NAME.....INDEX NO .....

P525/1
CHEMISTRY
Paper 1
$2^{3}/_{4}$ hours

ACEITEKA JOINT MOCK EXAMINATIONS, 2023

Uganda Advanced Certificate of Education

CHEMISTRY

PAPER I

2 hours 45 minutes

INSTRUCTIONS

Answer **all** questions in section **A** and **six** questions in section **B.**
Any **extra** question answered will not be marked.
All questions must be answered in the spaces provided
The Periodic Table with relative atomic masses will be provided**Illustrate your answers with equations where applicable** Molar gas constant R = 8.314 $Jmol^{-1}K^{-1}$
Molar volume of gas at s.t.p is 22.4 litres
Molar volume of gas at room temperature is 24 litres .

For Examiners Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A

(1) The standard electrode potential for some redox systems are shown below;

$VO^{2+}_{(aq)} + 2H^{+} + e \longrightarrow V^{3+}_{(aq)} + H_2O_{(aq)}$ $\quad E^{\theta} = +0.34V$

$MnO_{2(s)} + 4H^{+}_{(aq)} + 2e \longrightarrow Mn^{2+}_{(aq)} + 2H_2O_{(aq)}$ $\quad E^{\theta} = +1.23V$

(a) Write

(i) The cell notation for the cell formed when the half cells are combined. (1½ marks)

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(ii) The overall equation for the reaction. (1½ marks)

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(b) (i) Calculate the e.m.f of the cell in (a) (1½ marks)

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(ii) State whether the cell reaction in (a)(ii) is feasible or not.
Give a reason for your answer. (1 mark)

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(2) (a) To a mixture of manganese (IV) oxide and solid sodium chloride was added a few dropsof concentrated sulphuric acid and the mixture warmed.

(i) State what was observed. (½ mark)

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

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(b) Excess of the gaseous product formed in (a) was bubbled through aqueous solution of sodium thiosulphate.

(i) State what was observed. (1 mark)

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

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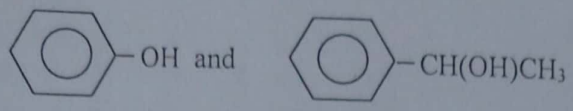
(3) Name the reagent that can be used to distinguish between the following pair of compounds. State the observations made.

(a)  and

Reagent — (1 mark)

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Observation (2 marks)

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(b) CH_3CH_2CHO and $CH_3COCH_2CH_3$

Reagent (1 mark)

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Observation (2 marks)

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(4) (a) Draw and name the shape of boron trifluoride.

Shape (1 mark)

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Name of the shape (½ mark)

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(b) Comment on polarity of boron trifluoride and explain your answer. (2½ marks)

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(c) Write equation for the reaction between boron trifluoride and ammonia. (1 mark)

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(5) Vegetable oils are used as raw materials in manufacture of soap.

(i) Explain what is meant by the term vegetable oil. (1 mark)

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(ii) Name any one source from which vegetable oil can be obtained. (½ mark)

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(iii) Describe briefly how soap is obtained from vegetable oil. (2 marks)

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(iv) Write general equation for the reaction leading towards formation of soap from vegetable oil.

(1 mark)

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(6) (a) Explain what is meant by the term **order of a reaction**. (1 mark)

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(b) The rate equation for a reaction between substances A, B and C is in the form; Rate = $k[A]^x[B]^y[C]^z$

Experiment	Initial concentration of A (mol l^{-1})	Initial concentration of B (mol l^{-1})	Initial concentration of C (mol l^{-1})	Initial rate (mol $l^{-3}s^{-1}$)
1	0.10	0.20	0.20	8.0×10^{-5}
2	0.10	0.05	0.20	2.0×10^{-5}
3	0.05	0.10	0.10	1.0×10^{-5}
4	0.10	0.10	0.10	2.0×10^{-5}

Use the data in the table to determine the order of reaction with respect to A, B and C respectively. ($1\frac{1}{2}$ marks)

(i) A

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

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

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(c) Determine the value of rate constant (1 mark)

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(7) (a) Explain what is meant by the term **first ionization energy** . (1 mark)

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(b) The first, second, third and fourth ionization energies of element M are; 800,2400,3700 and 25000 Kj mol^{-1} respectively.

State and explain the trend in variation in ionization energies of element M. (2½ marks)

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(c) (i) State the type of bond and structure that exists in the chloride formed by element M.

Type of bond

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Structure

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(ii) Give reason for your answer in (c)i. (1 mark)

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(8) Lithium and magnesium show similarities in some of their chemical properties howevertheir carbides react differently with water.

(a) State reasons why the chemical properties of lithium resemble that of magnesium.

(1½ marks)

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(b) Write equations for the reactions of carbides of lithium and magnesium with water.

(2 marks)

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(9) (a) (i) State grahams law of gaseous diffusion. (1 mark)

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(ii) Compound T with formula $Ni(CO)_x$ takes 46 minutes to diffuse through a porous medium. An equal volume of oxygen takes 19.90 minutes to diffuse through the same medium under thesame conditions. The vapour density of T is 85.35.

Determine the molecular formula of T. (3 marks)

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(b) Name compound T and state the co-ordination number nickel in the compound.

