the number of moles of tin in the 250 cm^3 of solution. (2 marks)

(iv) Determine the percentage, by mass, of tin in the solder. (2 marks)

END

THE PERIODIC TABLE

28

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 65·4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$ — indicates Atomic number.
2. $\underset{1\cdot0}{H}$ — indicates relative Atomic mass.

P525/2
CHEMISTRY
Paper 2
March 1994
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt **five** *questions including* **three** *questions from Section A and any* **two** *questions from Section B.*

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Where necessary use the following values:

$C = 12$; $H = 1$; $O = 16$; $Na = 23$; $Mg = 24$.

1 mole of gas occupies 22.4 dm^3 at s.t.p.

1 mole of gas occupies 24 dm^3 at room temperature.

Gas constant, $R = 8.3\ J\ mol^{-1}\ K^{-1}$

Faraday's constant, $F = 96500\ C$

Turn Over

SECTION A

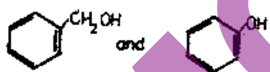
1. For each of the following pairs of compounds, name one reagent that can be used to

   (i) test for the functional group,
   (ii) distinguish between each of the pairs.
   Your answer should include the relevant observations (5 marks each)

(a) $CH_3CH_2CH_2CH_2OH$ and $CH_3-\overset{CH_3}{\underset{CH_3}{C}}-OH$

(b) $CH_3\overset{O}{\overset{\|}{C}}CH_3$ and CH_3CH_2CHO

(c) CH_3CHO and CH_3CH_2CHO

(d) 

27

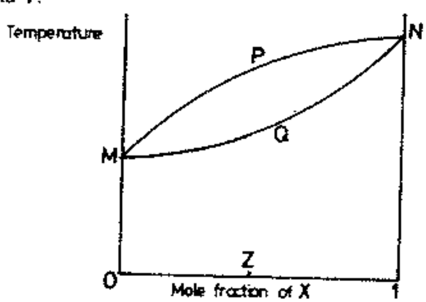
2. (a) State Raoult's Law. (2 marks)

(b) A mixture of liquids A and B obeys Raoult's Law. The vapour pressures of A and B and are 10.00 kN m^{-2} and 2.92 kN m^{-2} respectively at 20°C.

   (i) Calculate the composition of the vapour of a mixture containing 0.5 mol of each liquid at 20°C. (3 marks)

   (ii) Which of the liquids is more volatile? Give a reason for your answer. (2 marks)

(c) The diagram below shows the boiling point-composition of a mixture of liquids X and Y.



2

(i) Identify the curves P and Q and the points M and N. (4 marks)

(ii) Describe what happens when the liquid mixture of composition Z is boiled. (4 marks)

(iii) Explain how the principle in (ii) can be used to separate liquid mixtures by fractional distillation. (5 marks)

(a) Describe one general method for preparing the halogens (excluding fluorine) in the laboratory and write an equation for the reaction. (4½ marks)

(b) Describe the reactivity of fluorine, chlorine and bromine with

(i) water.

(ii) concentrated sodium hydroxide solution.

Your description should include equations. (12 marks)

(c) How would you distinguish between sodium bromide and sodium iodide, given chlorine water and tetrachloromethane? (3½ marks)

(a) Describe how the solubility product of magnesium hydroxide in water can be determined. (6 marks)

(b) (i) A saturated solution of magnesium hydroxide in water contains 1.44×10^{-4} mol of magnesium hydroxide per litre of solution at $25^{o}C$. Calculate the value of the solubility product, Ksp, of magnesium hydoxide at $25^{o}C$. (3 marks)

(ii) Solid magnesium hydroxide was shaken with a 0.1 M solution of magnesium nitrate until equilibrium was attained at $25^{o}C$.

Calculate the amount of magnesium hydroxide, in grams per litre, that dissolved. (6 marks)

(c) Equations of some reactions are given below:

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq) \qquad K_1 = 1.7 \times 10^{-10}$$

$$Ag^{+}(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2^{+}(aq) \qquad K_2 = 1.7 \times 10^{7}$$

Turn Over

(i) Derive an expression in terms of K_1 and K_2, for the equilibrium constant for the following reaction:

$$AgCl(s) + 2NH_3\,(aq) \rightleftharpoons Ag(NH_3)_2^+\,(aq) + Cl^-\,(aq)$$

(3 marks)

(ii) Calculate the value of the equilibrium constant in (i). (2 marks)

SECTION B

5. (a) (i) Explain what is meant by the term *lattice energy*. (2 marks)

(ii) State two factors that affect the magnitude of lattice energy. (3 marks)

(iii) Describe how the factors you have stated in (ii) affect lattice energy. (6 marks)

26 (b) (i) Draw a Born-Haber cycle for the formation of solid rubidium chloride from its elements. (4 marks)

(ii) Calculate the electron affinity of chlorine atom.
Use the following data: (3 marks)

Lattice energy of rubidium chloride	= 665 $kJ\,mol^{-1}$
Dissociation energy of chlorine gas molecules	= 226 $kJ\,mol^{-1}$
Heat of atomization of rubidium metal	= 84 $kJ\,mol^{-1}$
Ionization energy of rubidium atom	= 397 $kJ\,mol^{-1}$
Standard heat of formation of solid rubidium chloride	= -439 $kJ\,mol^{-1}$

(c) Calculate the heat of hydrogenation of ethyne to ethene from the following thermodynamic data:

$$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O\,(l) \quad \Delta H = -1393\ kJ\,mol^{-1}$$

$$C_2H_2 + 2\tfrac{1}{2}O_2(g) \longrightarrow 2CO_2(g) + H_2O\,(l) \quad \Delta H = -1310\ kJ\,mol^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \longrightarrow H_2O\,(l) \quad \Delta H = -285\ kJ\,mol^{-1}$$

(3 marks)

6. Write notes on each of the following reactions. Your answer should include a suitable example in each case, and also mechanisms for reactions (a) and (d).

