

2023



**EXAMINATION SERIES
FOR
ADVANCED LEVEL
FORM SIX**

CHEMISTRY I

QUESTIONS AND ANSWERS

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INTRODUCTION

This paper consists of CHEMISTRY I series of examinations (for form SIX students- Paper 01).

All exams have been composed based on the current recommend format from National Examination Council of Tanzania (NECTA) for the year of 2023. Some exams have been collected and reorganized from regional mock exams conducted in the year of 2022 and 2023.

The paper Aim to exposure students to variety of questions and how to attempt questions properly. Also, will help students to adapt new format as recommended by NECTA toward their final examination.

Not only students but also teachers can use it as teaching and learning material during their teachings.

ACKNOWLEDGEMENT

First and foremost, we would like to **praise and thank God, the Almighty**, who has granted countless blessing, knowledge, and opportunity to the **Tzshule Team**, so that we have been finally able to accomplish the work.

Secondly, we would like to thank CEO & Founder of Tzshule (**Mr. George Ramadhani**) for not giving up on his dream of developing and providing educational materials electronically throughout the country.

We'd also like to thank all **Tzshule Users** for your support and positive feedback, since it motivates and encourage us to do more and more in developing educational materials.

- GOD MAY BLESS YOU ALL -

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Our motto:

"Quality education, for future Generation"

THE UNITED REPUBLIC OF TANZANIA
PRESIDENT'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT
FORM SIX EXAMINATION SERIES #1
CHEMISTRY PAPER 1

Time 3:00 Hrs

YEAR: 2023

Instructions

1. This paper consists of sections A and B with a total of ten(10) questions.
2. Answer ALL questions in section A and two(2) questions from section B.
3. Mathematical tables and non-programable calculators may be used.
4. Cellular phones and any unauthorized materials are not allowed in the examination room.
5. Write your Examination Number on every page of your answer booklet(s).
6. The following information may be used.
 - (a) Universal gas constant, $R=8.314\text{JK}^{-1}\text{mol}^{-1}$ or $0.0821\text{atmdm}^3\text{mol}^{-1}$.
 - (b) Rydberg constant $R_H = 1.09678 \times 10^7 \text{m}^{-1}$
 - (c) standard pressure =1 atm= $760\text{mmHg}=1.0 \times 10^5\text{N/m}^2$
 - (d) 1 Mass of electron= $9.11 \times 10^{-31}\text{kg}$
 - (e) GMV=22.4dm³
 - (f) Velocity of light, $C= 3.0 \times 10^8\text{m/s}$
 - (g) K_f of water= $1.86^\circ\text{Cmol}^{-1}\text{kg}^{-1}$
 - (h) Freezing point of water= 0°C
 - (i) Planks constant, $h= 6.63 \times 10^{-34}\text{Js}$
 - (e) Atomic masses
 $H=1$, $C=12$, $O=16$, $N=14$, $Cl=35.5$, $Ca=40$, $Na=23$.

SECTION A (70 MARKS)

Answer all questions in this section.

1. (a) Using Dalton's atomic theory, explain the fact that potassium sulphate from Tanzania and that from Australia has the same mass percentages of the contained elements. (02 marks)

(b) Copper has two isotopes, ^{63}Cu and ^{65}Cu . The isotope ^{63}Cu has a relative isotopic mass of 62.9, and ^{65}Cu has a relative isotopic mass of 64.9. If the naturally occurring copper has a relative atomic mass of 63.55, what will be the percentage abundance of each isotopes? (02 marks)

(c) Calculate the uncertainty in the velocity of a bullet whose mass is 10g and its position is known with an accuracy of $\pm 0.1\text{nm}$ (03 marks)

(d) Calculate the wavelength of a second spectra line in the pfund series. (03 marks)

2. (a) Hydrogen bond have several impacts on physical and chemical properties of a compound. Give three impacts of hydrogen bond. (03 marks)

(b) Differentiate between sigma bond and pi bond. (03 marks) (c) Use the VSEPR model to predict the geometry of

(i) AsH_3

(ii) CCl_3F

(iii) NO_2

(iv) SF_5^- (04 marks)

3. (a) State

(i) Graham's law of effusion.

(ii) Dalton's law of partial pressure. (02 marks)

(b) Hydrogen diffused 7.94 times faster than a gaseous fluoride of phosphorous (under the same conditions). Calculate the molar mass of the fluoride and suggest its formula. (02 marks)

(c) Given that 3.50moles of ammonia occupy 5.20L at 47°C , calculate the pressure of the gas using

(i) Ideal gas equation

(ii) Van der Waal equation. (03 marks)

4. (a) Explain

- (i) Ebulioscopic constant (ii)
 Cryoscopic constant.
 (iii) Boiling point elevation. (03 marks)
- (b) Ethylene glycol ($\text{CH}_2\text{OHCH}_2\text{OH}$) is a common auto-mobile antifreeze. It is water soluble and fairly non-volatile (b.p 197°C). Calculate the freezing point of a solution containing 65.1g of ethylene glycol in 2505g of water. Can you advice a person to keep ethylene glycol in his car radiator during the summer? (04 marks)
- (c) A solution is prepared by dissolving 35.0g of haemoglobin (Hb) in enough water to make up 1L in volume. if the osmotic pressure of the solution is found to be 10.0mmHg at 25° , calculate the molar mass of haemoglobin. (03 marks)
5. (a) Classify the following metal oxides CaO , Na_2O , CO_2 , ZnO , PbO and SO_2 according to basic oxides, acidic oxides and amphoteric oxides. (03 marks)
- (b) (i) Explain why $\text{Al}_2(\text{CO}_3)_2$ and $\text{Fe}_2(\text{CO}_3)_3$ do not exist. (01 marks)
 (ii) Explain the uses of MgO and CaO in agriculture. (02 marks)
- (c) The degree of heating required to decompose the metal carbonates varies from one metal to another. Complete the following chemical reactions
 Heat
- (i) $\text{Na}_2\text{CO}_{3(s)} \longrightarrow$
- (ii) $\text{CaCO}_{3(s)} \longrightarrow \text{Heat} \rightarrow$
- (iii) $\text{ZnCO}_{3(s)} \longrightarrow \text{Heat} \rightarrow$
- (iv) $\text{MgCO}_{3(s)} \longrightarrow \text{Heat} \rightarrow$ (04 marks)
6. (a) Give the meaning of the following
 (i) Standard enthalpy of combustion.
 (ii) Standard enthalpy of hydrogenation.
 (iii) Enthalpy of vaporization. (03 marks)
- (b) Calculate the standard enthalpy change of the reaction
- $$\text{---O(g)} + \text{HCN(g)} \xrightarrow{\quad} \begin{array}{c} \text{OH} \\ | \\ (\text{CH}_3)_2\text{C} \\ | \\ \backslash \end{array}$$
- $$= \text{O(g)} + \text{HCN(g)} \xrightarrow{\quad} (\text{CH}_3)_2\text{C}$$

CN(g)

Mean standard bond enthalpies/kJmol⁻¹ are C=O, C—H, C—O, C—C, and H—O are 743, 412, 360, 348, and 463 respectively. (03 marks) (c) Calculate the lattice energy of sodium chloride from the following data and draw the Born Haber cycle. The standard enthalpy of formation of sodium chloride is -411kJ/mole, standard enthalpy of atomization of Na and chloride are respectively +108 and 121kJ/mole of gaseous atoms, the ionization energy of sodium is +493kJ/mole and the electron affinity of chlorine is -364kJ/mole.

