# THE UNITED REPUBLIC OF TANZANIA
# MINISTRY OF EDUCATION AND VOCATIONAL TRAINING


# CHEMISTRY SYLLABUS FOR ADVANCED SECONDARY EDUCATION

## FORM V- VI

First Print: 2009
Second Print: 2010
Third Print: 2016

ISBN:978-9976-61-277-6

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## 1.0 INTRODUCTION

### 1.1 Background Information

The A-level Chemistry syllabus for Tanzania was last reviewed in 1996. It has taken twelve years for the next review done in 2008.

The 2008 review has been done in the context of serious global and local changes and challenges such as ICT developments and cross-cutting issues.

The present review has been done according to the requirements of the contemporary curriculum paradigm shift, where the student is placed at the centre of the teaching-learning process. Student learning is supposed to be activity oriented and cooperative in nature.

The present A-level Chemistry curriculum review is based on the country-wide monitoring research which was done in 2007 on the implementation of the A-level curriculum. This review study was followed by a meeting of A-level stake holders, who contributed important ideas and recommendations which has guided the review process. Their comments have been taken on board.

The world in the last ten years has changed very much technologically and socially. The present review has put enough emphasis on the development in the learners skills and competences needed in every day life.This syllabus has treated quite well the Environmental and Soil Chemistry.

### 1.2 Brief Description of the Subject

Chemistry is studied as a principal subject. The content has been carefully selected and organised so as to promote interest and motivation throughout the course. The topics fall under 5 (five) blocks, namely General Chemistry, Physical Chemistry, Inorganic Chemistry, Environmental Chemistry and Organic Chemistry.

### 1.3 Rationale for Review of the Chemistry Subject Syllabus

The monitoring research which was done in 2007 to pave the way for the syllabus review identified the following gaps in the chemistry syllabus of 1996:

- The syllabus was knowledge - based and not learner - centred;
- It was not geared towards constructivism;
- It was missing important content areas such as soil chemistry, cross - cutting

issues, environmental and soil chemistry, as well as qualitative analysis.

In designing this syllabus, due consideration has been made for it to be learner centred, activity oriented and the cross-cutting issues have been integrated.

The sub-topics removed were Cyclic hydrocarbons and Amides. However, radioactivity was shifted to Physics. Extraction of metals, Environmental Chemistry, Soil Chemistry and Qualitative Analysis have been added. More over, teaching/learning strategies, assessment and number of periods per sub-topic have been included in the syllabus.

## 2.0 OBJECTIVE OF EDUCATION IN TANZANIA

The general aims of education in Tanzania are to:

a) guide and promote the development and improvement of the personalities of the citizens of Tanzania, their human resources and effective utilization of their resources in bringing about individual and national development;

b) promote the acquisition and appreciation of culture, customs and traditions of the people of Tanzania;

c) promote the acquisition and appropriate use of literary, social, scientific, vocational, technological, professional and other forms of knowledge, skills and understanding for the development and improvement of man and society;

d) develop and promote self-confidence and an inquiry mind, an understanding and respect for human dignity and human rights and a readiness to work hard for personal self advancement and national improvement;

e) enable and expand the scope of acquisition, improvement and upgrading of mental, practical productive and other life skills needed to meet the changing needs of industry and the economy;

f) enable every citizen to understand the fundamentals of the national constitution as well as the enshrined human and civic rights, obligation and responsibilities;

g) promote the love for work, self and wage employment and to improve performance in the production and service sectors;

h) inculcate principles of national ethics and integrity, national and

international cooperation, peace and justice through the study, understanding and adherence to the provision of the National Constitution and International basic charters and

i) enable a rational use, management and conservation of our environment.

## 3.0 AIMS AND OBJECTIVES OF SECONDARY EDUCATION

The general aims and objectives of education in Tanzania are to:

a) consolidate and broaden the scope of baseline ideas, knowledge, skills and principles acquired and developed at primary education levels;

b) enhance further development and appreciation of national unity, identity and ethnic personal integrity, respect for and readiness to work, human rights, cultural and moral values, customs, traditions and civic responsibilities and obligations;

c) promote the development of competency in linguistic ability and effective use of communication skills in Kiswahili and at least one foreign languages;

d) promote opportunities for the acquisition of knowledge, skills, attitudes and understanding in prescribed or selected fields of study;

e) prepare students to tertiary and higher education; vocational, technical and professional training;

f) inculcate a sense and ability for self-study, self-reliance and self-advancement in new frontiers of science and technology, academic and occupational knowledge and skills and

g) prepare the student to join the world of work.

## 4.0 GENERAL COMPETENCES FOR THE SUBJECT

A-level students who study Chemistry as a principal subject should strive to develop the ability to:

a) communicate well using chemical symbols, formulae and equations as well as the language of instruction;

b) use mathematical principles to understand the processes of qualitative and quantitative chemical reactions;

c) use knowledge and skills to solve social and environmental problems related to Chemistry;

d) learn Chemistry knowledge and skills from a variety of sources;
e) use knowledge and skills of Chemistry to address the problems of drug and substance abuse, as well as environmental destruction and
f) use principles of science and technology in the teaching and learning of Chemistry, and in solving Chemistry problems in the society.

## 5.0 GENERAL OBJECTIVE FOR THE SUBJECT

By the end of the A–Level Chemistry course, the learners should be able to;

a) use language and symbols to communicate chemical information;
b) apply mathematical skills to analyse and interpret chemical phenomena;
c) apply knowledge and skills of Chemistry for proper environment conservation;
d) cultivate an understanding and appreciation of the role and importance of Chemistry in everyday life;
e) explain how to combat the social predicament of substance abuse;
f) develop fundamental concepts, principles and skills in Chemistry to solve problems in the society and
g) to prepare themselves for further studies in Chemistry and related fields.

## 6.0 ORGANIZATION OF THE SYLLABUS

This syllabus has a slightly different structure and organization compared to the 1997 syllabus. The current syllabus has six (6) columns, namely topic/ subtopic, specific objectives, teaching and learning strategies, teaching and learning resources assessment and number of periods.

In addition the following changes were incorporated for improvement:

a) General competences for the whole course.
b) Competences for forms V and VI.
c) Suggested areas of assessment.
d) Number of periods per sub-topic.
e) Assessment for the subject.

### 6.1 Class Level Competences

Competences are the skills, knowledge and attitudes attained by the learners after a learning process. Competences have been stated for each of the class levels of the Chemistry course, i.e. Form V and VI. It is upon the class level

competences that the class level objectives were developed.

## 6.2 Class Level Objectives

The general objectives for formV and for form VI have been stated so as to indicate the scope of coverage within each level.

## 6.3 The Content Matrics

The Content Matrics for this syllabus has the following columns:

- Topic/sub-topic
- Specific instructional objectives
- Teaching/Learning Strategies
- Teaching/Learning Resources
- Assessment
- Number of Periods

### 6.3.1 Topic/sub-topics

**Topics**

The topics in this syllabus have been derived from the class level competences and objectives. Most of the topics in the 1996 A-level Chemistry syllabus have been retained. Some sub-topics have been left out in order to cut the syllabus short. However, some topics of major interest have been introduced, these include:

- Soil Chemistry
- Environmental Chemistry (CCI)
- Analytical Chemistry

**Sub-topics**

Topics have been divided into sub-topics. Each sub-topic comprises of a portion of the content of the topic in question.The sub-topics have also been arranged to attain a logical or der which facilitates transfer of learning.

### 6.3.2 Specific objectives

There are specific objectives for each sub-topic. These are the expected outcomes of classroom instruction. They also reflect the process involved to attain the competences expected. The objectives are meant to cover the whole range of learning domains; i.e cognitive, psychomotor and affective.

### 6.3.3 Teaching/learning strategies

The column of Teaching/Learning Strategies suggest that in the Teaching/Learning process, both the teacher and the students must be involved in activities. Students are encouraged to work in small groups for maximum participatory and co-operative learning. The teacher is supposed to help and facilitate students' learning activities. The whole syllabus encourages interactive and participatory Teaching/Learning. However, the Teaching/Learning strategies suggested in this syllabus are not exhaustive.The teacher and students may decide to use any other Teaching/Learning strategies which suit the Teaching/Learning environment and the availableTeaching/Learning resources to teach a particular topic.

### 6.3.4 Teaching/learning resources

In the teaching of A-level Chemistry a variety of Teaching/Learning resources of different nature, quality and quantity will be needed. Incase the commercial Teaching/Learning resources are not available in their environment, the teacher together with students are expected to collect or improvise alternative resources available in their environment.

### 6.3.5 Assessment

For every specific instructional objective, there is a suggested question or area for assessment. Formative and summative assessment should be geared towards mastering all the competences and skills developed within the course. Teachers should use assessment tools to assess student's ability by the end of the lesson. Examples of these tools are: Tests, quizes, assignments, exercises, project work, experimental work and portifolios.

### 6.3.6 Number of periods

Each sub-topic has been allocated a specific number of instructional periods. The teacher should ensure that the sub-topic is completed within the specified time. The longer and more difficult topics involving more practical sessions have been allocated more instructional periods.

## 7.0 INSTRUCTIONAL TIME

The A-level Chemistry syllabus is meant to be covered in two years. The subject matter content has been apportioned to Form V and Form VI.

The topics in form V are meant to be a pre-requisite for those taught in FormVI.

According to the Education Circular No. 9 of 2004, there are a total of 194 effective teaching days per year.The syllabus should be covered within those days. Two weeks have been reserved for mid-year and annual examinations in each year. Any lost instructional time must always be compensated for.

## 8.0 ASSESMENT FOR THE SUBJECT

The table in page ix shows the type of assessment, assessment measure and weight in percentage (%) to be covered at the end of the course. Teachers are strongly advised to apply wide selection of assessment measures in order to develop students' ability form a stering the subject mater during the instructional process continuous assess mentcarry 50% and final examination conducted by the National Examination Council of Tanzania (NECTA) will carry 50%.

| Typeof Assessment | Assessment measures | Frequency | | | | Weight % | Total % |
|---|---|---|---|---|---|---|---|
| | | FromV | | FormVI | | | |
| | | Term1 | Term2 | Term1 | Term 2 | | |
| Continuous Assessment | 1. Practical test | 5 | 5 | 5 | | 10 | |
| | 2. Tests | 2 | 2 | 2 | | 10 | |
| | 3. Individual assignment | 1 | 1 | 1 | | 5 | |
| | 4. Research Project | | | | 1 | 5 | |
| | 5. Field Work | | 1 | | | 5 | |
| | 6. Terminal Examination | 1 | 1 | 1 | 1 | 15 | 50 |
| Final Exam | National Examination | | | | 1 | 50 | 50 |
| | **Total Marks** | | | | | | **100** |

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## Table for the Distribution of Topic for Form V and VI

| Branches | Topics | |
|---|---|---|
| | **Form V** | **Form VI** |
| General Chemistry | 1. The Atomic<br>2. Chemical Bonding | |
| Physical Chemistry | 1. Gases<br>2. Relative molecular masses in solution<br>3. Two components liquid system<br>4. Energetics | 1. Chemical equilibrium<br>2. Chemical Kinetics<br>3. Electrochemistry<br>4. Acids, Bases and Salts<br>5. Solubility, solubility production and ionic production. |
| Inorganic Chemistry | 1. Periodic classification<br>2. Selected compounds of metals | 1. Extraction of metals<br>2. Transition elements |
| Organic Chemistry | 1. Aliphatic hydrocarbons<br>2. Aromatic hydrocarbons<br>3. Halogen derivatives of hydrocarbon<br>4. Hydroxyl compounds<br>5. Carbonyl compound<br>6. Carboxylic acids and derivatives | 1. Amines<br>2. Polymers |
| **Topics Added** | | 1. Environmental Chemistry<br>2. Soil Chemistry<br>3. Chemical Analysis |

## FORM V

### General Competences

By the end of the Form V Chemistry course, students should have the ability to:

1. communicate properly in Chemistry using symbols, formula and equations;
2. use general periodic trends to predict the physical and chemical properties of substances;
3. use various glass ware and a wide range of instruments to carry out chemical analysis;
4. apply chemical methods and design possible approaches to solve environmental problems.

### General Objectives

By the end of the Form V Chemistry course, students should be able to:

a) communicate well in Chemistry using symbols, formulae and equations;
b) carry out scientific measurements accurately to at least two decimal places;
c) perform quantitative and qualitative analysis experiments and analyse their results;
d) use Chemistry knowledge, principles and skills to solve daily problems;
e) analyse the chemical and physical nature and properties of matter.