(20 marks)

(a) Nucleophilic substitution.

(b) Nitration.

(c) Esterification.

(d) Dehydration of alcohols.

7. (a) (i) Write the name and formula of one ore of zinc. (2 marks)

(ii) Briefly describe how pure zinc can be obtained from the ore you have named in (i). (7 marks)

(b) (i) Name one reagent that can be used to distinguish between zinc ions and aluminium ions in solution. (1 mark)

(ii) State what would be observed when zinc and aluminium ions are separately treated with the reagent. Write equations for the reactions. (5 marks)

(c) Explain how zinc protects iron from rusting. (5 marks)

8. Explain each of the following observations:

(a) The boiling point of trimethylamine, $(CH_3)_3N$ is less than that of dimethylamine, $(CH_3)_2NH$. (4 marks)

(b) 0.01 M aqueous sodium chloride has the same freezing point as 0.02 M aqueous glucose. (4 marks)

(c) Alkenes undergo electrophilic addition reactions whereas carbonyl compounds undergo nucleophilic addition reactions. (7 marks)

(d) Copper (II) chloride dissolves in concentrated hydrochloric acid to form a brownish yellow solution; which on dilution with water, turns green-blue and finally pale blue.

END

Name .... Centre and Index No. ..../........

P.525/1
CHEMISTRY
Paper 1
March 1993
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

25

INSTRUCTIONS:

Answer **all** *questions in Part A and* **six** *questions in Part B.*

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

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

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

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

PART A

Answer **all** *the questions in this part.*

1. A solution containing x g of cane sugar (RMM = 342) in 105 g of water at a pressure of 101.3 Pa boiled at 100.06°C. Determine x.

   (K_b for water = 0.52°C mol^{-1} per 1000 g) (4 marks)

2. Draw the molecular structures of the following species and name the shapes of the species you have drawn. (4½ marks)

	Structure	Shape
(a) NO_2^-		
(b) PCl_5		
(c) ICl_2^-		

3. The two compounds **A**. $CH_3CH_2CH_2CH_2Br$ and **B**. $CH_3CH_2CHBrCH_3$ have the same functional group.

(a) Explain the term *functional group*. (2 marks)

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(b) Write equations to show how **A** can be converted to **B**. (2 marks)

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4. (a) (i) Name the three main types of radioactive emissions. (1½ marks)

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(ii) State two properties of one of the emissions named in (i). (2 marks)

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Turn Over

(b) Copper has a relative atomic mass of 63.55 and consists of two isotopes of mass numbers 63 and 65. Calculate the percentage composition of the isotopes. (3 marks)

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5. (a) Some bond energies are given in the table below:

Bond	Energy (kJ mol^{-1})
C-C	-337
C-H	-414
C-O	-360
O-H	-123

Calculate the heat of formation of gaseous ethanol. (3 marks)

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(b) Carbon monoxide burns in oxygen according to the following equation:

$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$

Calculate the enthalpy of combustion of carbon monoxide.

(Heats of formation of carbon monoxide, and carbon dioxide are -108 kJ mol^{-1} and -393 kJ mol^{-1} respectively). (2 marks)

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23

6. (a) The first five successive ionisation energies of elements X and Y are given in the table below:

Element	Ionisation Energies (kJ mol^{-1})				
	First	Second	Third	Fourth	Fifth
X	1310	3390	5320	7460	11000
Y	1410	2860	4710	7470	9450

Turn Over

(i) State the group in the Periodic Table which each of the elements belongs to.

(1 mark)

(ii) Explain your answer in (i)

(3 marks)

(b) Elements **A** and **B** both have high ionisation energies and high electron affinities. State the type of bond that exists in the compound formed by **A** and **B**.

(1 mark)

7. Write the structural formula and name of the product of each of the following reactions.

(2 marks each)

(a) $CH_3CH_2OH \xrightarrow[150^\circ C]{Conc.\ H_2SO_4}$

(b) $CH_2 = CH_2 \xrightarrow{Br_2/H_2O}$

(c) $CH_3\underset{}{\overset{CH_3}{\overset{|}{C}}}HCH_2COO^-Na^+ \xrightarrow[heat]{CaO}$

6

8. (a) What is meant by the term *buffer solution* ? (3 marks)

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(b) Calculate the mass of sodium ethanoate that should be added to 1 dm^3 of a 0.1 M ethanoic acid in order to give a solution whose pH is 4. State any assumption made. (K_a ethanoic acid = 1.8×10^{5} $mol\ dm^{-3}$) (4 marks)

22

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9. Benzene reacts with chlorine under two different conditions to give different products. State the two conditions and write equation for the reaction between benzene and chlorine under each condition. (4 marks)