(04 marks)

7. (a) By giving examples if possible explain the meaning of;

(i) Reversible reaction.

(ii) Law of mass action

(iii) Heterogenous chemical equilibrium (03 marks)

- (b) When 1.00mole hydrogen and 1.00 mole iodine are allowed to reach equilibrium in a 1.00dm³ flask at 450°C and $1.01 \times 10^5 \text{ Nm}^{-2}$, the amount of hydrogen Iodide at equilibrium is 1.56mol. Calculate K_p at 450°

(03½ marks)

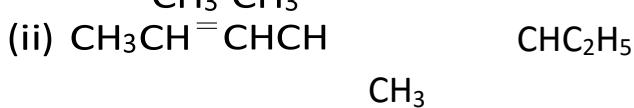
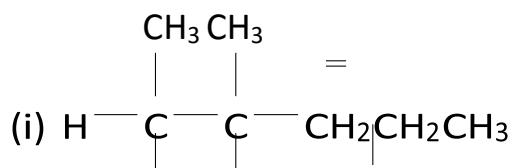
- (c) A molar mass determination gave a value of 82.5g/mole for dinitrogen tetraoxide, N₂O₄ at 25°C. Calculate the degree of dissociation at this temperature.

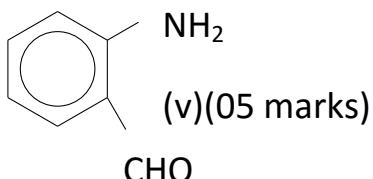
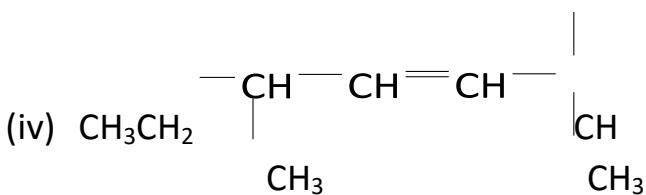
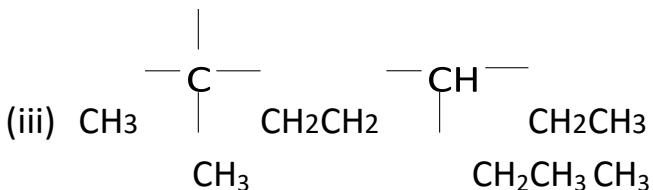
(03½ marks)

SECTION B (30 MARKS)

Answer any two (02) questions in this section

8. (a) Name the following organic compounds according to IUPAC rules





(b) Write all possible isomers for the following organic compounds and its IUPAC names

(i) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ (Butane)



(ii) $\text{CH}_3 \text{C}=\text{O} \text{ OH}$ (Ethanoic acid.) (05 marks)

(c) Write the structural formulae of the following

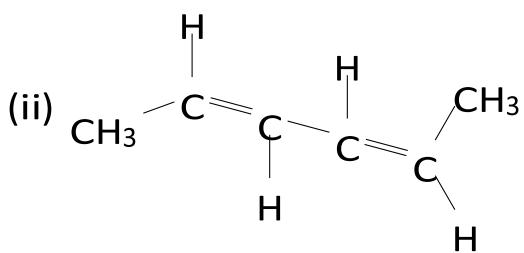
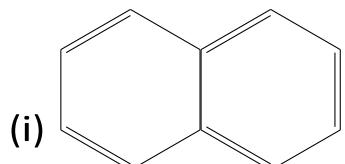
(i) Cyclo octatetraene.

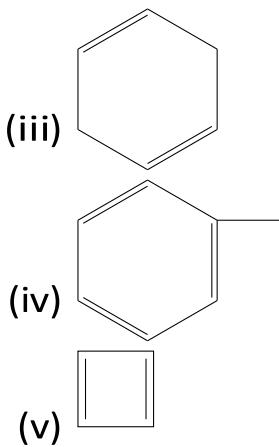
(ii) 2, 2 - dimethyl-3, 4-diethylheptane.

(iii) 2-Hydroxyl benzoic acid (iv) Butane 1, 2, 3, triol.

(v) Phenylethanone. (05 marks)

9. (a) Determine whether the following molecules are aromatic or not





$\frac{1}{022}$ marks)

- (b) Write equations to show how you would prepare each of the following compounds and organic reagents.

- (i) Bromobenzene.
- (ii) Benzoic acid.
- (iii) Ethylbenzene
- (iv) Nitrobenzene
- (v) Benzenesulphonic acid.
- (vi) Phenylethanone. (06 marks)

- (c) Two isomeric hydrocarbons P and Q have the molecular formula C_9H_{12} . On oxidation, P gives a monocarboxylic acid which when heated with excess sodalime yields benzene. Q is oxidised to give a tricarboxylic acid, which can then undergo nitration to give a mononitro derivatives

- (i) Deduce the structural formula of P and Q
- (ii) write chemical equations to show the reactions which have been described.

$\frac{1}{062}$ marks)

10. (a) Identify one isomer from alkanes with molecular formula C_5H_{12} which on photochemical chlorination yields.

- (i) A single monochloride.
- (ii) Three isomeric monochlorides
- (iii) Four isomeric monochlorides (06 marks)

- (b) Using reaction equation, explain the products formed when but-tene reacts with hydrogen halide.

- (i) In the presence of organic peroxides.

- (ii) In the absence of organic peroxides. (04 marks)
- (c) A chloro derivative of hydrocarbon J when treated with zinc copper couple gives a hydrocarbon with five carbon atoms. When J is dissolved in ether and treated with sodium a compound K(2, 2, 5, 5-tetramethyl hexane) is formed. What is the formula of compound J?