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| **1.0 THE ATOM**<br><br>1.1 Dalton's Atomic Theory | By the end of this sub- topic the student should be able to:<br>a) explain the Dalton's Atomic Theory; | i) Students to discuss main points of the Dalton's Atomic Theory.<br>ii) Students to perform experiments to practice subdividing a solid into fine powder and dilute a coloured solution to colourless. | • Wall chart showing main points of Dalton's Atomic Theory<br>• Copper (II) Sulphate<br>• Chalk<br>• $KMnO_4$<br>• $I_2$ crystals | Is the student able to explain the Dalton's Atomic Theory? | 6 |
| | b) establish evidence for the electronic structure of the atom; | Teacher to guide students to discuss the evidence for the electronic structure of the atom as suggested by Thomson, Rutherford and Bohr. | • Models<br>• Football | Is the student able to establish evidence for electronic structure of the atom? | |
| | c) describe the Atomic Models; | Students to draw the atomic models of Rutherford and Bohr and discuss their main features. | Wall chart showing models of Rutherford and Bohr | Is the student able to describe the Atomic models? | |
| | d) explain the concept of isotopy; | Students in small groups to discuss the Concept of isotopy, and the significance of isotopes in real life situations. | Wall chart showing isotopes of oxygen chlorine, magnesium. | Is the student able to explain the concept of isotopy? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | e) explain the Amendments of Daltons Atomic Theory. | Teacher to guide students to discuss the Amendments of Dalton's Atomic Theory as a result of the discovery of isotopes. | Wall charts showing amendments of Daltons Atomic Theory. | Is the student able to explain the Amendments of Dalton's Atomic Theory? | |
| 1.2 Bohr's Atomic Theory | By the end of this sub-topic the student should be able to:<br>a) describe energy levels and the hydrogen spectrum; | Students to discuss how the hydrogen Spectrum is developed from the electron transition between energy levels. Spectral lines forming the Lyman, Balmer, Paschen and Pfund series should be discussed. Teacher to relate the spectrum of elements to their identification. | • Charts showing diagrams of atomic spectrum<br>• Charts showing energy level | Is the student able to describe energy levels and the hydrogen spectrum? | 8 |
| | b) explain the Atomic Theory according to Bohr; | Teacher to guide students to discuss the AtomicTheory according to Bohr. | Wall chart showing the stationary states and movement of electrons. | Is the student able to Explain the Atomic Theory according to Bohr? | |
| | c) work out the characteristics of atomic spectrum (energy, frequency, and wave length). | Teacher to lead discussions on the energy, frequency and wave length of the radiations given when electron fall from n = 4 to n = 2, and from n = 4 to n = 1. | Wall chart showing the energy levels of hydrogen atom from Bohr model. | Is the student able to work out the characteristics of atomic spectrum? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| 1.3 The Atomic Mass | By the end of this sub-topic the student should be able to:<br>a) explain the sub- atomic particles; | Students to discuss inpairs the characteristics of each individual sub-atomic particles, namely electron, proton and neutron. | Wall chart showing mass spectrometer. | Is the student able to explain the sub-atomic particles? | 2 |
| | b) compare mass number with atomic number; | Students to compare mass number with the atomic number of atoms. | Wall chart showing mass spectrometer. | Is the student able to compare mass number with atomic number? | |
| | c) describe mass spectroscopy. | Students to draw a diagram of the mass spectrometer, and describe how it is used to measure atomic mass. | Wall chart showing mass spectrometer | Is the student able to describe mass spectroscopy? | |
| 1.4 The Quantum Theory | By the end of this sub-topic the student should be able to:<br>a) describe the wave-particle duality of the electron; | Students in small groups to discuss the wave–particle duality of the electron. | Wall charts showing formulae which relates an electron as a wave and particle | Is the student able to describe the wave- particle duality of the electron? | 6 |
| | b) explain the quantum numbers n, l, $m_l$ and $m_s$; | Teacher should lead a discussion on the meaning and implications of then, l, $m_l$ and $m_s$ | • Charts showing quantum numbers<br>• Pictures showing quantum numbers | Is the student able to explain the quantum numbers n, l, $m_l$, and $m_s$ | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | c) describe atomic or bitals s, p, d and f; | Students to draw the shapes of the s, p, and datomic orbitals. | Wall chart showing different shapes of or bitals | Is the student able to describe atomic orbitals s,p, dandf. | |
| | d) explain Hund'srule, Aufbau'sprinciple and Pauli'sexclusion Principle. | i) Teacher to guide students to discuss the implications of the Hund's rule, Aufbau principle and Pauli's Exclusion principle.<br>ii) Students to write the electronic configurations of elements using the s, p, d and f orbitals. | Wall charts showing how electrons are filled in different energy levels. | Is the student able to explain Hund's rule, Aufbau's principle sand Pauli's Exclusion principle? | |
| **2.0 CHEMICAL BONDING**<br><br>2.1 Types of Bonds | By the end of this sub-topic the student should be able to:<br>a) differentiate the characteristics of electrovalent and covalent bonding; | Students to brain storm the differences in the characteristics of the covalent and electrovalent bonds. | • Atomic models<br>• Diagrams showing covalent and electrovalent bonds. | Is the student able to differentiate the characteristics of electrovalent and covalent bonding? | 6 |
| | b) describe dative bonding; | Students to discuss the availability of the lone pair of electrons to electrophile in dative bonding. | Diagrams showing dative bond. | Is the student able to describe dative bonding? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | c) explain the meaning and significance of hydrogen bonding. | Teacher should lead students to discuss the effects of hydrogen bonding in the shape of ice. | Diagrams showing hydrogen bonding | Is the student able to explain the meaning and significance of hydrogen bonding? | |
| 2.2 Hybridization of Atomic Orbitals | By the end of this sub-topic the student should be able to:<br>a) explain the concept of hybridization of atomic orbitals. | Teacher to lead students to discuss the hybridization of atomic orbitals, so as to establish $sp^3$, $sp^2$ and sp hybrid orbitals and examples of molecules in which the hybrid bonds are found. | Diagrams showing hybridization of atomic orbitals | Is the student able to explain the concept of hybridization of atomic orbitals? | 6 |
| | b) describe the shapes of $sp^3$, $sp^2$ and sp hybrid orbitals; | Students to draw and describe the shapes of $sp^3$, $sp^2$ and sp hybrid orbitals. | • Diagrams showing shapes of hybridized orbital<br>• Models | Is the student able to describe the shapes of $sp^3$, $sp^2$ and sp hybrid orbitals? | |
| | c) explain the overlapping of hybrid orbitals to form molecular orbitals. | i) Students draw and use models to demonstrate the overlapping of hybrid orbitals to form molecular orbitals.<br>• Sigma bond from $sp^3 – sp^3$ overlapping<br>• Sigma and pie bonds from $sp^2 – sp^2$ overlapping<br>• Sigma and Pie bonds from sp – sp side way overlapping | • Wall charts showing over lapping of $sp^3 – sp^3$, $sp^2 – sp^2$ and sp – sp.<br>• Models | Is the student able to explain the overlapping of bybrid orbitals to form molecular orbitals? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | | ii) Teacher to guide students to discuss the relative strengths of molecular bonds from the type of overlapping involved. | | | |
| **3.0 GASES**<br><br>3.1 The Gas Laws | By the end of this sub-topic the student should be able to:<br>a) describe the gas laws; | i) Teacher to guide students to discuss Boyle'slaw and Charles'law<br>ii) Students to derive mathematical equations of<br>• Boyle'slaw<br>• Charles'law<br>• General Gas Equation | Wall charts showing the apparatus used to prove the laws. | Is the student able to describe the gas laws? | 6 |
| | b) use general gas equation to cary out calculations; | Students to use general gas equation and ideal gas equation to carry out calculations based on the gas laws. | Textbooks | Is the student able to use general gas equation to cary out calculations? | |
| | c) describe the Avogadro's law, Graham's law and Dalton's law of partial pressure. | i) Teacher to guide students to discuss Graham's laws and Dalton's law of partial pressure.<br>ii) Students to carry out calculations based on the laws. | Textbooks | Is the student able to describe the Avogadro's law, Graham's law and Dalton's law of partial pressure? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| 3.2 Kinetic Theory of Gases | By the end of this sub-topic the student should be able to:<br>a) describe the characteristics of a gas as influenced by pressure, volume, and temperature changes; | Teacher to guide students to discuss the behaviour of gases as influenced by pressure, volume and temperature changes. | • Wall charts and pictures<br>• Models | Is the student able to describe the characteristics of gas as influenced by pressure, volume and temperature changes. | 6 |
| | b) explain the Kinetic Theory of Gases and assumptions leading to the fundamental Kinetic Equation; | Teacher to guide students to explain Kinetic Theory of Gases and the postulates stipulated. | Wall chart showing cuboid | Is the student able to explain the Kinetic Theory of Gases and assumptions leading the fundamental Kinetic Equation? | |
| | c) use the fundamental Kinetic Equation to deduce the gas laws. | Students in small groups to discuss how to use the fundamental kinetic equation $PV=\frac{1}{3}nmu^2$ to deduce the gas laws. | Textbooks | Is the student able to use the fundamental Kinetic Equation to deduce the gas laws? | |
| 3.3 Relative Molecular Masses and Densities of Gases | By the end of this sub-topic the student should be able to:<br>a) describe molecular masses and relative densities of gases; | Teacher to guide students to discuss how molecular masses of gases are determined by Duma's and Victor Meyer's methods. | Textbooks | Is the student able to describe molecular masses and densities of gases? | 4 |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | b) describe different methods used to find molecular masses of gases; | Teacher to guide students to discuss relative molecular masses and densities of gases and vapours. | Duma's bulb, water bath, thermometer, propanone,victor Meyer's apparatus, diethyl ether, desiccators. | Is the student able to describe different methods used to find molecular masses of gases? | |
| | c) explain the abnormal relative densities of vapour. | Teacher to guide students to discuss how molecular masses of gases are affected by association and dissociation of vapours. | Textbooks | Is the student able to explain the abnormal relative densities of vapours? | |
| **4.0 RELATIVE MOLECULAR MASSES IN SOLUTION**<br>4.1 Colligative Properties of Solutions | By the end of this sub- topic the student should be able to:<br>a) explain the meaning of colligative properties; | Teacher to guide students to discuss the meaning of colligative properties. | • Beckman's apparatus<br>• Lands berger apparatus<br>• Freezing point apparatus<br>• Osmometer<br>• Weighing bottle | Is the student able to explain the meaning of colligative properties? | 6 |
| | b) explain how colligative properties of solutions are used to determine the molar masses of solutes. | Students in small groups to demonstrate how boiling point elevation, freezing point depression, lowering vapour pressure and osmotic pressure are used to determine the molar masses of solutes. | • Thermometer<br>• Common salt/ Sugar<br>• Water<br>• Beaker<br>• Source of heat | Is the student able to explain how colligative properties of solutions are used to determine the molar masses of solutes? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| 4.2 Laws Governing the Colligative Properties | By the end of this sub-topic the student should be able to:<br>a) describe the Raoult's law which governs colligative properties; | i) Teacher to guide students to discuss Raoult's law, Bladgens Law and Molar solutions.<br>ii) Students to perform experiments to demonstrate the elevation of boiling point and depression of freezing point.<br>iii) Teacher to guide students to discuss on the lowering of vapour pressure and osmotic pressure. | • Beckman's apparatus<br>• Freezing point apparatus<br>• Lands berger apparatus<br>• Osmometer<br>• Weighing bottle<br>• Plastic bottles | Is the student able to describe the Raoults law which governs colligative properties? | 8 |
| | b) determine the relative molar masses of solutes from Raoult's law; | Students to determine the relative molecular masses of solutes from colligative properties of solution under the guidance of the teacher. | • Beckman's apparatus<br>• Freezing point apparatus<br>• Lands berger apparatus<br>• Osmometer<br>• Weighing bottle<br>• Plastic bottles | Is the student able to determine there lative molar masses of solutes from Raoult's law? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | c) determine the degree of dissociation of strong electrolytes in solution. | i) Teacher to guide students to determine degree of dissociation using van't Hoff factor-i.<br>ii) Students to determine the relative molecular masses of solutes by using van't Hoff factor-i.<br>iii) Teacher should lead a discussion on how relative molecular masses of solutes are affected by association/ dissociation of solutes. | • Beckmans apparatus<br>• Osmometer<br>• Weighing bottle<br>• Weighing balance | Is the student able to determine the degree of dissociation of strong electrolytes in solution? | |
| **5.0 TWO COMPONENT LIQUID SYSTEMS**<br><br>5.1 Immiscible Liquids | By the end of this sub- topic the student should be able to:<br>a) describe the properties of immiscible liquids; | i) Students to perform an experiment showing immiscible liquids and partially miscible liquids.<br>ii) Teacher to guide students to discuss on low boiling point of immiscible liquids due to high vapour pressure. | • Separating funnels<br>• Beakers<br>• Immiscible liquids<br>• Partially miscible liquids | Is the student able to describe the properties of immiscible liquids? | 6 |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | b) explain the application of the immiscible liquids; | i) Student to investigate the distillation process of immiscible liquids.<br>ii) Teacher to guide students through discussion to explain how steam distillation of a compound of high boiling point can be achieved at lower temperature than that of either pure component. | • Distillation apparatus<br>• Immiscible liquids | Is the student able to explain the application of immiscible liquids? | |
| | c) determine the molar mass of a high boiling point liquid by using steam distillation. | Teacher to guide students to determine the molar masses of a high boiling point liquids. | • Steam distillation apparatus<br>• Immiscible liquids | Is the student able to determine the molar mass of high boiling liquid by using steam distillation? | |
| 5.2 Completely Miscible Liquids | By the end of this sub- topic the student should be able to:<br>a) describe the Raoult's Law; | Teacher should lead students in the discussion on Raoult's law and principles underlying the law. | • Manila sheets<br>• Marker pens | Is the student able to describe the Raoult's law? | 6 |
| | b) differentiate ideal from non-ideal solutions; | i) Students to give examples of ideal solutions and non-ideal solutions<br>ii) Teacher to guide students to distinguish ideal from non-ideal solutions. | • Ideal solutions<br>• Non–ideal solutions | Is the student able to differentiate ideal and non-ideal solutions? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
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| | c) demonstrate positive and negative deviation from Raoult's Law; | i) Students to brainstorm on solutions that exhibit positive and negative deviation from Raoult's law.<br>ii) Teacher to guide students to discuss reasons for positive and negative deviation from Raoult's law. | Wall chart showing positive and negative deviation from Raoult's law. | Is the student able to demonstrate positive and negative deviation from Raoult's law? | |
| | d) describe vapour pressure diagrams; | i) Teacher to lead students to sketch vapour pressure diagrams for ideal and non-ideal solutions.<br>ii) Students through group discussion to explain vapour pressure diagrams for positive and negative deviation.<br>iii) Teacher to lead students to discuss the concept of azeotropic mixtures. | Wall chart showing vapour pressure diagrams. | Is the student able to describe vapour pressure diagrams? | |

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| | e) demonstrate the process of fractional distillation; | i) Students under teacher's guidance to perform an experiment on the processes of fractional distillation.<br>ii) Teacher to guide students discuss the products of fractional distillation. | • Side armed flasks<br>• Thermometers<br>• Fractionating columns<br>• Boiling flasks<br>• Beakers<br>• Condensers | Is the student able to demonstrate the process of fractional distillation? | |
| | f) explain the application of fractional distillation. | Teacher to guide students to discuss on the application of fractional distillation in the local environment and in industry. | Fractional distillation apparatus | Is the student able to explain the application of fractional distillation? | |
| 5.3 The Distribution Law | By the end of this sub-topic the student should be able to:<br>a) explain the meaning of the distribution law | Teacher to guide students to brainstorm on the distribution of a solute between two immiscible solvents. | • Separating funnel<br>• Solute<br>• Two immiscible solvents | Is the student able to explain the distribution law? | 6 |
| | b) demonstrate the distribution law; | i) Students to perform an experiment to illustrate the distribution law e.g. distribution of iodine between water and petroleum ether. | • Pipettes<br>• Beakers<br>• Conical flasks<br>• Iodine<br>• Petroleum ether<br>• Separating funnel | Is the student able to demonstrate the distribution law? | |