Condition

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Equation

Turn Over

Condition

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Equation

PART B

Answer **six** *questions from this part.*

8. (a) In the industrial production of sulphuric acid by the Contact process, sulphur dioxide is oxidised to sulphur trioxide in the presence of a catalyst according to the following equation:

$$SO_2(g) + \frac{1}{2}O_2(g) \xrightleftharpoons{500°C} SO_3(g) \quad \Delta H = -96\ kJ\ mol^{-1}$$

(i) Name the catalyst used in the process. (1 mark)

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(ii) Explain why the reaction is carried out at 500°C. (2 marks)

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(iii) Sulphuric acid is used in the manufacture of super phosphate fertilizer. Write equation for the reaction. (1½ marks)

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(iv) Give one other large scale use of sulphuric acid. (½ mark)

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(b) Concentrated sulphuric acid contains 98% of the acid. Calculate the mass of the concentrated acid required to make a 2.0 M solution of sulphuric acid. (3 marks)

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(c) Name one reagent that can be used to identify the anion in sulphuric acid. (1 mark)

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11. Iron(III) hydroxide and phenylamine react with water according to the following equations:

21

$$Fe(OH)_3(s) \underset{}{\overset{H_2O}{\rightleftharpoons}} Fe^{3+}(aq) + 3OH^-(aq) \qquad K_s = 1 \times 10^{-38}$$

$$C_6H_5NH_2(aq) + H_2O(l) \rightleftharpoons C_6H_5\overset{+}{N}H_3(aq) + OH^-(aq) \qquad K_b = 4{\cdot}25 \times 10^{-10}$$

(a) Write expressions for the solubility product, K_s, for iron(III) hydroxide and the base dissociation constant, K_b for phenylamine. In each case state the assumption you have made. (5 marks)

Expression for K_s

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Assumption

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Expression for K_b

Assumption

(b) The equation for the reaction between phenylamine and iron (III) ions is given below:

(i) Write an expression for the equilibrium constant for the reaction. (1 mark)

(ii) Express the equilibrium constant in terms of K_s and K_b. (1 mark)

(iii) Calculate the value of the equilibrium constant. (2 marks)

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12. (a) 2-bromo-2-methylpropane reacts with aqueous sodium hydroxide to form an organic compound Y.

(i) Write equation and suggest a mechanism for the reaction. (3½ marks)

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(ii) Name one reagent that can be used to identify the functional group in Y. (1 mark)

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(b) Sodium metal was dissolved in excess ethanol. Write equation for the reaction. (1½ marks)

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(c) 2-bromo-2-methylpropane was added to the solution in (b) and the mixture was warmed. Write equation and indicate a mechanism for the reaction that took place. (3 marks)

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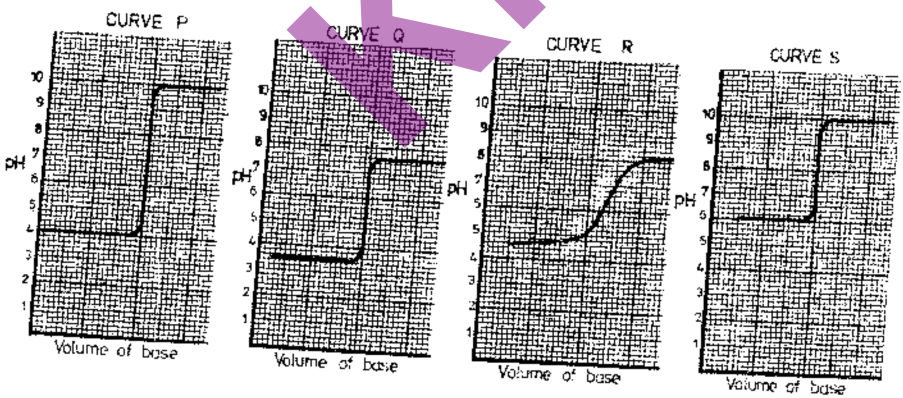
13. (a) The curves P, Q, R and S below show changes in pH during acid-base titration.



Which one of the curves corresponds to the titration of

a weak acid with a weak base?

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a strong acid with a weak base?

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a strong acid with a strong base?

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a weak acid with a strong base?

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(2 marks)

19

(ii) Cresol red, methyl red, bromothymol blue and phenolphthalein indicators change colour at the pH values of 1.0, 5.3, 6.8 and 9.2 respectively. Suggest the most suitable indicator that can be used in the titration of the acid and base used to obtain curve P. Give a reason for your answer. (1½ marks)

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(b) 48.00 cm^3 of a solution containing 7.00 g per litre of potassium hydroxide required 25.00 cm^3 of 0.12 M phosphoric acid for complete neutralisation

(i) Calculate the molar ratio in which phosphoric acid reacts with potassium hydroxide. (4 marks)

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(ii) Write equation for the reaction.

(1½ marks)

4. Some half reactions and their corresponding reduction potentials are given below.

$MnO_4^-(aq) + 8H^+(aq) + 5e \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$ $E = +1.51 V$

$MnO_{2(s)} + 4H^+(aq) + 2e \longrightarrow Mn^{2+}(aq) + 2H_2O(l)$ $E = +1.23 V$

$Sn^{2+}(aq) + 2e \longrightarrow Sn(s)$ $E = -0.136V$

$Sn^{4+}(aq) + 2e \longrightarrow Sn^{2+}(aq)$ $E = +0.15 V$

(a) (i) State what would be observed when excess tin powder is added to acidified solution of potassium manganate (VII). Explain your answer.