(05 marks)

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FORM SIX EXAMINATION SERIES #2
CHEMISTRY PAPER 1

Time 3:00 Hrs

YEAR: 2023

INSTRUCTIONS:

1. This paper consists of sections A and B with a total of ten (10) questions.
2. Answer ALL questions in section A and any two questions from section B
3. Section A carries seventy (70) marks and section B carries thirty (30) marks
4. Marks allocation has been indicated on each section
5. Cellular phones and any other unauthorized materials are not allowed in an examination room
6. Write your examination number on every page of your answer sheet
7. For calculation use the following
 - i. $R = 8.31J\text{Mol}^{-1}\text{K}^{-1}$ or $0.0821\text{atmMol}^{-1}\text{K}^{-1}\text{dm}^{-3}$
 - ii. Standard temperature = $273K$
 - iii. Standard pressure = $760\text{mmHg} = 1\text{atm} = 1.05 \times 10^5\text{Pa}$
 - iv. Velocity of light $c = 3.0 \times 10^8\text{ms}^{-1}$
 - v. Atomic masses: $N = 14, H = 1, C = 12, O = 16, Na = 23, Cl = 35.5$

SECTION A (70 Marks)

Answer **all** questions in this section. Each question carries ten (**10**) marks

1. a) When Rutherford's coworkers bombarded gold foil with alpha particles they result that overturned the existing (Thomson) model of the atom explain (02 marks)
- b) Two isotopes of potassium with significant abundance in nature are ^{39}K (isotopic mass 39.96 a.m.u, 93.258 %) and ^{41}K (isotopic mass 40.96 a.m.u, 6.730%). Flourine has only one naturally occurring isotope ^{19}F (isotopic mass 18.998 a.m.u). Calculate the formula mass of Potassium fluoride. (02 marks)
- c) An FM radio station broadcast at 99.5 MHz, calculate the wavelength of the corresponding radio waves. (02 marks)
- d) Identify the shell/subshell (orbits) that each of the following sets of quantum number refers to;
 - i. $n = 2, l = 1, M_l = 1, M_s = +\frac{1}{2}$
 - ii. $n = 3, l = 2, M_l = 2, M_s = +\frac{1}{2}$
 - iii. $n = 4, l = 1, M_L = -1, M_S = -\frac{1}{2}$
 - iv. $n = 5, l = 0, M_L = 0, M_S = +\frac{1}{2}$ (04 marks)

2. a) Define the following terms
 - i. Enthalpy of formation (01 mark)
 - ii. Enthalpy of reaction (01 mark)
 - iii. Enthalpy of combustion (01 mark)
 - iv. Enthalpy of transition (01 mark)
- b) In an experiment, 2g of methanol was burned completely in air the enthalpy changes of formation are as follows

$$\Delta fH/KJmol^{-1}$$

$CH_3OH_{(l)}$	-234
$CO_2(g)$	-394
$H_2O_{(l)}$	-286

- i. Write an equation for the combustion of methanol (01 mark)
- ii. Using your equation and data given above calculate ΔH (Standard enthalpy change of combustion) for methanol. (00 $\frac{1}{2}$ mark)
- iii. Comment on whether this reaction is endothermic or exothermic?



Bond	C - H	C - C	O = O	C ≡ O	O - H
Mean bond enthalpy $KJmol^{-1}$	+413	+347	+498	+743	+464

- i) Using the bond enthalpies and equations shown above ,calculate ΔH for the combustion of pentane (01 $\frac{1}{2}$ marks)
 - ii) Draw on energy diagram for the forward reaction labeling the reactants, products, ΔH and stating whether it is an exothermic or endothermic reaction.
- (03 marks)
3. a) State the following gas laws and provide their mathematical expression.
 - i. Charles law
 - ii. Avogadro's Law
 - iii. Dalton's law of partial pressure (03 marks)
 - b) i) Why bakery products(bread) becomes fluffy
ii) Why a basketball shrinks when left in a cold surface overnight.
(02 marks)
 - c) Automobile air bags respond to a collision of a present strength by electrically triggering the explosive decomposition of sodium azide (NaN_3) to its elements. In an industrial lab simulation, $15.3cm^3$ of nitrogen gas

collected over water at $25^{\circ}C$ and 755mmHg . How many grams of azide decomposed. (02 $\frac{1}{2}$ marks)

- d) Two perfumes are released at the same time from their container and you standing 7.5 metres away from both of them. Molecules of perfumes A have mass of 275 a.m.u and those of B has mass of 205 a.m.u .
- Which perfume will smell first and why?
 - If you smell the first perfume in 15 seconds, how long will it take for you to smell the second perfume? (02 $\frac{1}{2}$ marks)

4. a) Write an equation to show the;
- Burning of sodium in air
 - Decomposition of metal carbonates by heat
 - Dissolving of sodium oxide in dilute HCl (03 marks)
- b) i) Explain the importance of storing hydroxides in containers which are tightly closed.
- Give two (2) examples of water soluble and insoluble hydroxides.
 - Describe using Chemical equation(s), a chemical test that can be used to identify sulphates in solutions.
 - When lead carbonate reacts with dilute hydrochloric acid, why the reaction stops after a short while? (05 marks)
- c) Briefly explain four (4) uses of metal carbonates. (02 marks)
5. a) Arrange the following in order of increasing ionic character
- $\text{LiF}, \text{K}_2\text{O}, \text{N}_2, \text{SO}_2$ and ClF_3 (01 mark)
 - $\text{C-H}, \text{F-H}, \text{Br-H}, \text{Na-I}, \text{K-F}$ and Li-Cl (01 mark)
- b) i) Explain why the bond angle of H_2O is 104° while that of F_2O is 102° (01 mark)
- ii) Which of the following molecules CS_2 and OCS will have higher dipole moment? Explain your answer. (01 mark)
- c) i) Describe the change in hybridization of aluminium atom during the reaction
$$\text{AlCl}_3 + \text{Cl}^- \longrightarrow \text{AlCl}_4^-$$
 (02 marks)
- ii) On the bases of VSEPR theory discuss the geometry of CH_4 molecule. (02 marks)

d) Which hybrid orbital are used by carbon atoms in the following molecules.

- i. $\text{CH}_3 - \text{CH} = \text{CH}_2$
- ii. CH_3CHO (02 marks)

6. a) Draw the structural formula for the following molecules

- i. 3 – ethyl – 2 – methyl heptane
- ii. 3 – ethyl – 2,2 – diethyl hexane
- iii. 2 ,3 ,4 ,5 ,6 ,7 – hexamethyl octane
- iv. 2 – ethyl – 2 – methyl butane (04 marks)

b) How would;

- i. Ethyl chloride distinguished with vinyl chloride
- ii. Chloroform distinguished with carbon tetrachloride (04 marks)

c) Show how to prepare

- i. Acetylene from ethylene
- ii. 1 – butyne from acetylene. (02 marks)

7. a) Define

- i. Cation exchange
- ii. Cation exchange capacity
- iii. Ion exchange (03 marks)

b) Give four advantages of adding manure to the soil. (04 marks)

c) The specialist wants to determine the quality of limes so that to advise farmers and other stakeholders on the best liming material. Show how he can go about in calculating the neutralizing value of calcium hydroxide (Ca(OH)_2). (02 marks)

SECTION B (30 Marks)

Answer **two (2)** questions in this section. Each question carries fifteen (**15**) marks

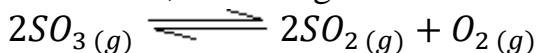
8. a) Briefly explain the following phases, giving one example for each,

- i. Reversible reaction
- ii. Heterogeneous equilibrium

b) i) State equilibrium law and provide the corresponding expression.

