P525/1
CHEMISTRY
Paper 1
2023
3 Hours 15 minutes

Uganda Advanced Certificate of Education.

CHEMISTRY

Paper 1

3 Hours 15 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 attached at the end of the paper.

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

Illustrate your artuess with equations were applicable.

Molar as constant, R = 8.314Jk^{-1} mol^{-1}

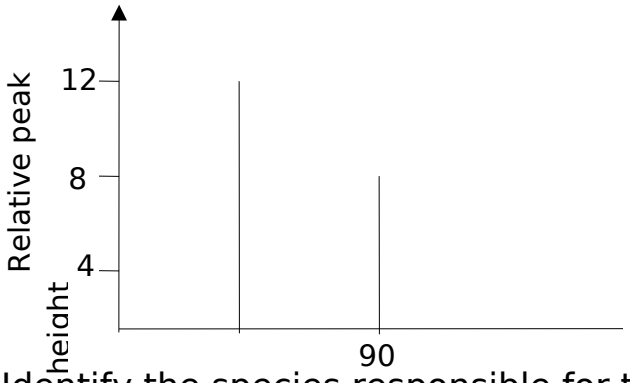
Molar volume of gas at S.t.p is 22.4 litres.

For Examiners Use Only																	

SECTION A (46 MARKS)

Answer **all** *questions in this section.*

1. The mass spectrum of dichlorine oxide Cl_2O shows molecular peaks at mass 86 and 90 with relative peak heights shown below.



a) Identify the species responsible for the molecular peaks. *(1 marks)*

.....
.....
.....

b) Calculate the molecular mass of dichlorine oxide. *(3 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

2. Given the mean bond enthalpies below.

Bond	**Mean bond enthalpy/kjmn^{-1}**
H-H	436
C-H	413

C-C	348
C=C	612

a) Define the term bond enthalpy. *(1 mark)*

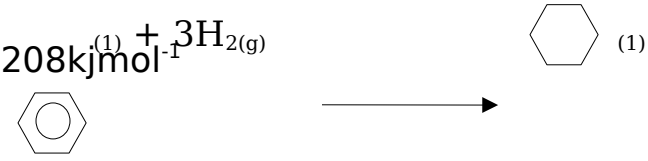
.....
.....
.....

b) Calculate the enthalpy of hydrogenation of cyclohexene to cyclohexane which occurs according to the following equation below.
(2 marks)



.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

c) The enthalpy of hydrogenation of benzene to cyclohexane was found to be



Comment on the relative stabilities of the double bond in benzene and cyclohexene and give reasons for your comment.
(3 marks)

.....
.....
.....

.....
.....
.....

3. Name one reagent that canbe used to distinguish between the following pairs of compounds. In each case, state what would be observed if each member of the pair is treated with the reagent named.
   a. $CH_3CH_2COCH_2CH_3$ and $CH_3CH_2CH_2COCH_3$ *(3 marks)*
      Reagent
      .....
      .....
      .....
      Observation
      .....
      .....
      .....

   b. $CH_3CH_2CH_2NH_2$ and $CH_3NHCH_2CH_3$ *(3 marks)*
      Reagent
      .....
      .....
      .....

      Observation
      .....
      .....
      .....

4. a) Write the general outer electronic configuration of group (II) elements. *(1 mark)*

   .....
   ....
   .....

b) Write the equation for the reaction (if any) g beryllium and magnesium with;

i. Water *(1 mark)*

.....

.....

.....

ii. Warm concentrated sodium hydroxide *(1 mark)*

.....

.....

.....

iii. Warm concentrated nitric acid *(1 mark)*

.....

....

.....

5. Oxygen reacts with nitrogen monoxide according to the equation below.

$2NO_{(g)} + O2_{(g)} \rightleftharpoons 2NO_{z\,(g)}$

The following data was collected for the above reaction.

Experiment No.	(O_2) $/10^{-2}$moldm^{-3}	(NO) $/10^{-2}$mol dm^{-3}	Rate of disappearance of NO/10^{-4}mol dm$^{-3}5^{-1}$
1	1.0	1.0	0.7
2	1.0	2.0	2.8
3	1.0	3.0	6.3
4	2.0	2.0	5.6
5	3.0	3.0	18.9

a) Deduce the order of reaction with respect to;

i. O_z *(1 mark)*

.....
.....
.....

ii. NO. *(1 mark)*

.....
.....
.....

b) i) Write the rate equation for the reaction.
(½ mark)

.....
....
.....

ii) Calculate the value of the rate constant, k, and state its units.
(1 ½ marks)

.....
....
.....

.....
....
.....