(3 marks)

(ii) Write equation for the reaction that takes place in (i) (1½ marks)

(b) Solid manganese(IV) oxide was added to acidified solution containing tin(II) ions.

(i) State what was observed and explain your answer. (3 marks)

18

(ii) Write equation for the reaction. (1½ marks)

15. Name the reagent that can be used to distinguish between each of the following pairs of compounds. In each case state what would be observed if the compounds are treated with the reagent you have named.

(a)  and 

Turn Over

(b) $CH_3C \equiv CCH_3$ and $CH_3CH_2C \equiv CH$

(c) 

16. (a) State three properties which are exhibited by chromium but not by calcium. (3 marks)

(b) Aqueous iron (II) solution was added to a solution containing chromium in oxidation state +6.

(i) State what was observed. (1 mark)

(ii) Write half equations and the overall equation for the reactions that took place (3½ marks)

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(c) State one application of chromium in oxidation state +6 in organic synthesis and write equation to illustrate your answer. (1½ marks)

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17 17. When 0.29 g of a substance X was burnt in oxygen, 0.66 g of carbon dioxide and 0.27 g of water were formed

(a) (i) Calculate the masses of carbon, hydrogen and oxygen in X. (3 marks)

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(ii) Determine the empirical formula of **X**. (3 marks)

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(b) **X** forms a yellow precipitate with 2,4-dinitrophenylhydrazine and a grey precipitate with ammoniacal silver nitrate solution. The vapour density of **X** is 29. Write the name and structural formula of **X**. (3 marks)

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END

16

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 65·4	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 150	63 Eu 152	64 Gd 157	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. $\overset{1}{H}$ —indicates Atomic number.
2. $\underset{1·0}{H}$ —indicates relative Atomic mass.

P525/2
CHEMISTRY
Paper 2
March 1993
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt **five** *questions including* **three** *questions from Section A and any* **two** *questions from Section B.*

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

Where necessary use the following values:

$C = 12$; $H = 1$; $O = 16$; $Na = 23$

1 mole of gas occupies 22.4 dm^3 at s.t.p.

1 mole of gas occupies 24 dm^3 at room temperature.

Gas constant, $R = 8.3\ J\ mol^{-1}\ K^{-1}$

Faraday's constant, $F = 96487\ C$

Turn Over

SECTION A

Answer **three** *questions from this section*

1\. (a) (i) Explain the terms *lattice energy*, *hydration energy* and *enthalpy of solution*. (6 marks)

(ii) Using potassium iodide, draw an energy diagram to show how the energy terms in (i) are related. (2 marks)

(iii) The enthalphy of solution and lattice energy of potassium iodide are +21 kJ mol^{-1} and -642 kJ mol^{-1} respectively. Calculate the hydration energy for potassium iodide. (2 marks)

(b) With the aid of a diagram, describe an experiment that can be carried out to determine the enthalphy of solution of ammonium chloride. Write an expression to show how the enthalphy of solution of ammonium chloride can be calculated from the results of the experiment. (10 marks)

15 2. (a) A compound X has molecular formula C_3H_8O.
.... Write the structural formulae and names of all the possible isomers of X. (3 marks)

(b) X reacted with iodine and aqueous sodium hydroxide to form a yellow precipitate.

(i) Identify X. (1 mark)

(ii) Write equation for the reaction between X and iodine in the presence of aqueous sodium hydroxide. (2 marks)

(iii) State what would be observed if X is reacted with acidified chromium (VI) oxide. Write equation for the reaction and name the main organic product. (3 marks)

(c) When X was heated with excess concentrated sulphuric acid, a gas, Y, which decolourised bromine water was evolved. Write equation for the reaction between

(i) X and sulphuric acid and suggest a mechanism for the reaction. (4 marks)

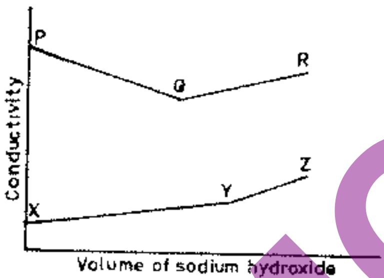
(ii) Y and bromine water and name the product. (2 marks)

(d) Y was used in the manufacture of hydroxybenzene. Write equation and indicate the conditions for the reaction. (5 marks)

3. (a) (i) State Faraday's laws of electrolysis. (4 marks)

(ii) A current of 2 A was passed for 30 minutes through a cell containing dilute sulphuric acid and the hydrogen produced at the cathode collected. Calculate the volume of the hydrogen, in cm^3, that was produced at $23^{\circ}C$ and 100 kPa. (6 marks)

(b)



Graphs **PQR** and **XYZ** show variations of the conductivities of solutions formed when equal volumes of 0.1 M hydrochloric acid and 0.1 M ethanoic acid respectively were titrated with 1 M sodium hydroxide solution. Account for the difference in the shapes of the graphs. (10 marks)

4. The elements beryllium, magnesium and barium belong to group II in the Periodic Table.

(a) (i) State three chemical properties shown by the elements. For each property, write an equation to illustrate your answer. (6 marks)

(ii) Explain the trend in the solubilities of the hydroxides of the elements in water. (3 marks)

(b) Beryllium differs in some of its properties from the rest of the elements in the group.