Name (½ mark)

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Co-ordination number. (½ mark)

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SECTION B

(10) (a)(i) Explain what is meant by the term **steam distillation.** (1 mark)

(ii) Compound Y contains carbon, hydrogen and nitrogen. On analysis of 1.86g of compound Yproduced 5.28g of carbon dioxide and 224cm^{3}of nitrogen measured at s.t.p. Determine the empirical formula of Y. (3 marks)

(b) A mixture of compound Y and water was steam distilled. The mixture boiled at 96^{0}C at760 mm Hg. The saturated vapour of water at 96^{0}C is 722 mm Hg. The distillate contains 78.61% by mass water.
Determine the;
(i) molecular mass of Y. (2 marks).

(ii) molecular formula of Y. (1 mark)

(c) (i) Compound Y forms white precipitate with bromine water.
Identify Y (½ mark)

(ii) Cold concentrated hydrochloric acid and sodium nitrite was added to compound Y and to the resultant solution was added naphthalen-2-ol in presence of sodium hydroxide solution. State what was observed and write equation for the reaction that takes place between theresultant solution and 2-napthalen-2-ol.

Observation ($\frac{1}{2}$ mark)

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Equation (1 mark)

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(11) (a) Copper (II) ethanoate was strongly heated until there was no further change.

(i) State what was observed. (1 mark)

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(ii) Write equation for the reaction that took place. ($1\frac{1}{2}$ marks)

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(b) When the gaseous product formed in (a) was passed through 2,4-dinitrophenyl hydrazine inacidic media a compound Q was formed.

Outline the reaction mechanism for the reaction leading towards formation of compound Q. ($5\frac{1}{2}$ marks)

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(c) Write equation(s) to show how the gaseous product that reacted with 2,4-dinitrophenyl hydrazine in acidic media to form compound Q can be synthesized from a carboxylic acid. Indicate the necessary reagents and conditions. (1mark)

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(12) (a) Strontium fluoride is a sparingly soluble salt.

(i) Write equation for solubility of strontium fluoride in water. (1 mark)

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(ii) Write the expression for solubility product of strontium fluoride. (1 mark)

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(b) The solubility of strontium fluoride in water at 25^0C is $0.109gdm^{-3}$.

Calculate the solubility product of strontium fluoride ($2^1/_2$ marks)

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(c) Calculate the solubility of strontium fluoride in 0.1M aqueous solution of strontium nitrate ($2^1/_2$ marks)

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(d) State and explain what would happen to the solubility of strontium fluoride when potassiumfluoride is added. ($1^1/_2$ marks)

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(e) State one application solubility product. ($^1/_2$ mark)

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(13) (a) A compound R contains by mass 90.66% lead and the rest oxygen. Molar mass ofcompound R is 684.9.

(i) Determine the empirical formula of R. (2 marks)

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(ii) Calculate the molecular formula of R. (1 mark)

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(b) Compound R was warmed together with dilute nitric acid until there was no furtherchange.

Write equation for the reaction that took place. ($1\frac{1}{2}$ mark)

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(c) The mixture formed in (b) was filtered and the residue was added to aqueous solution ofmanganese nitrate then followed by concentrated nitric acid.

State what was observed and write equation for the reaction that took place.

Observation ($\frac{1}{2}$ mark)

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Equation (1 mark)

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(d) To the filtrate obtained in (c) was added ammonium chromate solution followed by sodiumhydroxide solution. State what was observed and write equation(s) for the reaction(s) that tookplace.

Observation (1 mark)

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Equation(s) (2 marks)

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(14) (a) (i) Explain what is meant by the term **enthalpy of formation.** (1 mark)

(ii) Given that the heat of combustion of carbon, hydrogen and ethanoic acid are; -394, -286 and -878 respectively. Calculate the enthalpy of formation of ethanoic acid.

($3^1/_2$ marks)

(b) (i) Define the term **bond energy.**

(1 mark)

(ii) The enthalpies of atomization of carbon, oxygen and hydrogen are; 721, 249 and 218 Kj mol^{-1} respectively while the **bond energies** of C-C, C=O, C-O and O-H,are; 347,743, 358 and 463 Kj mol^{-1} respectively.

Use the information given above to calculate the bond energy of C-H in ethanoic acid in (a) ii.

($3^1/_2$ marks)

(15) Write equations to show how the following synthesis can be carried out. In each caseindicate the necessary conditions and reagents.

(a) Cyclohexanone from chlorobenzene. (3½ marks)

(b) CH_3COOCH_3 from CH_3MgBr (2½ marks)

(c) 2-Phenyl propane from 1-bromo propane. (3 marks)

(16) (a) During manufacture of nitric acid ammonia is catalytically oxidized.

(i) Write equation for the reaction. (1½ marks)

(ii) Name the catalyst used. (½ mark)

(iii) State other **two specific** optimum conditions employed. (1 mark)

(b) 1 mole of nitrogen monoxide gas formed in (a) was heated together with 2 moles of oxygenin one litre closed vessel and the reaction that took place is as shown below;

$2NO(g) + O2(g) \rightleftharpoons 2NO2(g)$

When equilibrium was attained it was established that 36% of the nitrogen monoxide had reacted. Determine the equilibrium constant K_C for the reaction. (3 marks)

(c) Write equation for the reaction of **warm moderately** concentrated nitric acid with;

(i) Lead. ($1\frac{1}{2}$ marks)

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

(17) Write **a mechanism** to show how each of the following conversions can be effected.

(a) $(CH_3)_2CBrCH_2CH_3 \longrightarrow (CH_3)_2C(OH)CH_2CH_3$ ($2\frac{1}{2}$ marks)

(b) Benzene $\longrightarrow$ Benzene sulphonic acid. ($3\frac{1}{2}$ marks)

(c) Methyl cyclohexene ⟶ Methyl cyclohexanol (2½ marks)

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