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| | | ii) Teacher to guide students discuss the results of the experiment leading to the calculation of the distribution constant. *Caution*: Avoid poisonous substances like tetrachloromethane and benzene. | | | |
| | c) apply distribution law in solvent extraction; | i) Students to perform an experiment to show application of distribution law in solvent extraction like in chromatography.<br>ii) Teacher to guide students in the discussion of different application of distribution law in solvent extration. | • Separating funnels<br>• Burettes<br>• Fitter paper<br>• Petridish<br>• Flowers<br>• Leaves<br>• Solvent (propanone) | Is the student able to apply distribution law in solvent extraction? | |
| | d) explain the deviations from the distribution law. | Teacher to guide students in discussing cases where there is deviation from the distribution law i.e. in association and in dissociation of the solute. | Textbooks | Is the student able to explain the deviations from the distribution law? | |

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| **6.0 ENERGETICS**<br><br>6.1 Heats of Reaction | By the end of this sub- topic the student should be able to:<br>a) explain the concept of heats of reaction; | i) Students to discuss different heat changes.<br>ii) Teacher to guide students through discussion on heats of formation, neutralization, combustion, dilution, atomization, solution and dissociation. | • Beaker<br>• Salt<br>• Thermometer<br>• Sourceof heat<br>• Acid<br>• Base<br>• Balance<br>• Distilled water | Is the student able to explain the concept of heats of reaction? | 6 |
| | b) determine the heat of neutralization; | i) Students to perform an experiment to determine heat of neutralization using NaOH and HCl.<br>ii) Teacher to guide students in discussing the heat change determination. | • Salt sample<br>• Calorimeters<br>• Alkalis<br>• Acids<br>• Thermometer<br>• Indicators | Is the student able to determine the heat of neutralization? | |
| | c) determine the heat of solution. | i) Students to perform an experiment to determine the heat of solution using different salts.<br>ii) Teacher should lead students in discussing the heats of solution. | • Thermometers<br>• NaOH<br>• HCl<br>• Calorimeter<br>• Sodium thiosulphate<br>• $CuSO_4.5H_2O$, $CuSO_4$ | Is the student able to determine the heat of solution? | |

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| 6.2 Hess's Law | By the end of this sub- topic the student should be able to:<br>a) explain the Hess's Law; | Teacher to guide students in the discussion on the concept of Hess's law. | • Thermometer<br>• Beaker<br>• Salt<br>• Acids<br>• Bases | Is the student able to explain the Hess's law? | 6 |
| | b) apply Hess's Law in the calculations of heat changes; | i) Students to carry out calculations on heat changes using Hess's law.<br>ii) Teacher to lead students in discussing various calculations where Hess's law is applicable. | Textbooks | Is the student able to apply Hess's law in the calculation of heat changes? | |
| | c) describe the Born Haber cycle; | Teacher to guide students in the discussion of Born-Haber cycle using compounds like NaCl, KBr, CaO and $MgCl_2$. | Diagram showing Born Haber cycle | Is the student able to describe the Born Haber cycle? | |
| | d) relate heats of formation to bond energies. | Teacher should lead students to discuss the relation between heats of formation and bond energies. | Charts and pictures | Is the student able to relate heat of formation to bond energies? | |
| **7.0 PERIODIC CLASSIFICATION**<br>7.1 Periodicity | By the end of this sub- topic the student should be able to:<br>a) explain the concept of periodicity; | Teacher to guide students to discuss the concept of periodicity. | Modern periodic table | Is the student able to explain the concept of periodicity? | 6 |

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| | b) compare the efforts of different scientist in trying to classify elements; | i) Teacher to guide students to classify elements according to Newland, Meyer, Mendeleev and Mosley.<br>ii) Students to use Mosley classification to establish a periodic table. | Wall chart showing modern periodic tables of Newsland, Meyer Mendeleev and Mosley | Is the student able to explain the progress of different scientists in classifying elements? | |
| | c) describe the main features of the modern periodic table; | i) Teacher should lead students to use the periodic law to establish groups, periods and blocks.<br>ii) Students to use the periodic law to construct a periodic table according to Mosley. | Modern periodic table | Is the student able to describe the main features of the modern periodic table? | |
| | d) compare the periodic law in terms of atomic masses versus atomic numbers. | Students to use the periodic law to compare atomic masses versus atomic numbers of elements. | Modern periodic table | Is the student able to compare the periodic law in terms of atomic masses versus atomic numbers? | |
| 7.2 Periodic Trends in Physical Properties | By the end of this sub-topic the student should be able to:<br>a) describe the general periodic trends in physical properties across periods and down the groups; | Teacher to guide students to discuss the general periodic trends in physical properties of elements across periods and down the groups considering atomic size, electronegativity, ionization energy and electron affinity. | Modern periodic table | Is the student able to describe the general periodic trends in physical properties across periods and in down the groups? | 6 |

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| | b) describe periodic trends in physical properties down the groups; | Teacher to lead students to discuss the periodic trend in physical properties of elements down the groups IA, IIA and VII. | Modern periodic table | Is the student able to describe periodic trends in physical properties down the group? | |
| | c) describe periodic trends in physical properties across period 3. | Teacher to guide students to discuss periodic trends in physical properties of elements across period 3. | Modern periodic table | Is the student able to describe periodic trends in physical properties across period 3? | |
| 7.3 Periodic Trends in Chemical Properties | By the end of this sub- topic the student should be able to:<br>a) describe trends in chemical properties in groups; | i) Teacher to guide students to discuss the reaction between elements in group IA, IIA and VIIA with air, H2O, HCl, NaOH, HNO3 and H2SO4<br>ii) Students to establish the trends in chemical properties of elements in groups IA, IIA VIIA. | • Modern periodic table<br>• $H_2O$, HCl, NaOH, $HNO_3$, $H_2SO_4$ | Is the student able to describe trends in chemical properties in groups? | |
| | b) describe trends in chemical properties along period 3 | i) Teacher to guide students to discuss the action of water on hydrides, chlorides, hydroxides and oxides of elements in period 3.<br>ii) Teacher should lead a discussion on the ionic character of chlorides, hydroxides and hydrides of elements in period 3. | • Modern periodic table<br>• Water<br>• Hydrides, chlorides, hydroxides and oxides of elements in period 3 | Is the student able to describe trends in chemical properties along period 3? | 4 |

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| | | iii) Students to prepare charts that describes the trends of chemical properties of elements in period 3. | | | |
| 7.4 Diagonal Relationship | By the end of this sub- topic the student should be able to:<br>a) explain the concept of diagonal relationship; | Teacher to guide students to discuss the concept of diagonal relationship. | Modern periodic table | Is the student able to explain the concept of diagonal relationship? | 6 |
| | b) explain the diagonal relationship between lithium and magnesium; beryllium and aluminium; | i) Teacher should lead a discussion on diagonal relationship of Li/Mg and Be/Al.<br>ii) Students to deduce the diagonal relationship between Lithium and Magnesium; beryllium and Aluminium. | Modern periodic table | Is the student able to explain the diagonal relationship between lithium and magnesium; beryllium and aluminium? | |
| | c) explain why the first elements in a group differ from the rest. | i) Teacher to guide students to discuss the reasons for anomalous behaviour of the first element in a group as compared to the rest of the elements<br>ii) Students to prepare charts that describe the anomalous behaviour of the first elements in group IA, IIA and VII A. | Modern periodic table | Is the student able to explain why the first elements in a group differs from the rest? | |

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| **8.0 SELECTED COMPOUNDS OF METALS**<br><br>8.1 Oxides | By the end of this sub- topic the student should be able to:<br>a) classify metal oxides; | Students to classify metal oxides as basic, acidic, amphoteric or mixed oxides. Metals selected are Na, Mg, Ca, Al, Fe, Cu, Zn and Pb. | Oxides of Na, Mg, Ca, Al, Fe, Cu, Zn and Pb. | Is the student able to classify metal oxides? | |
| | b) prepare oxides of metals by direct and indirect methods; | Students to prepare metal oxides in the laboratory by directly heating the metal in air also by indirect method using concentrated nitric acid. | • $HNO_3$<br>• Metal | Is the student able to prepare oxides of metals by direct and indirect methods? | |
| | c) demonstrate the reactions of metal oxides with water and with dilute acids; | Students to carry out reactions to demonstrate the properties of oxides as they react with water and dilute acids | • Dilute $H_2SO_4$<br>• DiluteHCl<br>• Metal oxides | Is the student able to demonstrate the reactions of metal oxides with water and with dilute acids? | 6 |
| | d) explain the uses of metal oxides; | Students to discuss the uses of metal oxides in furnaces and as liming materials | • MgO<br>• CaO | Is the student able to explain the uses of metal oxides? | |
| | e) describe the reactions of amphoteric oxides. | Students to write balanced equations for the reactions of normal and amphoretic oxides | • ZnO<br>• $Al_2O_3$<br>• PbO | Is the student able to describe the reactions of amphoteric oxides? | |
| 8.2 Hydroxides | By the end of this sub- topic the student should be able to:<br>a) prepare metal hydroxides by direct and in direct methods; | Students to prepare metal hydroxides by direct and in direct methods | • Metals selected<br>• Oxides of selected metals<br>• $H_2O$ | Is the student able to prepare metal hydroxides by different methods? | 6 |

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| | b) pescribe the properties of metal hydroxides; | Students to demonstrate experimentally how metal hydroxides react with other elements/compounds. | Hydroxide of selected metals | Is the student able to describe the properties of metal hydroxides? | |
| | c) explain the uses of metal hydroxides. | Teacher to guide students to discuss the uses of metal hydroxides in industry, including the manufacture of soap. | Hydroxide of selected metals | Is the student able to explain the uses of metal hydroxides? | |
| 8.3 Carbonates and Hydrogencarbonates | By the end of this sub- topic the student should be able to:<br>a) prepare metal carbonates by indirect methods; | Students to prepare carbonates and hydrogen carbonates by direct and indirect methods. | • lime water<br>• NaOH<br>• Straw | Is the student able to prepare metal carbonates by indirect methods? | 6 |
| | b) explain the non- existence of the carbonates of iron and aluminium; | Teacher to guide students to explain why the carbonates of iron and aluminium have never been prepared | • $Al_2O_3$<br>• $Fe_2O_3$<br>• Textbooks | Is the student able to explain the non- existence of the carbonates of iron and aluminium? | |
| | c) demonstrate the effect of heat on carbonates; | Students to demonstrate experimentally the effects of heat on metal carbonates. | • Carbonates of selected metals | Is the student able to demonstrate the effect of heat on carbonates? | |
| | d) describe the properties of metal carbonates and hydrogen carbonates; | Students to demonstrate the reactions of carbonates with water and with acid. | • $H_2O$<br>• Mineral acids<br>• Carbonates of selected metals | Is the student able to describe the properties of metal carbonates and hydrogen carbonates? | |

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| | e) describe the uses of carbonates and hydrogen carbonates. | Teacher to guide students to discuss the uses of metal carbonates and hydrogen carbonates in industry and in agriculture. | • Quick lime<br>• $Ca(OH)_2$ | Is the student able to describe the uses of carbonates and hydrogen carbonates? | |
| 8.4 Sulphates | By the end of this sub-topic the student should be able to:<br>a) prepare soluble and insoluble metal sulphates by direct and indirect methods; | Students to prepare metal sulphates by direct and indirect methods. | • $H_2SO_4$<br>• Glassware<br>• $Pb(NO_3)_2$<br>• $Na_2SO_4$<br>• Metals selected<br>• Oxides of selected metal | Is the student able to prepare soluble and insoluble metal sulphates by direct and indirect methods? | 6 |
| | b) describe the properties of sulphates; | Students to carry out experiments to test the properties of metal sulphates. | • $Na_2SO_4$<br>• $ZnSO_4$<br>• Glassware | Is the student able to describe the properties of sulphates? | |
| | c) describe the uses of sulphates; | Teacher to guide students go discuss the uses of metal sulphates in industry and in agriculture. | • $H_2SO_4$<br>• Sulphate of ammonia | Is the student able to describe the uses of sulphates? | |
| | d) demonstrate the effect of heat on sulphates. | Students to test the effects of heat on common sulphates of metals. | • $BaSO_4$<br>• $CuSO_4$ | Is the student able to demonstrate the effect of heat on sulphates? | |

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| 8.5 Chlorides | By the end of this sub- topic the student should be able to:<br>a) prepare metal chlorides by direct and indirect methods; | Students to prepare metal chlorides by direct and indirect methods. | • Dil.HCl<br>• $Cl_2$<br>• Metals selected<br>• oxides of selected metals | Is the student able to prepare metal chlorides by a variety of methods? | 6 |
| | b) describe the properties of metal chlorides; | Teacher should lead students to demonstrate experimentally the properties of metal chlorides. | Chlorides of metals selected | Is the student able to describe the properties of metal chlorides? | |
| | c) describe special characteristics of $FeCl_3$ and $AlCl_3$; | Teacher and students to discuss the special characteristics of $FeCl_3$ and $AlCl_3$ in the gaseous state. | • $FeCl_3$<br>• $AlCl_3$ | Is the student able to describe the special properties of $AlCl_3$ and $FeCl_3$? | |
| | d) explain the uses of chlorides. | Students to discuss the uses of metal chlorides. | Chlorides of metals selected | Is the student able explain the uses of chlorides | |
| 8.6 Nitrates | By the end of this sub-topic the student should be able to:<br>a) prepare metal nitrates by direct and indirect methods; | Students to prepare metal nitrates in the laboratory by direct and indirect methods. | • Dil.$HNO_3$<br>• Oxides of metals selected<br>• Hydroxides of metals selected<br>• Carbonates of metals selected | Is the student able to prepare metal nitrates by different methods? | 6 |