(i) State two properties in which beryllium differs from the rest of the members of the group. (2 marks)

(ii) Give reasons why beryllium shows different properties from the rest of the elements. (2 marks)

Turn Over

(c) (i) Name one reagent that can be used to distinguish between magnesium ions and barium ions. (1 marks)

(ii) State what would be observed in each case when the reagent in (i) was used. (2 marks)

(iii) Write equation(s) for the reaction(s) that take(s) place in (ii). (1½ marks)

(d) An aqueous solution of magnesium chloride has a pH less than 7. Explain. (2½ marks)

SECTION B

Answer **two** *questions from this section*

5. (a) Propanone reacts with iodine in the presence of an acid catalyst according to the equation

14

$$CH_3\overset{O}{\overset{\|}{C}}CH_3 + I_2 \dashrightarrow CH_3\overset{O}{\overset{\|}{C}}CH_2I + HI$$

The reaction is first order with respect to propanone and independent of the concentration of iodine.

(i) Explain the term *order of reaction*. (2 marks)

(ii) Write the expression for the rate law for the reaction. (1 mark)

(iii) Describe briefly how the order of the reaction with respect to iodine can be determined. (8 marks)

(b) The following kinetic data were obtained for the reaction between hydrogen peroxide, iodide ions and hydrogen ions.

Concentration (mol dm^{-3})			Rate of reaction
H_2O_2(aq)	I^-(aq)	H^+(aq)	(mol s^{-1})
0.010	0.010	0.10	1.75×10^{-6}
0.030	0.010	0.10	5.25×10^{-6}
0.030	0.020	0.10	1.05×10^{-5}
0.030	0.020	0.20	1.05×10^{-5}

(i) Determine the order of the reaction with respect to hydrogen peroxide; hydrogen ions and iodide ions. In each case give a reason for your answer. (4½ marks)

(ii) Write the rate equation for the reaction. (1 mark)

(iii) Calculate the rate constant for the reaction and indicate its units. (3½ marks)

6. (a) Sodium hydroxide is one of the raw materials used in the manufacture of soap

(i) Outline a process by which sodium hydroxide is manufactured. (6 marks)

(ii) Name one other raw material used in the manufacture of soap. (1 mark)

(iii) Describe a process by which soap is produced from sodium hydroxide and the material you have named in (ii) above. (3 marks)

(iv) Write equation for the reaction leading to the formation of soap. (2 marks)

(b) Explain the difference between the terms *soap* and *soapless detergent*. Your answer should include the advantages and disadvantages of using soap and soapless detergents in washing. (8 marks)

7. (a) The table below shows the solubilities of salt A and salt B at different temperatures.

Temperature (^oC)		0	10	20	30	40	50	60
Solubility (g per 100 g of water)	Salt A	13	20	32	45	63	85	110
	Salt B	32.5	34	35	36	37	38	39

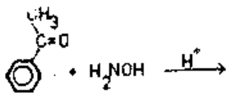
(i) Plot a graph of solubility against temperature for salt A and salt B using the same axes. (4 marks)

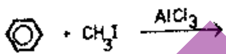
(ii) A saturated solution of salt A was cooled from 45°C to 25°C. Determine the mass of salt deposited. (2 marks)

(b) Explain how a pure sample of salt A can be obtained from a mixture containing salts A and B. Name one method that can be used to test for the purity of the separated sample. (8 marks)

(c) 25.0 cm^3 of a solution containing a mixture of sodium carbonate and sodium hydrogen carbonate required 15.00 cm^3 of 0.5 M hydrochloric acid for complete reaction using phenolphthalein indicator. 25.0 cm^3 of the solution of the mixture required 34.50 cm^3 of the acid using methyl orange indicator. Calculate the mass of sodium carbonate and sodium hydrogen carbonate in the solution in grams per litre. (6 marks)

8. (a) Complete the following equations and write a mechanism for the reaction in each case.

(i)  (4 marks)

(ii)  (3 marks)

13

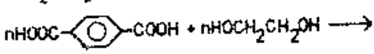
(b) Write equations to show how each of the following compounds can be prepared. In each case indicate the conditions for the reaction. (3½ marks each)

(i)  from phenylmethanol.

(ii) $CH_3CH_2NH_2$ from propanoic acid.

(c) Complete each of the following equations. State one use of the product in each case. (1½ marks each)

(i) $nCH_2{=}CH_2 \xrightarrow{\text{catalyst}}$

(ii) 

(iii) $nH_2N(CH_2)_6NH_2 + nHOOC(CH_2)_4COOH \longrightarrow$

(iv) $nCH_2{=}\overset{CH_3}{\overset{|}{C}}CH{=}CH_2 \longrightarrow$

END

Name .... Centre and Index No. ..../...........