- ii) List four characteristics of chemical equilibrium.

c) 16.0g of sample of sulphur trioxide was placed in an empty container where it decomposed at 800K, according to the following chemical reaction



At equilibrium, the total pressure and the density of the gaseous mixture were 3.6atm and 3.2g/dm^3 respectively. Calculate K_p for this reaction.

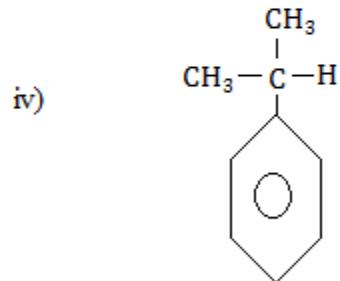
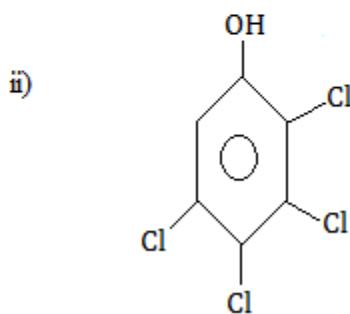
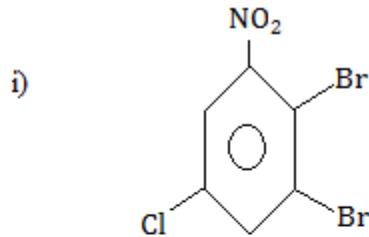
9. a) Define the terms

- i. Freezing point depression
- ii. Boiling point elevation
- iii. Osmotic pressure.

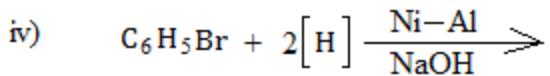
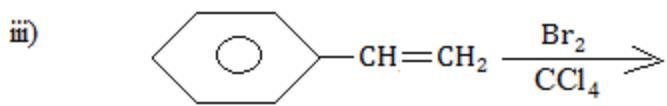
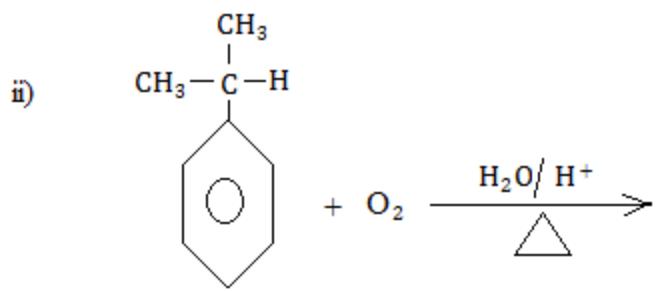
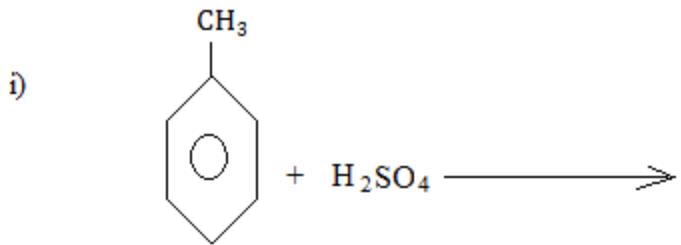
b) A solution is prepared by dissolving 10.6g of non-electrolyte and non-volatile solute in 90g of water. The vapour pressure of the solution at 60°C is found to be 0.1867atm . Calculate the approximate molecular mass of the solute if the vapour pressure of water at 60°C is 0.1966atm .

c) 0.75g of acetic acid displaced the boiling point of 125g of benzene by 0.255°C . What is the molecular state of acetic acid in benzene solution and the degree of association of acetic acid? Given $K_f = 5.0^\circ\text{C/kg}$

10.a) Give IUPAC names of the following aromatic compounds



b) Complete the following reactions



c) A compound $C_7H_5O_6N_3$ (A) undergoes oxidation with acidified dichromatic to give a mono carboxylic acid (B) $C_7H_3O_8N_3$. When (B) is heated in acetic acid solution (C) $C_6H_3O_6N_3$ is formed. What are names of A, B and C (*IUPAC names*).

THE UNITED REPUBLIC OF TANZANIA
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FORM SIX EXAMINATION SERIES #3
CHEMISTRY PAPER 1

Time 3:00 Hrs

YEAR: 2023

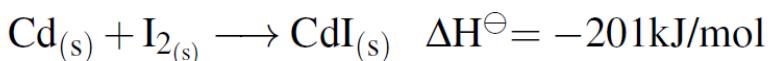
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 - (b) Rydberg constant $R_H = 1.09678 \times 10^7 \text{m}^{-1}$
 - (c) standard pressure = $1 \text{ atm} = 760 \text{mmHg} = 1.0 \times 10^5 \text{N/m}^2$
 - (d) 1 Mass of electron = $9.11 \times 10^{-31} \text{kg}$
 - (e) Density of water = 1g/cm^3
 - (f) Velocity of light, $C = 3.0 \times 10^8 \text{m/s}$
 - (g) Avogadron's constant = $6.022 \times 10^{23} \text{mol}^{-1}$
 - (h) $1\text{A}^\circ = 1.0 \times 10^{-10} \text{m}$
 - (i) Planks constant, $h = 6.63 \times 10^{-34} \text{Js}$
 - (e) Atomic masses
 $\text{H}=1, \text{C}=12, \text{O}=16, \text{N}=14, \text{Cl}=35.5, \text{Br}=80, \text{Na}=23.$

SECTION A (70 MARKS)

1. (a) Differentiate
 - (i) Emission spectra and absorption spectra
 - (ii) Line spectra and continuous spectra
 - (iii) Atomic orbital and degenerate orbital (03 marks)
 - (b) What is the wavelength of a photon (in nanometers) emitted during a transition from the fifth to second energy levels in hydrogen atom? To what region of the spectrum does this wavelength correspond? (04 marks)
 - (c) Suppose that the uncertainty in determining the position of an electron circling an atom in an orbit is 0.4A° . What is the uncertainty in the velocity? (03 marks)
-
2. (a) What do you understand by
 - (i) Octet rule
 - (ii) hybridization of atomic orbital
 - (iii) Orbital (03 marks)
 - (b) Using sketches, briefly explain three possible overlaps that can lead to formation of a sigma bond
 - (c) Give two reasons for the observed difference in bond strength between sigma and pi bonds in compounds.
 - (d) Predict the geometry of water, basing on the valence shell Electron pair Repulsion (VSEPR) theory.
-
3. (a) What do you understand by lattice enthalpy? What is its significance? (02 marks)
 - (b) Some values of lattice enthalpies/kJ/mol are NaCl-771, KCl-707, NaF-918, CsF-747, NaI-699, MgO-3791, BaO-3054. Comment on differences of lattice enthalpies of
 - (i) NaCl and KCl
 - (ii) NaCl and NaF
 - (iii) MgO and BaO
 - (iv) NaCl and MgO (04 marks)

- (c) Construct a Born-Haber cycle, and use it to calculate the standard lattice energy of cadmium (II) iodide



(04marks)

4. (a) (i) What is an ideal gas?