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| | b) describe the properties of metal nitrates; | Students to carryout experiments to test the properties of metal nitrates. | Nitrates of selected metals | Is the student able to describe the properties of metal nitrates? | |
| | c) describe the effects of heat on metal nitrates; | Students to test the effect of heat on metal nitrates. | Nitrate of selected metals | Is the student able to describe the effects of heat on metal nitrates? | |
| | d) explain the uses of metal nitrates. | Students to discuss the uses of nitrates in industry and in agriculture. | Wall chart showing the uses of nitrates. | Is the student able to explain the uses of metal nitrates? | |
| **9.0 ALIPHATIC HYDROCARBONS**<br><br>9.1 Sources of Organic Compounds | By the end of this sub- topic the student should be able to:<br>a) differentiate organic from in organic compounds; | Teacher should lead students to brain storm on the natural occurring organic compounds e.g. proteins, carbohydrates, plastics, fats, acids, synthetic organic compounds medicines, drugs and different salts. | • Wall chart showing<br>• Natural occurring organic compounds<br>• Synthetic organic compounds<br>• Different salts<br>• Organic materials<br>• Salts | Is the student able to differentiate organic and inorganic compounds? | 4 |
| | b) identify different sources of organic compounds; | Students under teacher's guidance to discuss different sources of organic compounds including petroleum, coal, and natural gas. | Wall chart showing compounds which can be obtained from<br>• petroleum<br>• coal | Is the student able to identify different sources of organic compounds? | |

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| | c) classify organic compounds into aliphatic and a romatic groups; | Teacher should lead students in the discussion on classes of aliphatic and a romatic hydro carbons; with examples i.e. aliphatic alkanes, alkenes and alkynes exclude cyclic hydrocarbons | Drawing on manila sheet showing aliphatic and aromatic groups. | Is the student able to classify alphatic and aromatic groups? | |
| | d) describe the special properties of the carbon atom. | Teacher should lead students in the discussion on unique features of carbon in organic compounds including the following:<br>i) It undergoes catenation<br>ii) Exhibits a variety of oxidation states<br>iii) Forms strong bonds with a variety of elements<br>iv) Forms multiple bonds. | • Models<br>• Wall charts showing<br>- variable oxidation states of carbon<br>- multiple bonds of carbon. | Is the student able to describe the special properties of the carbon atom? | |
| 9.2 Properties of Aliphatic Hydrocarbons | By the end of this sub- topic the student should be able to:<br>a) describe the general physical and chemical properties of aliphatic hydrocarbons. | Students under teacher's guidance to discuss physical and chemical properties of aliphatic hydrocarbons e.g. melting point, boiling point and solubility. | • Wall chart showing physical and chemical properties of aliphatic hydrocarbons<br>• Atomic models. | Is the student able to describe the general physical and chemical properties of aliphatic hydrocarbons? | 2 |

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| | b) explain the nature of bonding in aliphatic hydrocarbons. | Teacher to guide students to explain nature of bonding in aliphatic hydrocarbons. This has to explain the covalent nature of these compounds, formation of sigma and π bonds | • Wall chart showing formation of sigma and π bonds.<br>• Atomic models. | Is the student able to explain the nature of bonding in aliphatic hydrocarbons? | |
| 9.3 Alkanes | By the end of this sub- topic the student should be able to:<br>a) describe the general formula homologous molecular and structural formula and isomerism of alkanes. | Students to describe the general formula homologous series molecular and structural formulae and isomerism of alkanes. | Wall charts showing homologous series of alkane upto ten carbon atoms | Is the student able to describe the general formula homologous molecular and structural formula and isomerism of alkanes? | 6 |
| | b) describe the production of alkanes from coal, petroleum and natural gas; | Students under teacher's guidance to brain storm on production of alkanes from petroleum, coal and natural gas. | Wall charts showing thermal cracking of petroleum. | Is the student able to describe the production of alkanes from coal petroleum and natural gas? | |
| | c) explain the concept of saturation in terms of $sp^3$ hybridization in alkanes; | i) Students in groups to discuss the saturation of alkanes.<br>ii) Teacher to summarise the concept of saturation in alkanes in terms of $sp^3$ hybridization. | Atomic models | Is the student able to explain the concept of saturation? | |

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| | d) explain the physical and chemical properties of alkanes; | Teacher to lead students in the discussion of properties of alkanes i.e. reaction with strong acids and alkalis, combustion, halo genation and cracking process. | Atomic models | Is the student able to explain the physical and chemical properties of alkanes? | |
| | e) demonstrate laboratory synthesis of a simple alkanes; | Teacher to guide students in the preparation of alkanes | • $Al_4C_3$<br>• $H_2O$ | Is the student able to synthesis of a simple alkane in the laboratory? | |
| | f) describe the nature of alkanes as fuels; | Teacher to lead student in discussing the gaseous nature of some alkanes and their use as fuels. | Wall charts showing gaseous, liquids and solids as fuel of alkanes. | Is the student able to describe the nature of alkanes as fuels | |
| | g) name alkanes and their isomers. | i) Teacher to guide students in naming alkanes and their isomers using the IUPAC system.<br>ii) Students to name more complicated alkanes up to ten carbon atoms | Wall charts showing compounds of alkanes and their names | Is the student ableto name alkane and their isomers? | |
| 9.4 Alkenes | By the end of this sub- topic the student should be able to:<br>a) describe the industrial production of alkenes from the thermal cracking of heavy alkanes; | i) Students under teacher's guidance to brainstorm on industrial production of alkenes by thermal cracking of heavy alkanes.<br>ii) Teacher to summarise the production process of alkenes. | • Wall charts showing production of alkenes by thermal cracking of petroleum<br>• Fractional distillation of petroleum | Is the student able to describe the industrial production of alkenes? | 6 |

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| | b) explain the concept of unsaturation in terms of $sp^2$ hybridization in alkenes; | Teacher to guide students to discuss the concept of unsaturation in alkenes due to $sp^2$ hybridization. | Atomic models | Is the student able to relate $sp^2$ hybridization with unsaturation? | |
| | c) describe electrophilic addition reactions of alkene; | i) Teacher to guide students in discussing electrophilic addition reactions e.g. catalytic hydrogenation, halogenation, hydrohalogenation, addition of sulphuric acid etc.<br>ii) Teacher to explain Markownikov's rule.<br>iii) Teacher to guide students to discuss oxidation reactions of alkenes with bromine, $KMnO_4$ | Charts showing electro philic addition reactions | Is the student able to describe the electrophilic addition reactions of the alkenes? | |
| | d) demonstrate laboratory synthesis of a simple alkene; | Teacher should guide students to prepare a simple alkene in the laboratory. | • Alcohol<br>• Conc. $H_2SO_4$<br>• Beaker | Is the student able to describe the synthesis of ethene? | |
| | e) name alkenes and their isomers up to five carbon atoms. | i) Teacher to explain rules governing naming of alkenes.<br>ii) Students to name alkenes and their isomers up to five carbon atoms using IUPAC system. | Wall chart showing the names of five isomers of alkenes. | Is the student able to name the first five alkenes and their isomers up to five carbon atoms? | |

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| 9.5 Alkynes | By the end of this sub- topic the student should be able to:<br>a) describe the industrial production of alkynes from thermal cracking of heavy alkanes; | Teacher should lead students in discussing the industrial production of alkynes from thermal cracking of heavy alkanes | Wall chart showing production of alkynes from cracking of heavy alkanes. | Is the student able to describe the industrial production of alkynes? | 2 |
| | b) explain the unsaturation in alkynes in terms of sp hybridization; | Students under teacher's guidance to explain unsaturation in alkynes in terms of sp hybridization. | • Wall chart showing the diagrams of sp hybridization.<br>• Atomic models | Is the student able to relate alkyne unsaturation in terms of sp hybridization? | |
| | c) describe the Markownikov's mechanism in electrophilic addition reactions of alkynes; | i) Teacher to explain Markownikov's electrophilic addition reactions of alkynes<br>ii) Students to discuss elecrophilic addition reactions of alkynes. | Charts showing electrophilic addition reactions of alkynes Textbooks | Is the student able to describe the Markownikov' s electrophilic addition reactions of alkynes. | |
| | d) demonstrate laboratory synthesis of a simple alkyne; | Teacher to lead students to demonstrate the laboratory synthesis of ethyne (acetylene) by reacting cold water with calcium carbide. | • $CaC_2$<br>• Water<br>• Hard tube | Is the student able to describe the synthesis of acetylene? | |
| | e) name alkynes and their isomers up to five carbon atoms. | i) Teacher to explain rules governing IUPAC system of naming alkynes.<br>ii) Students to name alkynes upto five carbon atoms. | Wall charts showing the names of alkynes and their isomers | Is the student able to name alkynes and their isomers up to five carbon atoms? | |

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| **10.0 AROMATIC HYDROCARBONS**<br><br>10.1 Sources of Hydrocarbons | By the end of this sub- topic the student should be able to:<br>a) identify different sources of aromatic hydrocarbons; | Teacher should lead students to identify various sources of aromatic hydrocarbons. | • Charts showing different sources of aromatic hydrocarbons<br>• Materials containing aromatic compounds. | Is the student able to identify different sources of aromatic hydrocarbons? | 2 |
| | b) explain the special features of benzene | i) Teachers to introduce the Kekule structure of benzene;<br>ii) Teacher to explain the modern electronic structure of benzene in terms of π electron delocalization and resonance description.<br>iii) Students to prepare pictures and models that describe the structure of benzene. | • Charts showing:<br>• Kekule structure of benzene<br>• Modern structure of benzene ring | Is the student able to explain the special features of benzene? | |
| 10.2 Properties of Aromatic Hydrocarbons | By the end of this sub- topic the student should be able to:<br>a) describe the resonance delocalization of the benzene π system. | Teacher should lead students in the discussion of the resonance/ delocalization of the benzene π system. | Wall charts showing the resonance structure benzene. | Is the student able to describe the resonance/ delocalization of benzene π system? | 4 |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
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| | b) explain electrophilic substitution reactions of benzene | i) Teacher to explain the chemical reactivity of benzene in comparison with alkenes e.g. catalytic hydrogenation, free radical addition, ozonolysis and oxidation.<br>ii) Students to explain why benzene does not form addition products e.g. with hydrogen halides, sulphuric acid and $KMnO_4$.<br>iii) Teacher to lead students in discussing substitution reactions of benzene e.g. nitration, sulphonation, halogenation, Friedel–Crafts alkylation and acylation | Charts showing electrophilic substitution reactions of benzene. | Is the student able to explain electrophilic substitution reactions of benzene? | |
| 10.3 Substituted Benzene | By the end of this sub-topic the student should be able to:<br>a) describe the chemical properties of methyl benzene; | i) Teacher to guide students in the discussion of chemical properties of methyl benzene in comparison with benzene (to include hydrogenation, sulphonation, nitration and Friedel craft alkylation and acylation).<br>ii) Students to explain the effect of the methyl group to the ring. | Wall chart showing various chemical reactions of methyl benzene | Is the student able to describe the chemical properties of methyl benzene? | 4 |

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| | b) explain the effects of substituents on rates and orientation; | i) Teacher to explain factors which activate or deactivate the benzene ring, and factors which determine the orientation of substitution in the benzene ring.<br>ii) Students to explain the effect of substitution in rates and orientations (positions) for further substitutions for the following groups: X (halogens), OH, -R, $NO_2$, -COOH, $-SO_3H$, -CHO, $-CONH_2$.<br>iii) Teacher should lead a discussion on inductive and mesomeric effects in reactions. | • Wall charts showing chemical reactions of substient groups on the position of benzene ring.<br>• Wall chart showing groups which activate and deactivate benzene ring. | Is the student able to explain the effects of substituent groups on the rate of reaction? | |
| | c) explain directive influences in disubstituted benzene. | i) Teacher to explain the directive influences in disubstituted benzenes (rules involved).<br>ii) Students to explain some reactions of disubstituted benzene. | Charts showing directive influences in disubstituted benzene. | Is the student able to explain directive influences in disubstituted benezene? | |
| **11.0 HALOGEN DERIVATIVES OF HYDROCARBONS**<br>11.1 Structure and Nomenlature | By the end of this sub- topic the student should be able to:<br>a) describe the structures of haloalkanes and their isomers; | Teacher to guide students to write the structures of haloalkanes and their isomers. | Wall charts showing structures of haloalkanes and their isomers | Is the student able to describe the structures of haloalkane and their isomers? | 2 |

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| | b) name haloalkanes and their isomers; | i) Students in small groups to discuss how to name haloalkanes using IUPAC system<br>ii) Students to name haloakanes using IUPAC system | Wall chart showing the names of haloalkanes | Is the student able to name haloalkanes and their isomers? | |
| 11.2 Preparation of Haloalkanes | By the end of this sub- topic the student should be able to:<br>a) describe different methods of preparing haloalkanes | i) Teacher to lead a discussion on the methods of preparing the haloakanes<br>ii) Students in small groups to write the chemical reactions involving the preparations of haloalkanes | Wall charts showing chemical reactions involving preparations of haloalkanes | Is the student able to describe different methods of preparing haloalkanes? | 4 |
| | b) describe the polarity of carbon halogen bond | Teacher to lead a discussion on the polarity of carbon halogen bond. | Wall charts showing the polarity of carbon halogen bond | Is the student able to describe the polarity of carbon halogen bond? | |
| 11.3 Chemical Properties | By the end of this sub- topic the student should be able to:<br>a) describe the nucleophilic substitution reactions of haloalkanes | i) Students to name the nucleophilic reagents<br>ii) Teacher to guide students to discuss the nucleophilic substitution reactions of haloalkanes.<br>iii) Students to write the chemical reactions involving nucleophilic substitution of haloalkanes | • $OH^-$<br>• $RO^-$<br>• $CN^-$<br>• $Li[AlH_4]$<br>• $NH_3$ | Is the student able to describe the nucleophillic substitution reactions of haloalkanes? | 4 |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
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| | b) describe the elimination reactions in haloalkanes | i) Teacher to lead a discussion on the elimination reactions in haloalkanes.<br>ii) Students to write the chemical reactions involving elimination reactions in haloalkanes | Wall charts showing elimination reactions of haloalkanes | Is the student able to describe the elimination reactions in haloalkanes? | |
| | c) show the interconvertibility reactions | i) Teacher to guide students to discuss how alkanes, alkenes and alkyne scan be converted to alkyl halides and vice versa.<br>ii) Teacher to lead a discussion on how various conversions can occur through Grignard reagent.<br>iii) Students to do various conversions | Wall charts showing the interconvertibility reactions | Is the student able to show the interconvertibility reactions? | |
| 11.4 Uses and Hazards of Haloalkanes | By the end of this sub-topic the student should be able to:<br>a) describe the uses of haloalkanes; | Teacher to guide students to discuss the uses of halohydrocarbons<br>i) as solvents<br>ii) as insecticides<br>iii) in sythensis of polymers | Wall chart showing the uses of haloalkanes | Is the student able to describe the uses of haloalkanes? | 2 |