.....
....
.....

c) When the rate of disappearance of NO is 2.8×10^{-5}mol $dm^{-3}5^{-1}$ and the concentration of oxygen 7.0×10^{-2}mol dm^{-3};Calculate the concentration of nitrogen monoxide.
(2 marks)

.....

....
.....

.....
....
.....

.....
....
.....

6. Write the equation for the reaction between hot concentrated hydrochloric acid and

a) Lead (II) Oxide *(1 mark)*

.....
.....
.....

b) Lead (IV) Oxide *(1 mark)*

.....
....
.....

c) Red Lead Pb_3O_4 *(1 mark)*

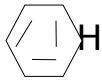
.....
.....
.....

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

a) $CH_3CH_2OH \xrightarrow[180^{O}C]{conc.H_{2SO4}}$ *(3 marks)*

.....
.....
.....
.....
.....
.....

.....
.....
.....
.....

b)  $H_3COCl/AlCl_3$ ⟶ *(3 marks)*

.....
....
.....

.....
....
.....

.....
....
.....

8. When $50cm^3$ of 0.1M aqueous ammonia was added to $50cm^3$ of 0.1M hydrochloric acid, the resulting solution had a pH of less than seven.
   a) Explain this observation. *(2 marks)*

.....
.....
.....
.....

.....
....
.....

.....
.....

b) Calculate the pH of the solution (Kh for ammonia chloride 6.34x 10^{-8}mol dm^{-3})

(4marks)

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

9. Writeequations for reactions that would take place and in each case state what would be observed: when;
   a. Sodium carbonate is added to an aqueous solution of chromium (III) sulphate.

(2 marks)

Observation

.....
....
.....

Equation

.....
....
.....

b. Concentrated ammonia solution is added dropwise until in excess to an aqueous cobalt (II) suplhate solution.
(3 marks)

Observation

.....
....
.....

Equation

.....
....
.....

SECTION B:(54 MARKS)

*Answer **six** questions from this section.*

10. a) A few crystals of a crystalline sold K were dissolved in water. To a portion of the solution, a few drops of concentrated nitric acid followed by Lead (IV) oxide were added and then the mixture boiled. A purple solution was formed.

i. Name the cation in K. *(1 mark)*

.....
.....
.....

ii. Write the equation for the reaction that took place when nitric acid and Lead (IX) Oxide were added to the solution of K.
(1 mark)

.....
.....
.....
.....
.....
.....

iii. To another portion of the solution of K; sodium carbonate solution was added. State what was observed and write equation for the reaction that took place.

(2 marks)

.....
....
.....

b) Further analysis showed that K contained 15.7% nitrogen and 53.7% oxygen.

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

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

ii. 10g of K in 1000g of water lowered the freezing point of solution by 0.104^0C. Determine the molecular formula of K. (Kf for water is 1.86^0C $mol^{-1}kg^{-1}$). Determine the molecular formula of K.
(2 marks)

.....
.....
.....
.....
.....
.....
.....

.....
.....
.....
.....
.....

iii. K was strongly heated; write the equation for the reaction that took place.

(1 mark)

.....
.....
.....

11. The equilibrium constant for the dissociation of hydrogen iodide at 472^0c, Kc, is 0.028. A 2 litre flask filled with 0.5 moles of hydrogen and 1 mole of iodine vapour was allowed to reach equilibrium at 472^0C.

a) Write an expression for the equilibrium constant Kc of the reaction taking place in the flask.

(½ mark)

.....
....
.....

b) Determine the equilibrium concentration of iodine in mol dm^{-3}.

(2 ½ marks)

.....
....
.....

.....
....
.....

.....

....
.....

.....
....
.....

.....
....
.....

.....
....
.....

.....
....
.....

c) State the effect of the following changes on the position of equilibrium and equilibrium constant.

i. Adding more iodine from outside the reaction flask. *(2 marks)*

.....
....
.....

ii. Adding helium gas at constant volume. *(2 marks)*
.....
.....
.....

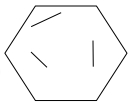
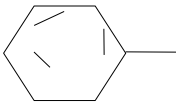
iii. Reducing temperature to 450^0C (dissociation of hydrogen iodide is exothermic).
(2 marks)

.....
.....
.....
.....
.....

12. Write equation to show how the following compounds can be synthesized.

a) CH_3COCl from ethene. *(3 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

b)  From  CH_2OH *(2 ½ marks)*

.....
.....
.....
.....
.....
.....
.....
.....

c) $CH_3CH_2CH_2CO_2H$ from Propan^{-1}-01. *(3 ½ marks)*

.....
....
....
....
.....