(ii) The pressure exerted by 12g of an ideal gas at temperature $t^\circ\text{C}$ in a vessel of volume V litres is one atmosphere. When the temperature is increases by 10%. Calculate the temperature t and volume V. Molecular mass of the gas = $120u$ (04½ marks)

- (b) Two flasks at the same temperature are joined by a glass tube with a stopcock. Flask A is a 4.0L flask containing $\text{N}_{2(g)}$ at 2.0 atm, while flask B is a 10.0L flask containing carbon monoxide gas at 1.4 atm. calculate the total pressure when the stopcock is opened. (02½ marks)

- (c) A straight glass tube has two inlets X and Y at the two ends. The length of the tube is 50cm. HCl gas through the inlet X and NH_3 gas through the inlet Y are allowed to enter the tube at the same time. White fumes first appear at a point P inside the tube. Find the distance of P from X (03 marks)

5. (a) The Oxo-acids have acidity strength in the order $\text{HClO}_4 > \text{H}_2\text{SO}_4 > \text{H}_3\text{PO}_4$.

Explain the trend of acidity of these oxo-acids. (03 marks)

- (b) With the aid of chemical equation (s) explain how you can prepare soluble chlorides. (04 marks)

- (c) by the aid of chemical equations describe the following

(i) Basic oxides

(ii) Amphoteric oxides

(iii) Acidic oxides (03 marks)

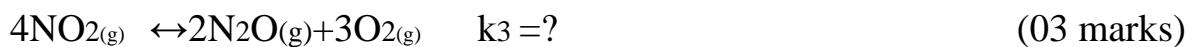
6. (a) Explain the following

- (i) Homogeneous catalyst
- (ii) Heterogeneous equilibrium
- (iii) Dynamic equilibrium (03 marks)

(b) Consider the following gas phase reaction equilibrium involving N_2O_4 .



Determine the equilibrium constant of the reaction.



(c) At the start of a reaction, there are 0.249 mol N_2 , 3.21×10^{-2} mol H_2 , and 6.42×10^{-4} mol NH_3 in a 3.50L reaction vessel at 375°C. If the equilibrium constant (k_c) for the reaction $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \leftrightarrow 2\text{NH}_{3(\text{g})}$ is 1.2 at this temperature, decide whether the system is at equilibrium. If it is not, predict which way the net reaction will proceed to achieve equilibrium.

(04 marks)

7. (a) Distinguish sigma bond from pi bond (03 marks)

(b) Predict the shapes of the following molecules using VSEPR theory

- (i) AsF_5
- (ii) PCl_3
- (iii) SF_6 (03 marks)

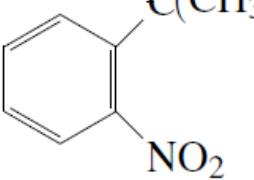
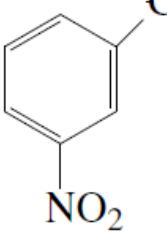
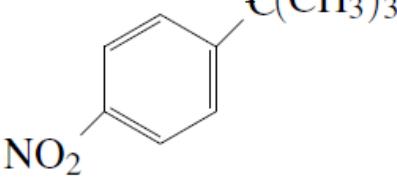
(c) (i) Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on basis of dipole moment.

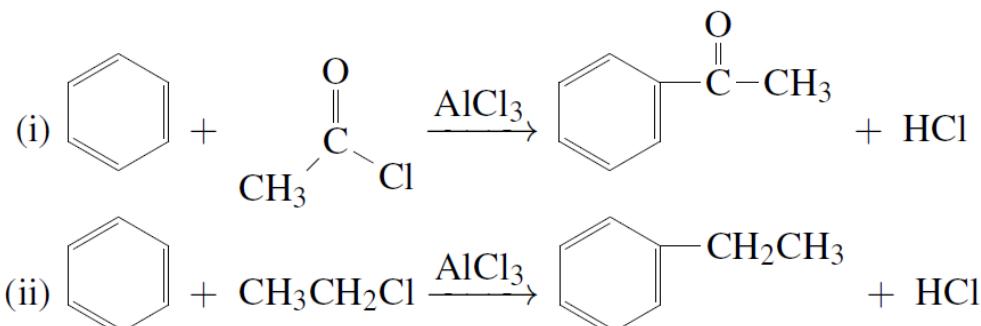
(ii) Write two significance of dipole moment. (04 marks)

SECTION B (30 MARKS)

8. (a) Account for the following

- (i) Benzene undergo addition reactions under harsh conditions.
- (ii) Nucleophilicity of benzene is affected by the substituent attached to it

- (iii) Halogens are deactivators but direct the coming electrophiles to ortho and para positions. (03 marks)
- (b) Compound A, C_7H_{14} is treated with bromine in presence dichloromethane to give B, $C_7H_{14}Br_2$. Compound B is treated with NaOH in presence of ethanol followed by $NaNH_2$ resulting in the formation of C. Compound C react with hydrogen in presence nickel catalyst to form 2-methylhexane. Compound C have no reaction with ammoniacal silver nitrate. Ozonolysis of A gives aldehyde D and ethanal . Deduce the structure formula of A, B, C and D. Write all the chemical reactions. (05 marks)
- (c) Three hydrocarbons, D, E and F, all have the molecular formula C_6H_{12} . D decolourises an aqueous solution of bromine and shows geometric isomerism. E also decolourises an aqueous solution of bromine but does not show geometric isomerism. F does not decolourises an aqueous solution of bromine. Draw the structural formula of D, E and F. Write all the chemical reaction. (02½ marks)
- (d) How the following conversion can be achieved in not more than four steps.
- Butylchloride to But-1-yne (01½ marks)
 - Ethene to benzene (01½ marks)
 - But-1-ene to Butan-2-one. (01½ marks)
9. (a) Explain the difference between the boiling temperatures of the following compounds:
- | COMPOUND | MOLAR MASS/gmol ⁻¹ | BOILING POINT/°C |
|-------------|-------------------------------|------------------|
| C_5H_{12} | 72 | 36 |
| C_3H_7Cl | 79 | 46 |
| C_3H_8 | 44 | -42 |
- (01½ marks)
- (b) Arrange the following products according to the percentage (%) yield obtained from the nitration of ter-butylbenzene. Justify the order.
- 
A
- 
B
- 
C
- (03 marks)
- (c) Write complete mechanisms for the following reactions.