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| | b) describe the hazards of haloalkanes. | i) Teacher to lead a discussion on hazards of halohydrocarbons which include:<br>• Damage of liver and causes of cancer due to chlorinated hydrocarbons and chlorofluoro carbons<br>• Ozone layer destruction<br>• Environmental pollution<br>ii) Teacher and students to visit the nearest health centre for more information<br>iii) Teacher and students to visit the land polluted by halohydorcarbons<br>iv) Students under teachers guide to suggest ways of rectifying the land polluted by hydrocarbons | • Pictures<br>• Wall charts showing<br>• Chemical reaction of Ozone layer destruction by haloalkanes<br>Ways of rectifying the land polluted by halohydorcarbons | Is the student able to describe the hazards of haloalkanes? | |
| **12.0 HYDOXYL COMPOUNDS**<br><br>12.1 Structure and Nomenclature | By the end of this sub- topic the student should be able to:<br>a) describe the structure of alcohols and phenols. | i) Teacher to guide students to write the structures of alcohols, phenols and their isomers.<br>ii) Students to write the structures of alcohols and phenols. | Atomic models | Is the student able to describe the structure of alcohols and phenols? | 2 |

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| | b) name alcohols and phenols; | i) Teacher to lead a discussion on how to name alcohols and phenols using IUPAC system.<br>ii) Students to name alcohols and phenols according to IUPAC system. | Wall chart showing names of alcohols and phenols | Is the student able to name alcohols and phenols? | |
| | c) classify alcohols | i) Teacher to guide students to classify alcohols into primary, secondary and tertiary alcohols.<br>ii) Students to distinguish primary, secondary and tertiary alcohols. | Wall chart showing classes of alcohols | Is the student able to classify alcohols? | |
| 12.2 Preparation of Hydroxyl Compounds | By the end of this sub- topic the student should be able to:<br>a) explain the synthesis of hydroxyl compounds; | i) Teacher to guide students to discuss various methods of introducing - OH group into organic molecules.<br>ii) Students under teacher's guidance to write various conventional methods of introducing -OH group into the organic molecules.<br>iii) Teacher to guide students to discuss Grignard synthesis of alcohols | • Wall charts showing various methods of introducing -OH group into organic molecules.<br>• Textbooks | Is the student able to explain the synthesis of hydroxyl compounds? | 2 |

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| | | iv) Student under teacher's guidance to practice the method of Grignard synthesis of alcohol. | | | |
| | b) explain industrial preparation of hydroxyl compounds | i) Students to discuss how alcohols can be prepared locally<br>ii) Teacher to guide students to discuss how methanol and ethanol are prepared industrially.<br>iii) Students under teacher's supervision to visit the nearby breweries and observe the process of beer production and collect information related to Chemistry. | Wall charts showing industrial preparation of methanol and ethanol.<br>• Starch<br>• Water<br>• Yeast | Is the student able to explain the industrial preparation of hydroxyl compounds? | |
| 12.3 Properties of Hydroxyl Compounds | By the end of this sub- topic the student should be able to:<br>a) explain the physical properties of hydroxyl compounds; | Teacher to guide students to discuss the physical properties of hydroxyl compounds, including<br>i) Polarity of O–H bond<br>ii) The size of alkyl or aryl group on solubility | Atomic model | Is the student able to explain the physical properties of hydroxyl compounds? | 6 |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
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| | b) describe the chemical properties of hydroxyl compounds; | Teacher to guide students to discuss the chemical properties of hydroxyl compounds under the following:<br>i) Comparison of acidity of alcohols and phenol and that of water,<br>ii) Reaction of alcohols with phosphorus trichloride, phosphorus pentachloride and thionyl chloride.<br>iii) Elimination reaction of alcohols,<br>iv) Inter convertibility of alkanols, alkanes, alkenes and alkynes,<br>v) Oxidation reactions.<br>vi) The difference between primary, secondary and tertiary alcohols,<br>vii) Iodoform reaction.<br>viii) Iodoform reaction in detecting structures of alcohols<br>ix) Esterifiction, etherification and reduction reactions.<br>x) Detection of phenols using ferric chloride solution. | • Wall chart showing various reactions of alcohols<br>• pH<br>• Ethanol | Is the student able to describe the chemical properties of hydroxyl compounds? | |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
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| | | xi) Electrophilic substitution in phenols (halogenation, alkylation, acylation, nitration and sulphonation).<br>xii) Difference between alkanols and phenols. | • Phenol<br>• Propan-2-ol<br>• NaOH<br>• $I_2$<br>• $FeCl_3$<br>• Heat source | | |
| | c) distinguish alkenes from phenols. | Teacher to guide students to describe the differences between alkanols and phenols | Phenol, Ethanol, NaOH, $I_2$, $FeCl_3$, Heat source | Is the student able to distinguish alkenes from phenols? | |
| 12.4 Uses and Hazards of Hydroxyl Compounds | By the end of this sub-topic the student should be able to:<br>a) give the uses of hydroxyl compounds; | Teacher to guide students to discuss the uses of alcohols and phenols. | Wall chart showing the uses of hydroxyl compounds | Is the student able to give uses of hydroxyl compounds? | 2 |
| | b) describe hazards of hydroxyl compounds. | Teacher should lead students to discuss the hazards of alcohols and phenols. | Wall charts showing the hazards of hydroxyl compounds | Is the student able to describe hazards of hydroxyl compounds? | |
| **13.0 CARBONYL COMPOUNDS**<br>13.1 Structure and Nomenclature | By the end of this sub- topic the student should be able to:<br>a) describe the carbonyl compounds; | Teacher should lead students to describe the carbonyl compounds i.e the functional groups –CHO and CO. | Wall charts showing carbonyl compounds | Is the student able to describe carbonyl compounds? | 2 |
| | b) name carbonyl compounds. | i) Teacher to explain the rules governing the IUPAC system of naming carbonyl compounds. | Wall charts showing names of carbonyl compounds | Is the student able to name carbonyl compounds? | |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
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| | | ii) Students to name carbonyl compounds and their isomers upto five carbon atoms (name simple aromatic carbonyl compounds). | | | |
| 13.2 Preparation of Carbonyl Compounds | By the end of this sub- topic the student should be able to:<br>a) explain the preparation methods of aldehydes; | Teacher to guide students in explaining methods of preparing aldehydes e.g. oxidation of alcohols (primary) and reduction of carboxylic acid s | • Methanol<br>• $K_2Cr_2O_7$<br>• $H_2SO_4$ | Is the student able to explain preparation methods of aldehydes? | 2 |
| | b) explain the preparation methods of ketones. | Teacher to lead students in explaining methods of preparing ketones e.g. oxidation of alcohols (secondary) and Friedel – Craft acylation. | Wall charts showing methods of preparing ketones | Is the student able to explain preparation methods of ketones? | |
| 13.3 Properties of Carbonyl Compounds. | By the end of this sub- topic the student should be able to:<br>a) describe the physical properties of carbonyl compounds; | i) Teacher to explain the polarity of the C= O bond of the carbonyl group<br>ii) Students to predict the effect of polarity to the physical properties (m.p, b.p. and solubility). | Wall charts showing the table of m.p, b.p and solubility of aldehydes and ketones | Is the student able to describe the physical properties of carbonyl compounds? | 2 |
| | b) explain the chemical reactions of carbonyl compounds. | i) Teacher should lead students to identify aldehydes from ketones. | • Wall charts showing various chemical reactions of aldehydes and ketones | Is the student able to explain the chemical reactions of carbonyl compounds? | |

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| | | ii) Teacher to guide students in explanation of chemical reactions of aldehydes and ketones to include nucleophilic addition, reactions of the alkyl group adjacent to carbonyl carbon atom and redox reactions | • Methanal<br>• Propanone<br>• Benedict's solution<br>• Tollen's reagent<br>• Test tubes | | |
| 13.4 Uses and Hazards of Carbonyl Compounds. | By the end of this sub- topic the student should be able to:<br>a) explain uses of carbonyl compounds; | Teacher to guide students to discuss the uses of carbonyl compounds. | Wall charts showing uses of carbonyl compounds | Is the student able to explain uses of carbonyl compounds? | 2 |
| | b) explain hazards of carbonyl compounds. | Teacher to guide students to discuss the hazards of carbonyl compounds. | Wall charts showing hazards of carbonyl compounds | Is the student able to explain hazards of carbonyl compounds | |
| **14.0 CARBOXYLIC ACIDS AND DERIVATIVES**<br><br>14.1 Carboxylic Acids | By the end of this sub- topic the student should be able to:<br>a) name carboxylic acids using IUPAC system; | Teacher should guide students to name carboxylic acids using IUPAC system. | Wall chart showing names of carboxylic acids | Is the student able to name carboxylic acids using IUPAC system? | 6 |
| | b) describe the carboxyl group in carboxylic acids; | Teacher should lead students to discuss about the resonance in the carboxyl functional group. | • Acetic acid<br>• Oxalic acid | Is the student able to describe the carboxyl group in carboxylic acids? | |

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| | c) explain preparation methods of carboxylic acids; | Students to prepare ethanoic acid in the laboratory. | • Ethanol<br>• $K_2Cr_2O_7$<br>• Dil.HCl | Is the student able to explain preparation methods of carboxylic acids? | |
| | d) explain properties of carboxylic acids; | i) Teacher to guide students to discuss the properties of carboxylic acids<br>ii) Students to discuss the contribution of hydrogen bonding in the physical properties of carboxylic acids | • Acetic acid<br>• Oxalic acid | Is the student able to explain properties of carboxylic acids? | |
| | e) explain uses and hazards of carboxylic acids. | Students in small groups to discuss the uses and hazards of carboxylic acids. | Wall charts showing uses and hazards of carboxylic acids. | Is the student able to explain uses and hazards of carboxylic acids? | |
| 14.2 Esters | By the end of this sub- topic the student should be able to:<br>a) name esters; | Teacher to guide students to name esters according to IUPAC system. | Wall charts showing name of esters | Is the student able to name esters? | 4 |
| | b) describe esters; | Teacher should lead students in the discussion about the resonance and delocalization of carboxylate group. | Ethylmethanoate | Is the student able to describe esters? | |
| | c) explain the properties of esters; | Students under teachers guide to discuss the chemical properties of ester including hydrolysis,trans esterification, alcoholysis, | Wallcharts showing various chemical properties of esters | Is the student ableto explain the properties of esters? | |

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| | | reduction with $LiAlH_4$ and reaction with Grignard reagent. | | | |
| | d) explain the uses of esters. | Students to discuss the uses of esters as organic solvents and in the manufacture of soap. | Wall charts showing uses of esters | Is the student able to explain the uses of esters? | |

## FORM VI

### General Competences

By the end of the Form VI Chemistry course, students should have the ability to:

1. apply mathematical principles to understand qualitative and quantitative chemical processes;
2. use Chemistry knowledge and skills to solve social and environmental problems;
3. apply the principles of science and technology to carry out scientific investigations and analysis;
4. carry out investigations on organic compounds and their uses in everyday life;
5. use soil kits to study the properties of soils and propose proper remedial measures.

### General Objectives

By the end of the Form VI Chemistry course, students should be able to:

a) explain how the factors of concentration, pressure, energy and catalyst affect the rate of Chemical reactions;
b) maximize the formation of products in equilibrium reactions;
c) compare and contrast different methods for the extraction of elements from their natural sources;
d) describe the nature and the principles involved in the aquatic, terrestrial and aerial pollution;
e) use scientific knowledge and skills to study the chemical nature and properties of soils;
f) describe the major principles of Organic Chemistry;

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING ANDLEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
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| **1.0 CHEMICAL EQUIILIBRIUM**<br><br>1.1 Reversible Reactions | By the end of this sub- topic the student should be able to:<br>a) explain the concept of reversible reactions and dynamic equilibrium; | i) Teacher to guide students to discuss the principles of reversible reactions and dynamic equilibrium.<br>ii) Students to demonstrate reversible reaction by adding dilute HCl on BiCl3.<br>iii) Students to draw energy diagram to show there action path ways for reversible and irreversible reactions. | • Energy level diagram of reversible reaction<br>• Dil.HCl<br>• $BiCl_3$ | Is the student able to explain the concept of reversible reactions and dynamic equilibrium? | 2 |
| | b) describe the law of Mass Action. | Teacher should lead students to derive the equilibrium Law, also known as the Law of Mass Action, from an equilibrium reaction and its balanced equation | • Ethanol<br>• Ethanoic acid | Is the student able to describe the law of Mass Action? | |
| 1.2 Equilibrium Constant | By the end of this sub- topic the student should be able to:<br>a) explain the concept of equilibrium constant in terms of concentrations, $K_C$, and partial pressures, Kp. | Teacher to guide students to discuss equilibrium constant in terms of concentration, Kc and partial pressures, Kp | • Charts showing reaction between $H_2$ and $I_2$<br>• Charts showing decomposing $N_2O_4$ | Is the student able to explain the concept of equilibrium constant in terms of Kc and Kp? | 4 |
| | b) derive equilibrium constants, $K_c$ and $K_p$ | Students to derive expressions for $K_c$ and $K_p$ from first principles, and establish their relationships. | • $N_2O4$<br>• $H_2$<br>• $I_2$ | Is the student able to derive equilibrium constants Kc and Kp? | |