P525/1
CHEMISTRY
Paper 1
March 1992
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 1

2 hours 45 minutes

Answer **all** *questions in Part A and* **six** *questions in Part B.*

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

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

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

For Examiner's Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

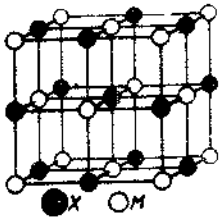
Turn over

12

PART A

Answer **all** *questions in this part*

1. The diagram below shows the lattice structure of an ionic salt *MX*.



(a) State the coordination number of M^+ and X^- ions. Explain your answer. (3 marks)

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(b) Name the type of lattice structure shown in the diagram above. (1 mark)

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2. When 20 g of a mixture containing anhydrous sodium carbonate and sodium hydrogen carbonate was heated and cooled, the mass of the mixture changed to 13.8 g.

(a) Write equation for the reaction that took place during the heating. ($1\frac{1}{2}$ marks)

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(b) Calculate the percentage of sodium hydrogen carbonate in the mixture.

($4\frac{1}{2}$ marks)

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3. (a) *Steam distillation* is one of the methods used for the separation of a component from a liquid mixture.

State one requirement for the component to be separated by steam distillation.

(1 mark)

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(b) A mixture containing a substance X was steam distilled at 760 mm Hg and 98 ^{o}C. The distillate contained 85% by mass of water. If the vapour pressure of water is 734 mm Hg at 98 ^{o}C, calculate the molar mass of X. (3 marks)

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4. Name reagent(s) that can be used to distinguish between each of the following pairs of compounds. In each case state what would be observed when the compounds are treated with the reagent(s) you have named. (3 marks each)

(a) $(CH_3)_3COH$ and $CH_3CH_2CH_2CH_2OH$

Reagent(s) ....

....

Observations ....

....

....

(b) $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_2CH_3$ and $CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}CH_3$

Reagent(s) ....

....

Observations

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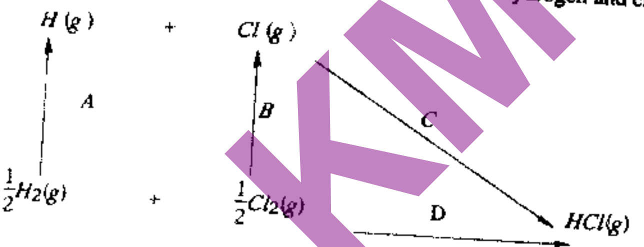
5. The energy diagram for the reaction between hydrogen and chlorine is given below.



(a) Identify the energy changes

A ....

B ....

C ....

D ....

(2 marks)

Turn over

(b) Calculate the enthalpy change for the reaction.

(The H-H, Cl-Cl, and H-Cl bond energies are 435.9, 241.8 and 431.0 kJ mol^{-1} respectively) ($2\frac{1}{2}$ marks)

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6. (a) Write an ionic equation for the reaction between sodium hydroxide and

(i) silicon(IV) oxide. ($1\frac{1}{2}$ marks)

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(ii) lead(IV) oxide. ($1\frac{1}{2}$ marks)

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(b) When lead(IV) oxide is heated with sulphur dioxide, a white solid is formed. Explain the observation. (3 marks)

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7. (a) Define the term *cracking*. (2 marks)

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(b) Name two types of cracking and state the difference between them. (3 marks)

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8. The equations for some half cell reactions are given below:

$Cd^{2+}(aq) + 2e \longrightarrow Cd(s) \quad E^{o} = -0.440$ volts

$H_2O_2(aq) + 2H^{+}(aq) + 2e \longrightarrow 2H_2O(l) \quad E^{o} = +1.77$ volts

(a) Write

(i) the cell notation. (2 marks)

....

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(ii) the equation for the overall cell reaction. (1 mark)

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(b) The electrodes were connected externally by a conductor.

State the direction of flow of electrons. (1 mark)

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9. Write equations to show how each of the following compounds can be synthesised.

(a) CH_3CO_2H (from CH_3OH) ($3\frac{1}{2}$ marks)

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(b) $CH_3CH_2CH_2CO_2CH_3$ (from $CH_3CH_2CH_2CH_2OH$) (3 marks)

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PART B

Answer **six** *questions from this part*

10. (a) Phenylamine hydrochloride, undergoes hydrolysis in water.

Write

(i) equation for the reaction. ($1\frac{1}{2}$ marks)

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(ii) an expression for the hydrolysis constant, K_h (1 mark)

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(b) A solution containing 15.0 g of phenylamine hydrochloride in 100 cm^3 of water was shaken with 100 cm^3 of benzene. At equilibrium the benzene layer contained 0.12 g of phenylamine.

Calculate

(i) the molar concentration of phenylamine in the benzene layer.

(2 marks)

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(ii) the hydrolysis constant, K_h, of phenylamine hydrochloride.