(06 marks)

(d) Give one chemical test to distinguish the following

- (i) But-2-ene and butane
- (ii) Benzylchloride and chlorobenzene
- (iii) 1-chloropropane, 2-chloropropane and 2-chloro-2methylpropane

(04½ marks)

10. (a) Define the following terms

- (i) Liming
- (ii) Cation exchange capacity
- (iii) Percentage base saturation
- (iv) macronutrients (04 marks)

(b) A soil sample was collected from certain farm for laboratory analysis. After being analyzed the soil had the following exchangeable cations.

$$\text{Ca}^{2+} = 30 \text{ meq}/100\text{g}$$

$$\text{Mg}^{2+} = 16 \text{ meq}/100\text{g}$$

$$\text{K}^+ = 39 \text{ meq}/100\text{g}$$

$$\text{H}^+ = 4 \text{ meq}/100\text{g}$$

How many milligrams of these elements were in the soil and what is the percentage base saturation of the soil sample (PBS). (07 marks)

- (c) Mention four (4) factors which influence the soil acidity. (02 marks)
- d) (i) What are the benefits of liming? (mention any four) (02 marks)
- (ii) Not all calcium and magnesium compounds are suitable for liming. Explain (02 marks)

THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

FORM SIX EXAMINATION SERIES #4

CHEMISTRY PAPER 1

Time 3:00 Hrs

YEAR: 2023

Instructions

1. This paper consists of sections A and B with a total of **ten(10)** questions.
2. Answer **ALL** questions in section A and **two(2)** questions from section B.
3. Mathematical tables and non-programable calculators may be used.
4. Cellular phones and **any** unauthorized materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).
6. The following information may be used.
 - (a) Universal gas constant, $R=8.314\text{JK}^{-1}\text{mol}^{-1}$ or $0.0821\text{atm dm}^3\text{mol}^{-1}$.
 - (b) Rydberg constant $R_H = 1.09678 \times 10^7 \text{m}^{-1}$
 - (c) standard pressure = 1 atm = $760\text{mmHg} = 1.0 \times 10^5 \text{N/m}^2$
 - (d) 1 Mass of electron = $9.11 \times 10^{-31} \text{kg}$
 - (e) Density of water
 - (f) Velocity of light, $C = 3.0 \times 10^8 \text{m/s}$
 - (g) Avogadron's constant = $6.022 \times 10^{23} \text{mol}^{-1}$
 - (h) Planks constant, $h = 6.63 \times 10^{-34} \text{Js}$
 - (i) Atomic masses
 $\text{H}=1, \text{C}=12, \text{O}=16, \text{N}=14, \text{Cl}=35.5, \text{Br}=80, \text{Na}=23.$

This paper consists of five printed pages

SECTION A (70 MARKS)

Answer All questions from this section.

1. (a) Why does hydrogen spectrum have large number of lines despite the fact that hydrogen has only one electron. **(02 marks)**
(b) Calculate the wavelength of an alpha particle having a mass of 6.7×10^{-25} kg moving with a speed of 1000m/s. **(04 marks)**
(c) Naijongoro a chemistry teacher at Muungano secondary school told his student that “Dalton atomic theory is primitive” support Mr. Naijongoro using four points. **(04 marks)**
2. (a) Write down the molecules or ions that undergo the following hybridization scheme;
(i) Sp³d
(ii) Sp³d²
(iii) Sp³ **(03 marks)**
(b) CO₂ is a non-polar molecule while H₂O is polar molecule. Explain. **(03 marks)**
(c) Makene a form five student was arguing that double bond is a weaker than single bond because double bond has a weak Pi bond. But Anna happened to educate Makene that in double bond there are two bonds strong sigma bond and weak pi bond while in single bond there is only one bond, which is strong sigma bond. Using four points justify that sigma bond is different from pi bond. **(04 marks)**
3. (a) Define the following
(i) Ebullioscopic constant
(ii) Van't Hoff's factor
(iii) Colligative properties **(03 marks)**
(b) The vapour pressure of water at 50°C is 92.5mmHg. At the same temperature a solution containing 9.14g of urea in 150g of water has a vapour pressure of 90.8mmHg. Determine the molecular mass of urea. **(03 marks)**
(c) What is the boiling point of a solution made by dissolving 45.0g of NaCl in 500g of water (Ebullioscopic constant,k_b= 0.512) **(04 marks)**
4. (a) Explain the following
(i) Heat of neutralization
(ii) Heat of solution **(02 marks)**
(b) 1.150g of sucrose was burnt in a bomb calorimeter. If the temperature rose from 23.42°C to 27.64°C and the heat capacity of the calorimeter was

$4.9\text{KJ}^{\circ}\text{C}^{-1}$, what was the heat of combustion of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) in KJ/md? **(04 marks)**

(c) Calculate the heat of formation of ethyl alcohol ($\text{C}_2\text{H}_5\text{OH}$) if the heat of combustion of ethyl alcohol is -1380.7KJ/mol and the heats of formation of $\text{CO}_{2(g)}$ and $\text{H}_2\text{O}_{(l)}$ are -393.9KJ/mol and -286KJ/mol respectively.

(04 marks)

5. (a) Aluminium oxide is said to be amphoteric. Explain this fact by aid of chemical equation. **(03 marks)**

(b) Iron (III) carbonate never exists. Explain this statement. **(01 marks)**

(c) Explain the following with the aid of chemical reaction if applicable.

(i) $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ when heated can never give anhydrous MgCl_2

(ii) CuCl_2 solution is acidic to litmus paper

(iii) Fe_3O_4 is called mixed oxide. **(06 marks)**

6. (a) Explain these concept

(i) Dynamic equilibrium.