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| | c) use equilibrium constants to determine the quantities of reacting substances and their products. | Students to carry out experiments on the use of equilibrium constant to find out the equilibrium concentrations of reactants and products in an equilibrium reaction. | • Ethanol<br>• Ethanoic acid | Is the student able to use equilibrium constants to determine the quantities of reacting substances and their products. | |
| 1.3 Factors Affecting Chemical Equilibium | By the end of this sub-topic the student should be able to:<br>a) Explain the meaning of Le Chatelier's Principle to industrial processes | Teacher should lead students to discuss the meaning of industrial significance of the Le Chetelier's Principle | Diagrams showing Harber process and Contact process | Is the student able to explain Le Chatelier's Principle to industrial processes? | 4 |
| | b) explain how different factors affect the position of a chemical equilibrium; | Students to discuss in small groups how the position of chemical equilibrium can be affected by:<br>i) Temperature<br>ii) Pressure<br>iii) Concentration<br>iv) Catalyst. | • Platinum<br>• Source of heat<br>• Pictures<br>• Diagrams | Is the student able to explain how different factors affect the position of chemical equilibrium? | |
| | c) apply the Le Chatelier's principle to industrial processes. | Students to discuss the industrial application of the Le Chatelier's Principle in the following industrial processes<br>i) Haber process for the synthesis of ammonia; | • $NH_3$<br>• $H_2SO_4$<br>• Diagrams<br>• Pictures | Is the student able to apply Le Chatelier's principle to industrial processes? | |

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| | | ii) Contact process for the synthesis of sulphur trioxide, which is used to produce sulphuric acid. | | | |
| **2.0 CHEMICAL KINETICS**<br><br>2.1 Factors Affecting the Rate of a Chemical Reaction | By the end of this sub- topic the student should be able to:<br>a) explain howa chemical reaction may be affected by different factors; | Teacher to guide students to discusson how the following factors affect the rate of a chemical reaction:<br>i) Concentration<br>ii) Temperature<br>iii) Pressure<br>iv) Catalyst<br>v) Physical state of aggregation<br>vi) Light | • $MnO_2$<br>• $KMnO_4$<br>• Heat source | Is the student able to explain factors which affect the rate of a chemical reaction? | 6 |
| | b) explain the kinetic nature of reacting substances; | Students to discuss the kinetic behaviour of solid, liquid and gaseous substances at different temperature conditions. | • Marble Chips<br>• Powdered calcium carbonate<br>• HCl and $NH_3$ | Is the student able to explain the Kinetic nature of reacting substances? | |
| | c) use Arrhenius equation to determine activation energy Ea, and rate constant. | Teacher to lead students to demonstrate experimentally the application of the Arrhenius equation to find activation energy, $E_a$, and the rate constant of a chemical reaction, K. | • Glassware<br>• HI<br>• $KMnO_4$<br>• $H_2C_2O_4$ | Is the student able to use Arhenius equation to determine activation energy, Ea, and rate constant. | |

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| 2.2 Order of Reaction | By the end of this sub-topic the student should be able to:<br>a) explain the concept of order of reaction; | i) Teacher to guide students to discuss the concept of order of reaction<br>ii) Students to differentiate the concepts of molecularity and order of a chemical reaction. | • Glassware<br>• $H_2SO_4$ | Is the student able to explain the concept of order of reaction? | 6 |
| | b) relate the rate determining step to the order of reaction; | Students to discuss the relationship between the order of a reaction and its rate determining step. | • $H_2O_2$<br>• $N_2O_5$<br>• Wall chart<br>• Pictures | Is the student able to relate the rate determine step to the order of reaction? | |
| | c) describe the mechanism of a reaction in relation to its molecularity; | Teacher to guide students to derive the relationship between the mechanism of a reaction and its molecularity. | • HI<br>• $Na_2S_2O_3$ | Is the student able to describe mechanism of a reaction in relation to its molecularity. | |
| | d) derive expressions for $1^{st}$ and $2^{nd}$ order reactions; | Students to demonstrate experimentally how to derive expression for the first and second order reactions. | • $H_2O_2$<br>• $NO_2$ | Is the student able to derive expressions for $1^{st}$ and $2^{nd}$ order reactions? | |
| | e) determine 1st and $2^{nd}$ order reactions experimentally. | Students to engage the integrated rate law to derive expressions for the $1^{st}$ and $2^{nd}$ order reactions. | • $Na_2SO_2$<br>• HCl<br>• Stop watch | Is the student able to determine 1st and 2nd order reactions experimentally? | |

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| **3.0 ELECTRO CHEMISTRY**<br><br>3.1 Oxidation and Reduction | By the end of this sub- topic the student should be able to:<br>a) differentiate oxidation and reduction reactions; | i) Teacher to guide students to discuss the concepts of oxidation and reduction in terms of electron transfer and change of oxidation state in reactions.<br>ii) Students to give varied examples of oxidation and reduction reactions. | • Rusted iron<br>• $FeCl_2$ | Is the student able to differentiate oxidation and reduction reaction? | 10 |
| | b) balance oxidation and reduction half reactions; | Students to write molecular and ionic balanced reaction equations for the following chemical reactions<br>i) Reduction of an acidified potassium permanganate by sodium nitrite;<br>ii) Reduction of a solution of sodium dichromate with potassium bromide;<br>iii) Oxidation of an oxalic acid solution using acidified potassium permanganate;<br>iv) Oxidation of sodium thiosulphate from in directly liberated iodine;<br>v) An acidified mixture of KI and $KIO_3$ oxidizes sodium thiosulphate solution. | • $KIO_3$<br>• $KMnO_4$<br>• $Na_2Cr_2O_7$<br>• $H_2(COO)_2$<br>• $Na_2S_2O_3 . 5H_2O$ | Is the student able to balance oxidation and reduction half reactions? | |

| TOPICS/ SUB TOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
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| | c) perform redox titrations; | Students should carry out practical experiments for each of the redox reactions. | • KI<br>• KMnO4<br>• $H_2C_2O_4$ | Is the student able to perform various redox titrations? | |
| | d) explain the effects of electricity on electrolytes (Faraday's Laws of electrolysis); | i) Students to demonstrate experimentally the Laws of electrolysis by using metal and inert electrodes;<br>ii) Students to compare the quantity of electricity supplied with the amount of substance liberated during electrolysis. | • Metal electrodes<br>• Inert electrodes<br>• $CuSO_4$<br>• HCl<br>• $H_2SO_4$ | Is the student able to explain the effects of electricity on electrolytes? | |
| | e) explain corrosion as a redox reaction; | Students to discuss the conditions and the balanced ionic equations for the corrosion of iron. | • Galvanized iron<br>• Iron<br>• Rusted iron<br>• Pictures | Is the student able to explain corrosion as a redox reaction? | |
| | f) compare the mechanism of iron corrosion protection by zinc and tin. | i) Students to discuss the conditions and the balanced ionic equations for the protection of corrosion through galvanization and through cathodic protection using a sacrificial anode;<br>ii) Students should compare the efficiency of corrosion protection by galvanization and by tin coating. | • Tin<br>• Zinc<br>• Diagrams<br>• Wallcharts | Is the student able to compare the mechanism of iron corrosion protection by zinc and tin? | |

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| 3.2 The Nernst Equation | By the end of this sub- topic the student should be able to:<br>a) explain standard electrode potentials. | Teacher should lead students to discuss the concept of standard electrode potentials and their significance. | • Wall chart showing cells<br>• Textbooks<br>• Pictures | Is the student able to explain standard electrode potentials | 6 |
| | b) explain the effect of varying electrolyte concentration on the emf of a cell; | Students to demonstrate experimentally the production of emf by varying the concentrations of electrolytes. | • $CuSO_4$<br>• $ZnCl_2$<br>• Gulvanoic cell | Is the student able to explain the effect of varying electrolyte concentration on the emf of a cell? | |
| | c) determine the emf of a cell by using the Nernst equation; | Teacher to guide students on how to use the Nernst equation to find the emf of a cell. | • KI<br>• $CuSO_4$<br>• Diagram showing Daniel and Galvanic cell | Is the student able to determine the emf of a cell by using the Nernst equation? | |
| | d) calculate equilibrium constants for redox reactions. | Students to calculate equilibrium constants for redox reactions. | • $CuSO_4$<br>• $ZnCl_2$<br>• KI | Is the student able to calculate equilibrium constants for redox reactions? | |
| 3.3 Electrolytes in Solutions | By the end of this sub- topic the student should be able to:<br>a) use the Van't Hoff factor-i, in the calculation of the degree of ionization; | Students should demonstrate experimentally how to find the degree of ionization of an electrolyte by using the Van't Hoff factor-i, and carry out related calculations. | • $K_4Fe(CN)_6$<br>• $C_2H_4O_2$ | Is the student able to use the Van't Hoff factor-i, in the calculation of the degree of ionization? | 4 |

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| | b) describe the electrical conductivity of solutions of electrolytes. | i) Teacher to guide students to discuss the concept and principles of Ostwald's dilution.<br>ii) Students in small groups to discuss specific conductance and molar conductance.<br>iii) Teacher to guide students to describe the conductance of weak and strong electroytes at infinite dilution. | • Conductance bridges<br>• Electroytes | Is the student able to describe the electrical conductivity of solutions of electrolyte? | |
| **4.0 ACIDS, BASES AND SALTS**<br>4.1 Acids and Bases | By the end of this sub- topic the student should be able to:<br>a) explain the Arrhenius concept of acids and bases; | Teacher to guide students in the discussion of Arrhenius concept of acids and bases. | • Water<br>• Wood ash<br>• Lemons<br>• Charts<br>• Pictures<br>• Beakers<br>• Acids<br>• bases | Is the student able to explain the Arrhenius concept of acids and bases? | 2 |
| | b) explain the Lowry- Bronsted concept of acids and bases; | i) Students to discuss the conjugate acid base pairs.<br>ii) Teacher to guide students to discuss several examples of conjugate acid base pairs based on the donation and acceptance of a proton. | • Weak acid<br>• Strong acid Weak base<br>• Strong base | Is the student able to explain the Lowry-Bronsted concept of acids and bases? | |

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| | c) explain the Lewis concept of acids and bases. | Teacher should lead students to discuss the Lewis concept of acids and bases. | • Diagrams<br>• Magic marker | Is the student able to explain the Lewis concept of acids and bases? | |
| 4.2 Ionic Equilibrium of Acids and Bases | By the end of this sub- topic the student should be able to:<br>a) explain the ionization of weak acids in water, leading to the acid dissociation constant, $K_a$ | i) Teacher to guide students through group discussion to explain ionization of a weak acid in water.<br>ii) Teacher to lead students in derivation of acid dissociation constant, $K_a$ , in relation to hydrogen ion concentration.<br>iii) Students to carry out calculations related to $K_a$ | Textbooks | Is the student able to explain the ionization of weak acids in water, leading to the acid dissociation constant, $K_a$? | 6 |
| | b) explain the ionization of a weak base in water, leading to the base dissociation constant, $K_b$ | Teacher to guide students in discussing the ionization of a weak bases in water leading to dissociation constant for a weak base, $K_b$ . | Textbooks | Is the student able to explain the ionization of a weak base in water, leading to the base dissociation constant, Kb? | |
| | c) carry out calculations based on $K_a$ and $K_b$. | i) Students to carry out calculations based on $K_b$.<br>ii) Teacher summarize few calculations on $K_a$ and $K_b$. | Textbooks | Is the student able to carry out calculations based on $K_a$ and $K_b$? | |

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| 4.3 Ionic Product of Water and pH | By the end of this sub- topic the student should be able to:<br>a) derive the expression for $K_W$; | Teacher to guide students in the derivation of ionic product of water, $K_W$ i.e. $K_W = [H^+][OH^-]$ | Textbooks | Is the student able to derive the expression for $K_W$? | 2 |
| | b) express the strength of a solution in terms of pH and pOH; | Teacher to supervise students on carrying out calculations based in pH and pOH.<br>Note: pKw = pH + pOH. | Diagram of pH scale | Is the student able to express the strength of a solution in terms of pH and pOH? | |
| | c) carry out calculations based on pH and pOH. | Students to carry out calculations based on pH and pOH. | Textbooks | Is the student able to carry out calculations based on pH and pOH? | |
| 4.4 Buffer Solutions | By the end of this sub- topic the student should be able to:<br>a) explain the concept of a buffer solution; | i) Students to brainstorm on the concept of buffer solutions giving examples.<br>ii) Teacher to summarise the concept of buffer solutions. | Acetic acid/sodium acetate ammonia/ammonium chloride | Is the student able to explain the concept of a buffer solution? | 4 |
| | b) describe the properties of buffer solutions; | Teacher to guide students in the discussion of properties of buffer solution. | Charts showing how buffer works when small amounts of base and acid are mixed. | Is the student able to describe the properties of buffer solutions? | |
| | c) prepare buffer solutions; | Students under teacher's guidance to prepare buffers from weak acid and its salt, and from a weak base and its salt. | • Acetic acid/sodium acetate<br>• Ammonia/ammonium chloride. | Is the student able to prepare buffer solutions? | |

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| | d) carry out calculations based on buffer solutions. | Teacher to supervise students carrying out calculations on buffer solutions. | Textbooks | Is the student able to carry out calculations based on buffer solutions? | |
| 4.5 Salt Hydrolysis | By the end of this sub- topic the student should be able to:<br>a) explain the concept of salt hydrolysis; | Teacher to guide students to discuss the concept of salt hydrolysis.<br>i) Salt from weak acid and strong base;<br>ii) Salt from weak base and strong acid;<br>iii) Salt from weak base and weak acid. | • Sodium acetate<br>• Ammonium chloride<br>• Ammonium acetate | Is the student able to explain the concept of salt hydrolysis? | 2 |
| | b) describe the behaviour of salts when hydrolysed. | Teacher to guide students in showing the behaviour of different salts towards litmus when hydrolysed. | • Litmus paper<br>• Universal indicator | Is the student able to describe the behaviour of salts when hydrolysed? | |
| **5.0 SOLUBILITY, SOLUBILITY PRODUCT AND IONIC PRODUCT**<br>5.1 Solubility | By the end of this sub-topic the student should be able to:<br>a) explain the concept of solubility; | Students under teachers guidance to brainstorm on the concept of solubility | • $BaSO_4$<br>• $CaCO_3$ | Is the student able to explain the concept of solubility? | 2 |
| | b) explain common ion effect. | Teacher to guide students to discuss the concept of common ion effect and how it affects solubility of sparingly soluble salts | • AgCl<br>• $AgNO_3$ | Is the student able to explain common ion effect? | |