($4\frac{1}{2}$ marks)

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11. The first ionisation energies and the first electron affinities of the group VII elements are given in table 1

Table 1

Element	First ionisation energy (kJ mol^{-1})	First electron affinity (kJ mol^{-1})
Fluorine	1681	-328
Chlorine	1250	-349
Bromine	1139	-325
Iodine	1007	-295

(a) State how the first electron affinities of the elements generally vary with their first ionisation energies. (2 marks)

8

(b) Explain why the first electron affinities of these elements have negative signs. (3 marks)

(c) Give reason(s) for the abnormally low value of electron affinity of fluorine.
(2 marks)

(d) State the trend in the first ionisation energies of the elements and give a reason for your answer.
(2 marks)

12. Complete each of the following equations and suggest a mechanism for the reaction in each case. (9 marks)

(a)  $CH_2I + OH^-(aq) \xrightarrow{heat}$

(b)  $+ \; Cl_2 \xrightarrow{Fe}$

7

(c) $(CH_3)_3C\,Cl \xrightarrow[heat]{CH_3CH_2O^-}$

13. **Hydrogen reacts with nitrogen to produce ammonia according to the following equation:**

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Write an expression for the equilibrium constant, K_c. (1 mark)

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(b) State, giving reason(s), what would happen to the value of the equilibrium constant when

(i) pressure is increased at constant temperature (3 marks)

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(ii) argon is added to the reaction mixture at constant pressure. (2 marks)

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(iii) argon is added to the reaction mixture at constant volume (3 marks)

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Turn over

14. When a pale green solid P was heated, it decomposed to a green solid Q and a gas that turned lime water milky was evolved. Q dissolved in dilute nitric acid to give a green solution, R. On adding dilute sodium hydroxide solution to R, a green precipitate, S, , insoluble in excess alkali was obtained. S dissolved in aqueous ammonia to give a purplish blue solution.

(4 marks)

(a) Identify compounds P,Q,S and solution R.

P ....

Q ....

S ....

Solution R ....

(b) Write equation for the reaction between

(i) Q and nitric acid. ($1\frac{1}{2}$ marks)

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(ii) R and sodium hydroxide. ($1\frac{1}{2}$ marks)

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(iii) S and ammonia. (2 marks).

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15. (a) (i) State Kohlrausch's law of ionic conductivity at infinite dilution. (1 mark)

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(ii) Calculate the molar conductivity of methanoic acid at infinite dilution.

(λ_o (HCOONa) $= 9.5 \times 10^{-2}$ S m^2 mol^{-1}; λ_o (NaCl) $= 1.26 \times 10^{-1}$ S m^2 mol^{-1}; λ_o (HCl) $=$ 4.26×10^{-1} S m^2 mol^{-1})
(2 marks)

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(b) Ionic conductivities of Ag^+ and Cl^- ions at infinite dilution are 6.2×10^{-2} and 7.6×10^{-2} S m^2 mol^{-1} respectively at 298 K. The electrolytic conductivity of silver chloride at 298 K is 1.22×10^{-4} S m^{-1}. Calculate the solubility, in mol dm^{-3}, of silver chloride at 298 K. (5 marks)

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(c) Name one practical application of ionic conductivity apart from the determination of solubility of electrolytes. (1 mark)

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16. (a) An alkyne, Z, has molecular formula C_4H_6.

Write the names and structural formulae of all possible isomers of Z (2 marks)

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(b) Z reacts with a solution of copper (I) chloride in aqueous ammonia to give a red precipitate.

(1 mark)

(i) Identify Z

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(ii) Write equation for the reaction between Z and excess hydrogen bromide. (1 mark)

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(c) Write equation(s) to show how Z can be synthesised from but-1-ene. (3 marks)

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(d) Write the structural formulae and names of two hydrocarbons that are not alkynes but are isomeric with Z.

(2 marks)

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17. Polystyrene and nylon are both synthetic polymers.

(a) In each case write the structural formula(e) of the monomer(s); state whether the polymer is formed by addition or condensation polymerisation and write the structural formula of the polymer.

(6 marks)

Polymer	Structural formula of monomer	Method of formation of polymer	Structural formula of polymer
Polystyrene			
Nylon			

(b) Write equation(s) to show how styrene can be synthesised starting from 2-phenylethanol.

(3 marks)

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END

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 65·4	31 Ga 69·7	32 Ge 72·6	33 As 74·9	34 Se 79·0	35 Br 79·9	36 Kr 83·8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44	45	46	47	48	49	50	51	52	53	54

P525/2
CHEMISTRY
Paper 2
March 1992
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(PRINCIPAL SUBJECT)

Paper 2

2 hours 30 minutes

Attempt **five** *questions including* **three** *questions from Section A and any* **two** *questions from Section B.*

Mathematical tables and graph papers are provided.

Non-programmable scientific electronic calculators may be used.

(C = 12, H = 1, O = 16, 1 mole of gas occupies 22.4 dm^3 at s.t.p.)

Turn over

SECTION A

Answer **three** *questions from this section*

1. (a) (i) State two common oxidation states of chromium. (1 mark)

(ii) Write the electronic configuration of chromium ions in the oxidation states you have stated in (i). (Atomic number of chromium = 24). (2 marks)

(iii) Write the formula of one compound in each case in which chromium shows the oxidation states you have stated in (i). (Your answer should not include chrome alum and potassium chromate). (2 marks)

(b) A dilute solution of chrome alum, $K_2Cr_2(SO_4)_4.2H_2O$ was prepared and divided into two portions.