(ii) irreversible reactions

(03 marks)

(b) At 773K , the reaction between gaseous nitrogen and hydrogen to form ammonia gas has a $K_C = 6.0 \times 10^{-2}\text{dm}^6\text{mol}^{-2}$. Compute the value of K_p for this reactions. **(03 marks)**

(c) A mixture of CO and steam consisting of 0.25 mol each constituent is placed in 500ml flask and the mixture heated up to 900K . The reaction equations is $\text{CO}_{(g)} + \text{H}_2\text{O}_{(g)} \rightleftharpoons \text{CO}_{2(g)} + \text{H}_{2(g)}$. What is the composition of the equilibrium mixture at this temperature if the K_C for this reaction is 1.56? **(04 marks)**

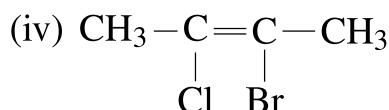
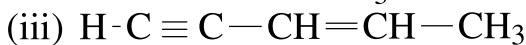
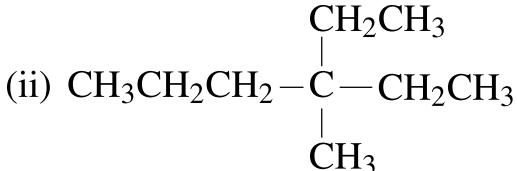
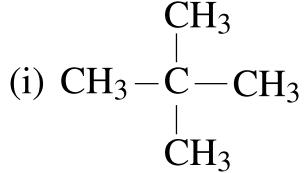
7. (a) (i) Catenation

(ii) Isomerism

(iii) Mesomerism

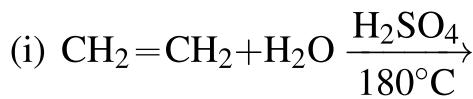
(03 marks)

(b) Give the IUPAC name of the following organic compounds



(04 marks)

(c) Show the product and mechanism of the following reactions



(03 marks)

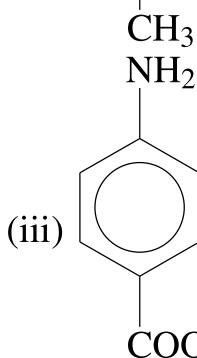
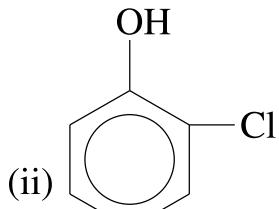
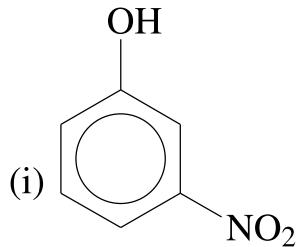
SECTION B (30 MARKS)

Answer **two (2)** questions in this section.

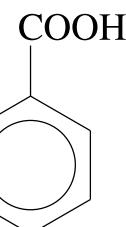
8. (a) (i) By using the chemical equation explain why tertiary haloalkane can not undergo SN_2 reaction.

(ii) Benzene is more reactive than Nitrobenzene while methylbenzene is more reactive than benzene. Explain this observation. **(04 marks)**

(b) Explain which substituent entered in the benzene ring first



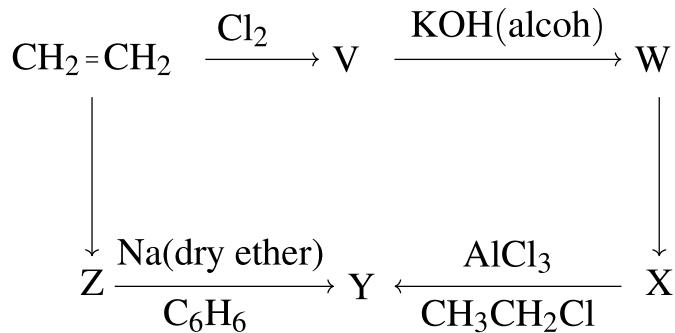
(03 marks)



(c) Convert CH_3CH_3 to

in not more than three steps. **(03 marks)**

(d) From the scheme below identify the molecules V, W, X, Y and Z.



(05 marks)

9. (a) The soil of Mjimwema has very low pH due to waste from factories, acid rain, over application of ammonium fertilizer and leaching of basic cations. What do we call this phenomenon? Explain three (3) effects of the phenomenon.

(04 marks)

- (b) Mzee Juma was telling Mzee Ally that do not waste money to buy UREA, DAP and NPK just use animal dungs will give the same results. As a chemist educate Mr.Juma and Mr.Ally the different between artificial fertilizer and Natural fertilizer by giving three (3) points. **(03 marks)**

- (c) 50 g of oven dry soil was shown to have 4meq Ca^{2+} , 2meq Na^+ , 3meq Mg^{2+} , 1meq H^+ , 2.5meq Al^{3+} , 1meq Na^- and 1.5meq K^+ at their exchange sites

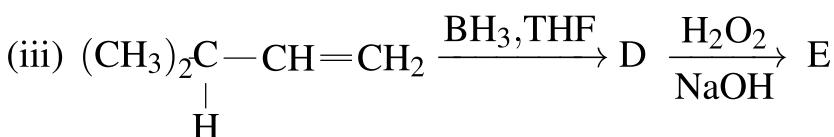
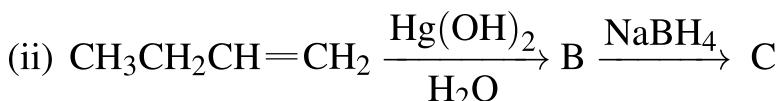
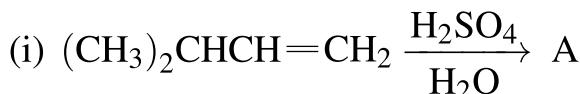
(i) calculate the percentage base saturation of the soil.

(ii) Calculate the mass of magnesium in 150g of soil

(iii) Explain the nature of the soil

(09 marks)

10. (a) Predict the major product(s) for each of the following reactions



- (b) When 1, 2-dibromodecane was treated with potassium hydroxide in aqueous ethanol, it yielded a mixture of three isomeric compounds of molecular formula $\text{C}_{10}\text{H}_{19}\text{Br}$. Each of these compounds was converted to dec-1-yne on reaction with sodium amide in dimethyl sulphoxide. Identify the three compounds. **(06 marks)**

- (c) Explain briefly the preparation of acetylene (ethyne) by

(i) pyrolysis of natural gas.

(ii) Action of water on calcium carbide.

(04 marks)

THE UNITED REPUBLIC OF TANZANIA
PRESIDENT'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT
FORM SIX EXAMINATION SERIES #5
CHEMISTRY PAPER I

Time 3:00 Hrs

YEAR: 2023

Instructions

1. This paper consists of sections A and B with a total of **ten (10)** questions.
2. Answer **all** questions from section A and **two(02)** questions from section B
3. Each question carries ten (10) marks in section A and fifteen (15) marks in section B.
4. Mathematical tables and non – programmable calculators may be used
5. Cellular phones and any unauthorized materials are not allowed in the examination room
6. Write your examination number on every page of your answer sheet(s)
7. Where necessary the following constants may be used:

$$C = 12, H = 1, N = 14, O = 16, Ca = 40, R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

SECTION A (70 Marks)