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| 5.2 Solubility Product | By the end of this sub-topic the student should be able to:<br>a) describe solubility product as an equilibrium constant; | i) Students to discuss solubility product, $K_{sp}$, of a sparingly soluble salt.<br>ii) Teacher to guide students to discuss factors affecting solubility product, Ksp<br>• High concentration<br>• Temperature<br>• Complex formation | • $BaSO_4$<br>• AgCl | Is the student able to describe solubility product as an equilibrium constant? | |
| | b) calculate solubility product of substances; | i) Teacher to guide students in carrying out calculations related to solubility product of salts.<br>ii) Students to carry out calculations related to solubility product of salts. | Textbooks | Is the student able to calculate solubility product of substances? | 4 |
| | c) compare solubility and solubility product. | i) Students to discuss the relationship between solubility and solubility products.<br>ii) Teacher to summarise the contributions given by students. | Wall chart showing relationship between solubility and solubility product. | Is the student able to compare solubility and solubility product? | |
| 5.3 Ionic Product | By the end of this sub-topic the student should be able to:<br>a) explain the concept of ionic product; | Teacher should lead students to discuss the concept of ionic product, Q. | • $Na_2SO_4$<br>• $Ba(NO_3)_2$<br>• Textbooks | Is the student able to explain the conceptof ionic product? | 4 |

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| | b) compare solubility product and ionic product; | i) Students to discuss the relationship of solubility product, Ksp, and ionic product, Q, for sparingly soluble substances.<br>ii) Teacher to summarise the relationship between solubility product and ionic product, that is:<br>• If Ksp < Q ppt occurs<br>• If Ksp > Q no ppt<br>• If Ksp = Q saturated | Charts showing the relationship of solubility product and ionic product | Is the student able to compare solubility product and ionic product? | |
| | c) explain the prediction of precipitation using ionic product and solubility product. | i) Teacher to guide students in the discussion on how solubility product and ionic product can be used to explain precipitation in qualitative analysis.<br>ii) Teacher should lead a discussion on systematic qualitative analysis by group separation.<br>iii) Students to carryout systematic qualitative analysis by group separation. | Qualitative sheet | Is the student able to explain the prediction of precipitation using ionic product and solubility product? | |

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| **6.0 EXTRACTION OF METALS**<br><br>6.1 Extraction of Metal by Thermal Reduction | By the end of this sub- topic the student should be able to:<br>a) describe the natural occurrence of metal ores of the selected elements; | i) Teacher to guide students to discuss the natural occurance of metal ores of Sn, Al and Cu<br>ii) Students to write natural occurrence of metal ores of tin, aluminium and copper. | Wall chart showing natural occurance of metal ores of Sn, Al and Cu. | Is the student able to describe the natural occurrence of metal ores of the selected elements? | 6 |
| | b) describe the preliminary stages of ore concentration; | Teacher should lead a discussion on the preliminary stages of ore concentration<br>i) Crushing<br>ii) Concentration by floatation<br>iii) Roasting in air. | • Wall chart showing preliminary stages of ore concentration<br>• Pictures | Is the student able to describe the preliminary stages of are concentration? | |
| | c) explain the mechanism of thermal reduction; | Teacher to guide students to discuss the mechanisms of thermal reduction. | Textbooks | Is the student able to explain the mechanism of thermal reduction? | |
| | d) describe the chemical reactions involved in the thermal reduction of tin; | i) Teacher should lead a discussion on how Sn can be extracted by Blast furnace.<br>ii) Students to write important reaction equations taking place in the Blast furnace. | Wall chart showing important reaction equations taking place in the Blast furnace. | Is the student able to describe the chemical reactions involved in the thermal reduction of Sn? | |

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| | e) explain why some metals cannot be extracted by thermal reduction method. | i) Teacher to guide students to discuss why some metals can't be extracted by thermal reduction methods.<br>ii) Students to write some metals which can't be extracted by thermal reduction method. | Wall chart showing Metals which can't be extracted by thermal reduction method | Is the student able to explain why some metals can not be extracted by thermal reduction method? | |
| 6.2 Extraction of Metals by Electrolytic Reduction | By the end of this sub- topic the student should be able to:<br>a) explain the criteria for selecting the electrolytic procedure for extracting some metals; | Teacher to guide students to discuss the criteria for selecting electrolytic procedure for extraction of metals. | Wall chart showing activity series | Is the student able to explain the criteria for selecting the electrolytic method of metal extraction? | 6 |
| | b) explain the mechanism of electrolytic reduction; | i) Teacher should lead discussion on the mechanism of electrolytic reduction.<br>ii) Students to write reduction equations. | Wall chart showing reduction equations. | Is the student able to explain the mechanism of electrolytic reduction? | |
| | c) describe the chemical reactions involved in the electrolytic reduction of aluminium and copper; | i) Teacher to guide students to discuss the reactions involved in the electrolytic reduction of Al and Cu.<br>ii) Students to write important reactions taking place at the electrodes. | Wall chart showing chemical equations occurred at the cathode and anode. | Is the student able to describe the chemical reactions involved at the cathode and anode? | |

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| | d) explain why some metal cannot be extracted by electrolytic reduction. | i) Students under teachers guidance to discuss why some metals cannot extracted by electrolytic reduction.<br>ii) Students to write some metals which can't be extracted by electrolytic reduction | Wall chart containing some metals which can't be extracted by the electrolytic reduction. | Is the student able to explain why some metal cannot be extracted by electrolytic method? | |
| **7.0 TRANSITION ELEMENTS**<br><br>7.1 Characteristics of Transition Elements | By the end of this sub- topic the student should be able to:<br>a) describe the concept of transition elements; | i) Teacher to lead students to discuss the concept of transition elements.<br>ii) Students to write electronic configuration of elements with atomic number 21-30.<br>iii) Students to discuss in small groups whether Cu and Zn are transition elements or not. | • Modern periodic table<br>• Wall chart showing electronic configuration of transition elements with atomic number 21–30. | Is the student able to describe the concept of transition elements? | 6 |
| | b) explain the variable oxidation states in transition elements; | i) Teacher should lead a discussion on the variable oxidation states of transition elements.<br>ii) Students to determine the variable oxidation states of transition elements from their different compounds | Wall chart showing variable oxidation states of each transition elements of atomic number 21-30. | Is the student able to explain the variable oxidation states in transition elements? | |

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| | | iii) Teacher to guide students to discuss the cause for variable oxidation states of transition elements. | | | |
| | c) explain the formation of coloured ions; | Teacher should lead discussion on the Crystal Field Theory. | Wall chart showing diagram of spliting d-orbitals. | Is the student able to explain the formation of coloured ions? | |
| | d) explain the formation of complexes in transition elements; | Teacher to lead a discussion on the concept of empty d-orbitals which can be utilized by other elements/ compounds. | • Wall chart showing empty d-orbital of transition elements of atomic number 21 –30.<br>• Transition elements of atomic number 21-30 | Is the student able to explain the formation of complexes in transition elements? | |
| | e) explain the magnetic properties of transition elements; | i) Teacher to guide students to discuss the cause of magnetism in transition elements.<br>ii) Students to classify transition metals as<br>• diamagnetic<br>• Paramagnetic<br>• Ferromagnetic | • Transition elements of atomic number 21-30<br>• Magnetic bar<br>• Wall chart showing elements which are diamagnetic paramagnetic and ferromagnetic. | Is the student able to explain the magnetic properties of transition elements? | |

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| | f) describe the catalytic properties of transition elements. | i) Teacher should lead students to discuss the concept of catalytic properties of transition elements.<br>ii) Students in groups to describe with examples the industrial process where transition elements act as catalysts<br>• Haber process<br>• Contact process<br>• Hydrogenation of oil<br>• Liberation of iodine from potasium iodide. | • Finely divided Fe<br>• $V_2O_5$<br>• Ni<br>• $I_2$<br>• $Fe^{3+}$<br>• $Cu^{+}$<br>• KI | Is the student able to describe the catalytic properties of transition elements? | |
| 7.2 Complex Formation and Ligands | By the end of this sub- topic the student should be able to:<br>a) describe the factors which favour complex ion formation; | Teacher to lead a discussion on the factors that favours the formation of complex ions, which includes:<br>• small ionic radii<br>• utilization of vacant d-orbitals. | Wall chart showing the central metal ion and ligands. | Is the student able to describe the factors favouring complex ion formation? | 6 |
| | b) differentiate an ionic from cationic complexes; | i) Students to give varied examples of cationic and an ionic complexes.<br>ii) Students to differentiate cationic complexes from an ionic complexes. | Wall chart showing cationic and an ionic complexes | Is the student able to differentiate an ionic from cationic complexes? | |

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| | c) describe the positive, negative and neutral ligands; | i) Teacher should guide students to discuss the concept of ligands.<br>ii) Students in small groups to discuss and classify positive, negative and neutral ligands. | Wall charts showing positive negative and neutral ligands | Is the student able to describe the positive, negative and neutral ligands? | |
| | d) name complexes using IUPAC system; | i) Teacher should lead students to discuss on how to name complexes according to IUPAC system.<br>ii) Students to name complexes according to IUPAC system. | Wall charts showing the name of complexes. | Is the student able to name complexes using IUPAC system? | |
| | e) explain why some precipitates dissolve in excess alkali, while others do not; | i) Students in groups to prepare solutions of the following salts: $AgNO_3$; $Zn(NO_3)_2$; $Ca(NO_3)_2$; $Pb(NO_3)_2$; $Cu(NO_3)_2$; $Fe(NO_3)_3$; KOH; $Mg(NO_3)_2$<br>ii) To each solution add sodium hydroxide solution in small amount, then in excess.<br>iii) Students to explain why some precipitates dissolve in excess alkali, while others do not. | • $AgNO_3$<br>• $Zn(NO_3)_2$<br>• $Ca(NO_3)_2$<br>• $Pb(NO_3)_2$<br>• $Cu(NO_3)_2$<br>• $Fe(NO_3)_3$<br>• KOH<br>• $Mg(NO_3)_2$ | Is the student able to explain why some precipitates dissolve in excess alkali while others do not? | |

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| | f) draw the shapes of planar, tetrahedral and octahedral complexes. | Teacher to assist students to draw/ sketch the shapes of planar, tetrahedral and octahedral complexes | • $[Ni(CN)_4]^{2+}$<br>• $[Cu(H_2O)_4]^{2+}$<br>• $[Fe(CN)_6]^{4-}$ | Is the student able to draw the shapes of planar, tetrahedral and octahedral complexes? | |
| **8.0 AMINES**<br><br>8.1 Structure and Nomendature | By the end of this sub- topic the student should be able to:<br>a) describe the structures of amines; | Teacher to guide students to write the structure of $1^0$, $2^0$ and $3^0$ amines. | • Atomic models<br>• Wall chart showing the structures of amines | Is the student able to describe the structures of amines? | 2 |
| | b) give the systematic names of amines. | Students in small groups to name amines according to IUPAC system. | Wall charts showing structures and names of amines | Is the students able to give systematic names of amines. | |
| 8.2 Preparation properties and Uses of Amines. | By the end of this sub- topic the student should be able to:<br>a) describe different methods of preparing amines; | Students in small groups to discuss how amines can be prepared by<br>i) Alkylation of ammonia;<br>ii) Reduction of nitro–alkane;<br>iii) Reduction of amides. | • R–X where x = Cl, Br, I<br>• $NH_3$<br>• R–C = N<br>• $H_2$<br>• Ni<br>• Li $[AlH_4]$ | Is the student able to describe different methods of preparing amines? | 4 |
| | b) describe the physical and chemical properties of amines; | Teacher to guide students to discuss<br>i) Physical properties of amines;<br>ii) Chemical properties of amines | Wall charts showing various physical and chemical properties of amines | Is the student able to describe the physical and chemical properties of amines? | |

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| | c) explain the use of amines. | Students in small groups to discuss the uses of amines. | Wall charts showing various uses of amines. | Is the student able to explain the uses of amines? | |
| **9.0 POLYMERS**<br><br>9.1 Concept of Polymers | By the end of this sub- topic the student should be able to:<br>a) describe the concept of polymers; | Teacher to guide student to discuss the concept of polymers. | • Polythene<br>• Polyvinyl chloride<br>• Cotton cellulose<br>• Nylon 6.6<br>• Terylene | Is the student able to describe the concept of polymers? | 4 |
| | b) describe the structures of polymers; | Teacher should lead students to describe the structures of polymers. | Wall charts showing different structures of polymers | Is the student able to describe the structures of polymers? | |
| | c) identify monomers from polymers. | Teacher should lead students to identify monomers from the polymer. | Wall charts showing different structures of polymers | Is the student able to identify monomers from polymers? | |
| 9.2 Types of Polymers | By the end of this sub- topic the student should be able to describe different types of polymers | Teacher to guide students to describe<br>types of polymer i.e.<br>i) Synthetic polymers<br>ii) Natural/ synthetic rubber<br>iii) Vulcanisation | Wall chart showing different types of<br>• Synthetic polymers<br>• Natural/synthetic rubber<br>• Vulcanisation | Is the student able to describe different types of polymers? | 2 |

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| 9.3 Preparation of Synthetic Polymers | By the end of this sub- topic the student should be able to:<br>a) describe additional polymerisation; | Teacher to guide students to discuss how additional polymer are prepared. | • Wall charts showing additional polymers<br>• Pictures | Is the student able to describe additional polymerisation? | 2 |
| | b) describe condensation polymerisation. | Teacher to guide student to discuss how condensation polymers are prepared. | • Wall chart showing condensation polymers<br>• Pictures | Is the student able to describe condensation polymerisation? | |
| 9.4 Properties and Hazards of Polymers | By the end of this sub- topic the student should be able to:<br>a) describe the properties of polymers; | Teacher should lead students to discuss the properties of polymers | Wall charts showing the properties of polymers | Is the student able to describe the properties of polymers? | 2 |
| | b) describe the hazards of polymers. | Students in small groups to discuss the hazards of polymers | Wall charts showing the hazards of polymers | Is the student able to describe the hazards of polymers? | |
| **10.0 ENVIRONMENTAL CHEMISTRY**<br>10.1 Conservation | By the end of this sub- topic the student should be able to:<br>a) explain the meaning and significance of environmental conservation; | Teacher should lead students to discuss environmental conservation by considering the following:<br>i) Protection of mineral ores against over exploitation.<br>ii) Management of industrial chemical wastes before disposal. | Pictures showing mining process | Is the student able to explain the meaning and significance of environmental conservation? | 6 |