.....
....
.....

.....
....
....
....
.....
.....
....
....
....
.....

13. a) The chemistry of fluorine differs significantly from that of chlorine.

i. State two differences between the chemistry of fluorine and chlorine besides their reaction with sodium hydroxide.

(2 marks)

.....
.....
.....
.....
.....
.....
.....
.....
.....

ii. Write equations for the reactions of fluorine and chlorine with cold dilute sodium hydroxide.
(2 marks)

Fluorine

.....
.....
.....
.....
.....

Chlorine

.....
.....
.....
.....
.....

iii. Write equations for reaction of hot concentrated sodium hydroxide, with fluorine and chlorine.
(2 marks)

Fluorine

.....
.....
.....

Chlorine

.....
.....
.....

b) Hydrogen chloride may be prepared by action of concentrated sulphuric acid on potassium chloride but a corresponding method may not be used for hydrogen bromide.

i) Account for this difference. *(2 marks)*

.....
.....
.....

.....
.....
.....

c) Using an equation only, suggest one method of preparing hydrogen bromide.

(1 mark)

.....
.....
.....

14. Soap is prepared by a process known as saponification.

a) Name the two raw materials used in the preparation of soap.

(2 marks)

.....
.....
.....

b) Briefly describe how soap is obtained from the two raw materials named above.

(3 marks)

.....
.....
.....
.....
.....
.....
.....

c) Sodium chloride is usually added during preparation of soap state the purpose and the principle behind it.

(2 marks)

.....
.....
.....

d) Give one advantage and one disadvantage of soap over soapless detergents.

(2 marks)

Advantage:

.....
.....
.....

Disadvantage:

.....
.....
.....

15. 0.1M sodium hydroxide was gradually added to 20cm^3 of 0.1M ethanoic acid in a conical flask.

a) Determine the pH of the solution in the conical flask.

i) Before any sodium hydroxide was added. (Ka for ethanoic acid is
1.8x10^{-5}mol dm^{-3}). *(2 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

ii) At half neutralization. *(2 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

iii) At complete neutralization *(3 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....
.....
.....
.....
.....
.....

b) Draw a sketch graph of pH against volume of sodium hydroxide added. *(2 marks)*

16. Barium sulphate is sparingly soluble in water

a) Write

i) An equation for the solubility of barium sulphate in water. *(1 ½ marks)*

.....
.....
.....

ii) The expression for the solubility product of barium sulphate. *(1 mark)*

.....
.....
.....

b) A saturated solution of barium sulphate contains $1.5x10^{-5}$ moles per litre of the salt. Calculate the solubility product of barium sulphate. *(2 marks)*

.....
.....
.....
.....
.....
.....

c) Calculate the solubility of barium sulphate in a liter solution of 0.01M barium
chloride in mol dm^{-3}. State any assumptions made. *(3 marks)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

d) The solubility product of barium carbonate is $3.61x10^{-9}$ mol^2dm^{-6}. A solutioncontains both barium carbonate and barium sulphate. Which of the two salts will be precipitated out first when barium chloride solution is added to the solution?

Give a reason for your answer. *(1 ½ mark)*

.....
.....
.....

17. a) Define the term standard electrode potential.
(1 mark)

.....
.....
.....
.....
.....

b) The standard electrode potentials, E^{θ} for four half cell reactions are given below;

	E^{θ}/Volts
$MnO^{-}_{4(aq)} + 8H^{+}_{(aq)} + 5\bar{e} \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$	+1.52
$SO_4^{2-}{}_{(aq)} + 2H^{+}_{(aq)} + 2\bar{e} \longrightarrow SO_3^{2-}{}_{(aq)} + H_2O_{(l)}$	+0.20
$Br_{2(aq)} + 2\bar{e} \longrightarrow 2Br^{-}_{(aq)}$	+1.06
$Cl_{2(aq)} + 2\bar{e} \longrightarrow 2Cl^{-}_{(aq)}$	+1.36

i) Write an equation for the reaction between the sulphite ions and acidified solution of potassium manganate (VII)
(1 ½ mark)

.....
.....
.....

ii) Calculate the E^{θ} for the reaction in (i) *(1 ½ mark)*

.....
.....
.....
.....
.....

iii) State whether the reaction in (i) above is feasible giving reasons for your
answer. *(1 mark)*

.....
.....
.....

b) Explain why hydrochloric acid is not used to acidity titrants in volumetric analysis
involving potassium permanganate. *(3 mark)*

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

c) Write the cell convention for the reaction between bromine water and acidified
potassiummanganate (VII) solution. *(1 mark)*

.....
.....
.....

END