Answer all questions from this section

1. (a) Correct the following Dalton's atomic theory according to the modern atomic theory
 - (i) Matter is made up of small indivisible particles called atoms.
 - (ii) Atom can neither be created nor destroyed(b) Explain the fact of each of the following phenomena for cathode rays
 - (i) They rotate small paddle when placed on their path
 - (ii) They deflect magnetic fields(c) Draw the degenerate orbital of d – orbital when all orbitals are orienting in the same axis.(d) Hydrogen atom has only one electron, how it is possible that the hydrogen spectrum has simultaneous a large number of lines?
2. (a) For the chemical bonding to be ionic bond. Explain the features of the following factors:
 - (i) Cationic size
 - (ii) Anionic size
 - (iii) Ionization energy(b) What should be done to metallic bond increase malleability of the wire.(c) Explain the following phenomenon;
 - (i) Boiling point increases as molecular weight increase but the boiling point of $\ddot{N}H_3$ is higher than that of PH_3 .
 - (ii) Hydrogen bond in NH_3 is 110kJmol^{-1} but in H_2O is 220 kJmol^{-1}
 - (iii) NCl_5 is not formed but PCl_5 is formed though N and P are in the same group.
3. (a) The graph of volume against temperature for Charles law does not pass through origin. Why?
(b) Both diffusion and effusion involve the movement of gas molecules from the region of high concentration to the region of low concentration. What is the difference between the two?
(c) Duma's method is a technique used for the determination of molecular mass of gases but the technique uses liquid instead of gases. Why?
(d) Give the necessary condition for the compound like $AlCl_3$ to have unexpected molar mass during Victor Meyer's experiment
4. (a) For each of the followings below, show the possibility of forming product for various value of the reaction quotient (QC) and equilibrium constant (KC). Tell whether the product will be formed if:
 - (i) $QC > KC$
 - (ii) $QC < KC$

(b) Give reasons for the following.

- (i) Glycol and water are used in a car radiator while driving in cold countries.
 - (ii) Oceans do not freeze even at sub – zero temperature.
 - (iii) Sodium chloride or Calcium chloride is used to clear the snow on the roads.
 - (iv) The Osmotic pressure measurement is preferred for determining the molecular mass of proteins.
5. (a) Classify the following metal oxides: CaO, Na₂O, CO₂, ZnO, PbO and SO₂ according to basic oxides, acidic oxides and amphoteric oxides.
- (b) With the aid of a balanced chemical equation describe the following:
- (i) Any soluble metal carbonate and its method of preparation.
 - (ii) Any insoluble metal carbonate and its method of preparation.
- (c) (i) How metal carbonate and metal hydrogen carbonate distinguished?
- (ii) Use balanced chemical equation to verify your answer in C(i) above.
6. (a) Define the following terms.
- (i) Standard enthalpy of formation.
 - (ii) Standard enthalpy of combustion.
 - (iii) Specific heat capacity.
 - (iv) Enthalpy of vaporization.
- (b) Calculate the lattice energy of Sodium chloride from the following data and draw the Born Haber cycle. The standard enthalpy of formation of Sodium chloride is – 411 kJ/mole. Standard enthalpy of atomization of Na and chloride are +108 and 121 kJ/mole of gaseous atoms, the ionization energy of Sodium is +493 and the electron affinity of chloride is – 364kJ/mole.
- (c) Most chemical reactions are carried out at constant pressure. Is the statement correct or not correct? Justify your answer.

7. (a) Define the following terms:

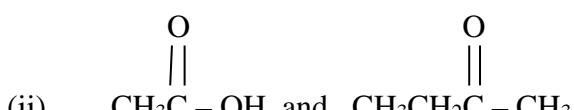
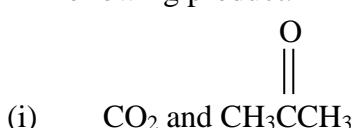
- (i) Reversible reaction
 - (ii) Heterogeneous reaction.
 - (iii) Homogenous reaction
 - (iv) Reaction quotient
- (b) (i) State two (2) applications of the equilibrium constant.
(ii) Consider the following reaction $N_2O_4 \rightarrow 2NO_2$ show that $K_p = K_c RT$.
- (c) When the solid silver is added to a solution containing Ag⁺, Fe²⁺ and Fe³⁺ with initial concentration of 0.4m, 0.20M and 0.60m respectively, the following reversible reaction occurs $Ag^{+}_{(aq)} + Fe^{3+}_{(aq)} \rightleftharpoons Fe^{3+} + Ag_{(s)}$

If the K_c for this reaction is 5.96 at 298K, calculate the equilibrium concentrations of each ion in the solution.

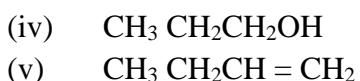
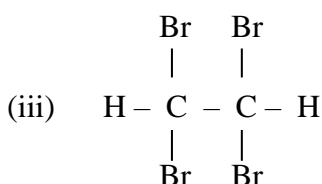
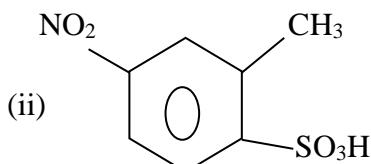
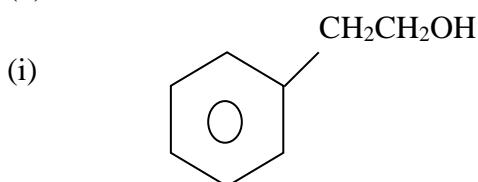
SECTION B (30 Marks)

Answer any two (2) questions from this section

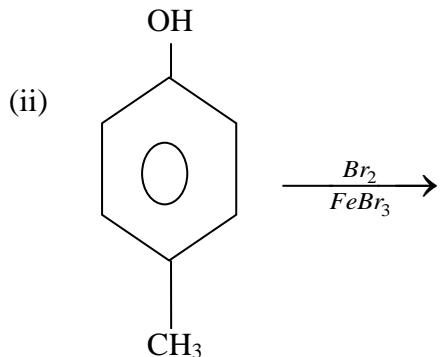
8. (a) You are provided with three test tubes in the laboratory and asked to identify the organic compound present in each of the three test tubes. If test tube A has propene, B has ethyne and C has benzene. How could you identify these reagents?
- (b) Show the organic reaction for each of the compound in 8(a) above reacting with its tester.
- (c) Give the alkene compound for which oxidation reaction acidic KMnO₄ gives the following product.



9. (a) (i) Define Aromaticity
(ii) State Huckel's rule
- (b) Give the IUPAC names of the following compounds



(c) Complete the following reactions



10. (a) Define the following

- (i) Water pollution
- (ii) Over – liming
- (iii) Manure

(b) (i) Most soils in humid tropics are acidic. Justify this statement.

(ii) Describe two roles of acid rain in environmental pollution.

(c) (i) If your soil is deficient in Nitrogen which nutrients supplement would you prefer to use between urea and manure? Give three reasons for your choice.

(ii) You are a specialist who wants to determine the quality of lime so that you can advice farmers and other stakeholders on the best liming material. Show how you can go about in calculating the neutralizing value of Calcium hydroxide $[Ca(OH)_2]$