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| | b) compare between resource protection and utilization; | Teacher to guide students to discuss the differences between resource protection, utilization and conservation in this respect, mineral ores, coal, natural gas and petroleum should be considered. | • Pictures<br>• Diagrams<br>• Wall charts showing the differences between resource protection and resource utilization. | Is the student able to differentiate resource protection from resource utilization? | |
| | c) describe possible reasons for environmental destruction; | Students in small groups to discuss the following reasons of environmental destruction:<br>i) Agricultural chemicals;<br>ii) Dumping of solid and liquid industrial wastes on the land and into large water masses, engravers, wells and oceans.<br>iii) Opening up gaseous effluents from industry into the air. | • Diagrams<br>• Pictures<br>• Agricultural chemicals | Is the student able to describe possible reasons for environmental destruction? | |
| | d) describe environmental management interventions. | Teacher and students to discuss the following environmental management interventions:<br>i) Chemical treatment of urban sewage<br>ii) Chemical treatment of urban supplies of edible/ portable water. | • $CuSO_4$<br>• Water treatment<br>• Chemicals<br>• Alums | - Is the student able to describe the environmental management interventions? | |

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| | | | | - Is the student able to predict any possible intervention measures for proper environmental management? | |
| 10.2 Pollution | By the end of this sub-topic the student should be able to:<br>a) explain the concept of pollution | Students in small groups to discuss the meaning and significance of pollution in real life situation. | Diagrams and pictures showing polluted land, water and air | Is the student able to explain the concept of pollution? | |
| | b) describe aquatic, terrestrial and aerial pollution and their intervention measures; | i) Students in small groups to discuss the sources of materials which cause aquatic terrestrial and aerial pollution, and how to prevent or manage them<br>ii) Students to discuss the effects of gaseous, terrestrial and aquatic pollution to human and other animals | • Pictures<br>• Diagrams | Is the student able to differentiate aquatic from terrestrial and aerial pollution? | |
| | c) explain the chemical basis of Ozone layer destruction; | Students to collect information from libraries or the internet on the chemical reactions which lead to the destruction of the natural Ozone layer. | • Journals<br>• Diagrams<br>• Wall charts showing equations of the | Is the student able to explain how the Ozone layer is destroyed chemically? | |

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| | | They should write equations for such reactions | natural ozone layer destruction. | | |
| | d) describe the chemical basis of the green house effect; | Students to seek information from libraries or the internet on the chemical reactions of the compounds which cause global warming in the context of green house effect | • Journals<br>• Pictures<br>• Wall charts showing chemical reactions which causes global warming | Is the student able to explain the chemical basis of green house effect? | |
| | e) describe possible intervention measures for proper environmental management. | Teacher to guide students to discuss possible intervention measures for proper environmental management | Wall charts showing possible measures for proper environmental management. | Is the student able to describe possible intervention measures for proper environmental management? | |
| **11.0 SOIL CHEMISTRY**<br><br>11.1 Soil Colloids | By the end of this sub- topic the student should be able to:<br>a) explain the meaning and significance of soil colloids; | Teacher to guide students to discuss the meaning and significance of soil colloids. | • Pictures<br>• Soils | Is the student able to explain the meaning and significance of soil colloids? | 2 |
| | b) describe the properties of soil colloidal particles | Students in small groups to discuss the following properties of colloidal particles<br>i) Surface area | • Pictures<br>• Diagrams | Is the student able to describe the properties of colloidal particles? | |

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| | | ii) Electric charge<br>iii) Ion exchange | | | |
| 11.2 Ion Exchange | By the end of this sub- topic the student should be able to:<br>a) explain the mechanism of ion exchange in a soil; | Teacher to guide students to discuss the mechanism of ion exchange in a soil sample. | • Diagrams<br>• Pictures | Is the student able to explain the mechanism of ion exchange in soil? | 4 |
| | b) describe cation exchange capacity of a soil sample; | Students in small groups to discuss the meaning and significance of the cation exchange capacity of soil. | • Pictures<br>• Textbooks | Is the student able to Describe the cation exchange capacity of soil? | |
| | c) calculate the percentage base saturation of a soil sample. | Teacher to help students in the calculations of the percentage base saturation of different samples of soils, preferably taken from different geographical areas | • Diagrams<br>• Wall charts showing calculations of percentage base saturation of different type of soil. | Is the student able to calculate the percentage base saturation of asoil sample? | |
| 11.3 Soil Reaction | By the end of this sub- topic the student should be able to:<br>a) explain the concept of soil reaction; | Teacher to guide students to discuss the meaning of soil reaction i.e. the soil pH (the acidity and alkalinity of the soil) | • pH meter<br>• Soil kit<br>• Pictures | Is the student able to explain the concept of soil reaction? | 6 |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
|---|---|---|---|---|---|
| | b) explain the significance of soil pH; | i) Students to use soil kit or any other improvised method to measure the pH of a sample of soil.<br>ii) Teacher to guide students to discuss how very high or very low pH of the soil can influence:<br>• Availability of nutrient elements to plants;<br>• The formation of insoluble complex compounds in the soil;<br>• The collapse or growth of the population of micro organisms in the soil;<br>• The roting of plant roots. | • Soil kit<br>• pH meter<br>• Diagrams<br>• Wall charts showing the pH range Vs availability of plant nutrients. | Is the student able to explain the significance of soil pH? | |
| | c) describe the organic and in organic causes of soil acidity. | Students to discuss how the following contribute to the increase of soil acidity.<br>i) Decomposition of organic matter;<br>ii) Presence of soluble aluminium ions, $Al^{3+}$ and iron (III) ion, $Fe^{3+}$ in the soil; | • pH meter<br>• Soil kit<br>• Wall charts showing equations of $Al^{3+}$ and $Fe^{3+}$ how they cause soil acidity. | Is the student able to describe the organic and inorganic causes of soil acidity? | |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING AND LEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBER OF PERIODS |
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| | | iii) Excessive leaching due to irrigation or rainfall;<br>iv) Industrial fertilizers. | | | |
| 11.4 Liming and Liming Materials | By the end of this sub- topic the student should be able to:<br>a) explain the meaning and significance of liming; | Students under teacher's guidance to discuss the meaning and significance of liming as a treatment to soil pH | Fertile and infertile soils. | Is the student able to explain the meaning and significance of liming? | 4 |
| | b) describe the efficiency of liming materials; | Students to discuss the neutralizing values of carbonates, oxides, hydroxides and silicates | • $CaCO_3$<br>• CaO<br>• $Ca(OH)_2$<br>• $CaSiO_3$ | Is the student able to describe the efficiency of liming materials? | |
| | c) describe the beneficial effects of liming; | Students in small groups to discuss the beneficial effects of liming. | • CaO<br>• $CaCO_3$ | Is the student able to explain the beneficial effects of liming? | |
| | d) outline the detrimental effects of overliming; | i) Students in small groups to discuss the detrimental effects of overliming;<br>ii) Students to carry out projects to study the relative growth of plants under different pH conditions i.e. strongly acidic, weakly acidic, neutral; weakly basic and strongly basic. | • pH meter<br>• Soilkit<br>• CaO<br>• $CaCO_3$ | Is the student able to describe the detrimental effects of overliming? | |

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| 11.5 Fertilizers and Manures | By the end of this sub- topic the student should be able to:<br>a) explain the similarities and differences between fertilizers and manures; | Students in small groups to discuss the differences and similarities between industrial fertilizers and manures. | • Fertilizers<br>• Organic manures | Is the student able to differentiate manures from fertilizers? | 4 |
| | b) mention the commonly used N, P and K fertilizers; | Students to mention the advantages of straight and mixed fertilizers of N, P and K. | Mixed and straight fertilizers | Is the student able to mention the commonly used N, P and K fertilizers? | |
| | c) classify straight and mixed fertilizers | Students to mention example of straight and mixed fertilizers and classify them. | Mixed and straight fertilizers | Is the student able to classify straight and mixed fertilizers. | |
| **12.0 CHEMICAL ANALYSIS**<br>12.1 Volumetric Analysis | By the end of this sub- topic the student should be able to:<br>a) standardize an acid using a standard base; | Students to carry out volumetric analysis to standardize an acid using a standard base ($Na_2CO_3$). | • $Na_2CO_3$<br>• dil.HCl<br>• glassware<br>• M.O | Is the student able to standardize an acid using a standard base? | 20 |
| | b) standardise a base using a standard acid; | Students to carry out volumetric analysis to standardize an alkali using a standard acid, (oxalic acid) | • Oxalic acid<br>• NaOH<br>• P.O.P<br>• Glassware | Is the student able to standardize a base using a standard acid? | |

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| | c) determine volume of HCl used when $Na_2CO_3$ is titrated against HCl using P.O.P. and M.O indicators; | Students to determine volume of HCl used when $Na_2CO_3$ is tritated against HCl using P.O.P. and M.O indicators. | • Dil. H.Cl<br>• $Na_2CO_3$<br>• P.O.P<br>• M.O | Is the student able to determine volume of HCl used when $Na_2CO_3$ is tritrated against HCl using P.O.P and M. O? | |
| | d) determine the proportions in a mixture by the double indicator method; | Students to determine through volumetric analysis the proportions of sodium carbonate and sodium hydroxide in a mixture by double indicator method. | • $Na_2CO_3$<br>• M.O<br>• NaOH<br>• POP<br>• HCl | Is the student able to Determine the proportions in a mixture by the double indicator method | |
| | e) standardize sodium thiosulphate using potassium permanganate; | Students to standardize sodium thiosulphate by potassium permanganate. | • $KMnO_4$<br>• Sodium thiosuphate<br>• dil-$H_2SO_4$ | Is the student able to standardize sodium thiosulpahate by using potassium permanganate? | |
| | f) standardize sodium thiosulphate using potassium iodate; | Students to standardize sodium thiosulphate by using potassium iodate by volumetric method. | • $KIO_3$<br>• Sodium thiosulphate<br>• KI<br>• Starch | Is the student able to standardize sodium thiosulphate using $KIO_3$? | |
| | g) carry out a volumetric estimation of copper in copper (II) sulphate. | Students to carry out experimentally the volumetric estimation of copper in copper (II) sulphate by the indirect method of iodine production. | • $CuSO_4$<br>• $I_2$ | Is the student able to carry out volumetric estimation of copper? | |

| TOPICS/SUBTOPICS | SPECIFIC OBJECTIVES | TEACHING ANDLEARNING STRATEGIES | TEACHING AND LEARNING RESOURCES | ASSESSMENT | ESTIMATED NUMBEROF PERIODS |
|---|---|---|---|---|---|
| 26.2 Qualitative Analysis | By the end of this sub- topic the student should be able to:<br>a) explain the meaning and significance of qualitative analysis; | Teacher to guide students to discuss the meaning and significance of qualitative analysis. | • Glassware<br>• NaOH<br>• HCl | Is the student able to explain the meaning and significance of qualitative analysis | 20 |
| | b) carry out qualitative analysis to identify cations and anions in a salt or mixture of salts. | Students to carry out systematic qualitative analysis through group analysis to identify cations and anions in a single salt or a mixture of salts. | • HCl<br>• $H_2S$<br>• NaOH<br>• $NH_4OH$ | Is the student able to carry out qualitative analysis to identity cations and anions in a salt or mixture of salts? | |
| 26.3 Physical Chemistry Analysis | By the end of this sub-topic the student should be able to:<br>a) determine the order of a reaction experimentally; | Students to carryout experiments to verify first and second order chemical rections. | • HI<br>• Ester<br>• $Na_2S_2O_3$<br>• $HCl/HNO_3$ | Is the student able to determine the order of reactions experimentally? | 20 |
| | b) determine activation energy, $E_a$, experimentally; | Students to carryout several experiments to determine the activation energy, $E_a$, of a chemical reaction. | • Glassware<br>• Heat source<br>• Water bath<br>• $Na_2S_2O_3$<br>• HCl<br>• $H_2C_2O_4$<br>• $KMnO_4$ | Is the student able to determine activation energy of a reaction experimentally? | |

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| | c) use the partition law to establish the distribution of a substance between two phases; | Students to carryout experiments to verify the partition law, where a substance is distributed between two layers or phases | • $NH_3$ between water and $CHCl_3$<br>• $NH_3$ between water and isobutyl alcohol | Is the student able to explain the distribution of a substances between two layers? | |
| | d) determine heats of reaction. | Students to carryout experiments to determine the following heats of reactions<br>• Heat of reaction<br>• Heat of neutralization<br>• Heat of disolution | • $NH_4Cl$<br>• Mg<br>• $MgCO_3$<br>• HCl<br>• NaOH<br>• $H_2SO_4$ | Is the student able to determine heats of reaction experimentally? | |

Qualitative analysis shall test the identification of the following an ions:

- Sulphate: $SO_4^{2-}$
- Carbonate: $CO_3^{2-}$
- Hydrogen carbonate $HCO_3^-$
- Nitrate: $NO_3^-$
- Nitrite $NO_2^-$
- Chloride: $Cl^-$
- Chromate: $CrO_4^{2-}$
- Dichromate $Cr_2O_7^{2-}$
- Oxalate $C_2O_4^{2-}$
- Acetate $CH_3COO^-$

Qualitative analysis shall also test the identification of the following cations through group separation analysis

**Table for Group Separation**

| Analytical groups | Ions of solution precipitated | Nature of precipitates |
|---|---|---|
| I | $Ag^+$, $Pb^{2+}$ | Chlorides |
| II | $Cu^{2+}$, $Cd^{2+}$, $Bi^{3+}$ | Sulphides |
| II | $Sb^{3+}$, $Sn^{2+}$ | Sulphides |
| III | $Fe^{3+}$, $Al^{3+}$, $Cr^{3+}$ | Hydroxides |
| IV | $Zn^{2+}$, $Mn^{2+}$, $Ni^{2+}$, $Co^{2+}$ | Sulphides |
| V | $Ba^{2+}$, $Ca^{2+}$, $Sr^{2+}$ | Carbonates |
| VI | $Na^+$, $K^+$, $Mg^{2+}$, $NH_4^+$ | No ppt formed |