(i) The first portion turned blue litmus red. Explain the observation and write equation to illustrate your answer. (4 marks)

(ii) To the second portion was added few drops of sodium carbonate solution. State what was observed and explain your answer. (5 marks)

3 (c) When about 1 cm^3 of dilute sulphuric acid was added to about 1 cm^3 of potassium chromate, an orange solution was observed. Addition of an excess dilute sodium hydroxide solution to the mixture gave a yellow solution.
Write equations for the reactions that took place. (3 marks)

(d) Briefly describe a test that can be carried out in the laboratory to confirm that potassium chromate contains chromium ions. (3 marks)

2. (a) The boiling point of water is 100 ^oC and that of ethanol is 80 ^oC. A mixture of the two liquids when distilled, gives a constant boiling mixture at 78.2 ^oC containing 95.6% ethanol.

(i) Draw a labelled diagram of boiling point against composition for the water-ethanol mixture.
Explain the shapes of the curves in the diagram. (9 marks)

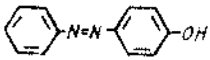
(ii) Describe what would happen if a mixture containing less than 95.6% of ethanol is fractionally distilled. (4 marks)

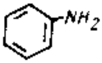
(b) (i) A solvent, Y, of molecular mass 62 has a vapour pressure of 1.0×10^4 N m^{-2} at 298 K. 23.3 g of a non-volatile solute of molecular mass 270 was added to 100 g of Y at 298 K.
Calculate the vapour pressure of the solution. (4 marks)

(ii) State and explain the effect of increasing the concentration of the solute on the boiling point of Y. (3 marks)

3. Write equations to show how each of the following compounds can be synthesised. In each case indicate the reagents and the conditions for the reactions.

(a) CH_3CO_2H (from ethene) (4 marks)

(b)  (from phenylamine) (3 marks)

(c)  (from benzoic acid) (5½ marks)

(d) $CH_3CH_2OCH_2CH_3$ (from ethanal) (4 marks)

(e) $CH_3CO_2CH_2CH_2CH_3$ (from 1-bromopropane) (3½ marks)

4. (a) Explain what is meant by each of the following terms.

(i) rate equation

(ii) order of reaction

(iii) molecularity. (9 marks)

(b) The data in table I were obtained for the reaction between a bromoalkane (RBr) and hot aqueous sodium hydroxide.

Table I

Time (min)	0	9	18	27	40	54	72	105
Conc of RBr (mol dm^{-3})	0.106	0.096	0.086	0.077	0.065	0.054	0.043	0.030

(i) Plot a graph of concentration of the bromoalkane against time. (3 marks)

(ii) From the graph determine the order of reaction. Give a reason for your answer. (2 marks)

(iii) State whether the bromoalkane is primary, secondary or tertiary. (1 mark)

(iv) Suggest a mechanism for the reaction. (2 marks)

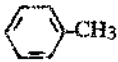
(v) Draw a labelled energy diagram for the reaction. (3 marks)

 Turn over

SECTION B

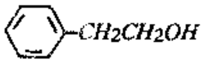
Answer **two** *questions from this section*

5. Complete each of the following equations and in each case outline a mechanism for the reaction.

(a) 

$\xrightarrow[uv\ light]{Cl_2}$

(b) $(CH_3)_2C = CH_2 \quad \xrightarrow{HCl}$

(c) 

$\xrightarrow[heat]{conc\ H_3PO_4}$

(d) $CH_3CH = CH_2 \xrightarrow[warm]{H^+/H_2O}$

(e) $CH_3CH_2CHO + R\,NH_2 \xrightarrow{H^+}$ (20 marks)

2

6. (a) (i) State Hess' law. (2 marks)

(ii) Explain the terms *standard state of a substance* and *standard enthalpy change for a reaction.* (4 marks)

(b) Describe briefly how the enthalpy change of neutralisation of hydrochloric acid can be determined. (9 marks)

(c) The standard enthalpies of combustion of carbon, sulphur and carbon disulphide are -394, -297 and -1075 $kJ\ mol^{-1}$ respectively.
Calculate the standard enthalpy of formation of carbon disulphide. (5 marks)

7. Explain each of the following observations:

(a) The pH of pure water is 7.0 at 25 °C and 6.4 at 75 °C. (2 marks)

(b) The Ka of methanoic acid is 1.7×10^{-4} and that of ethanoic acid is 1.7×10^{-5} at 25 °C. (5 marks)

(c) Beryllium carbonate decomposes at 25 °C whereas calcium carbonate decomposes at 900 °C. (4 marks)

(d) Benzene and cyclohexene can be hydrogenated to cyclohexane. The enthalpies of hydrogenation of benzene and cyclohexene are 200 kJ mol^{-1} and 121 kJ mol^{-1} respectively.

(4 marks)

(e) A solution containing ammonium chloride and ammonia has a buffer action.

(5 marks)

8. (a) (i) Outline the chemical process involved in the manufacture of nitric acid. Illustrate your answer with suitable equations.

(6 marks)

(ii) State two large scale uses of nitric acid.

(1 mark)

(b) Concentrated nitric acid is 70% (w/w) and has a density of 1.42 g cm^{-3}.
Calculate the molarity of the concentrated nitric acid.

(3 marks)

(c) 12.68 cm^3 of the acid in (b) was dissolved in water and the solution made up to 250 cm^3 with distilled water. Calculate the volume of the solution that would react completely with 25.0 cm^3 of a 0.2 M sodium carbonate solution.

(4 marks)

(d) Briefly discuss the reaction between copper and nitric acid. Illustrate your answers with equations.

(6 marks)