Republic of Zambia

MINISTRY OF EDUCATION

CHEMISTRY

TEACHING MODULE

FORM 1: TERM 1

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CHEMISTRY
TEACHING MODULE
FORM 1:TERM 1

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Vision

Quality, life- long education for all which is accessible, inclusive and relevant to individual, national and global needs.

Preface

The **Chemistry Teaching Module** for Form 1 is designed to help teachers prepare and deliver competence-based lessons with a comprehensive understanding of Chemistry concepts, fostering a deep appreciation for the role of Chemistry in everyday life and its applications in various fields. This module aims to assist teacher help learners develop analytical thinking, problem-solving skills, and practical laboratory techniques through a structured and progressive learning approach.

This module prescribes on hands-on activities, inquiry-based learning experience, encouraging learners to explore, experiment, and engage in scientific reasoning

The Teaching Module aims to help teachers create a stimulating and supportive learning environment where learners can develop a profound understanding of Chemistry. The module helps guides Teachers on learners which are designed to help learners grow intellectually and personally by preparing them for professions in science and technology as well as for higher education by encouraging curiosity, critical thinking, and practical skills.

It is hoped that this module will inspire learners to explore the fascinating world of Chemistry and appreciate its significance in shaping the future.

Joel Kamoko, (Mr.)
Permanent Secretary- Educational Services
MINISTRY OF EDUCATION

Acknowledgement

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Last but not the least, the commitment and hard work of all the staff at the Curriculum Development Centre in ensuring that this module comes to reality is recognised.

Charles Ndakala, (Dr.)
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MINISTRY OF EDUCATION

Contents

How to use this Module

To effectively use this Chemistry Teaching Module for Form 1:

- Read and familiarise yourself with the module's content, learning activities, and assessment guides.
- Plan your lessons in advance, using the module's suggested teaching and learning activities.
- Use a variety of teaching methods, including demonstrations, discussions, group work, and hands-on experiments.
- Encourage active learning by asking open-ended questions, promoting critical thinking, and fostering problem-solving skills.
- Assess learners learning regularly, using the module's suggested assessment strategies and tools.
- Provide feedback and support to learners, helping them to identify areas for improvement and develop their skills.
- Integrate technology into your teaching, using multimedia resources and interactive simulations to enhance student engagement and understanding.
- Monitor student progress and adjust your teaching strategies as needed, to ensure that all students meet the learning objectives

By following these steps, you can effectively use this Chemistry Teaching Module for Form 1 to support your teaching and promote learning.

Introduction

Chemistry as a fundamental science subject, which plays an important role in shaping learners' understanding of the natural world. As learners transition from upper primary to secondary education, it is necessary to provide them with an all-inclusive and engaging introduction to Chemistry. Therefore, the Chemistry Teaching Module for Form 1 is a comprehensive educational resource designed to support the teaching and learning of Chemistry for learners in their first year of secondary education. It covers fundamental concepts and principles of Chemistry, aligning with the 2024 Chemistry syllabus. The module includes topic and subtopic overviews, suggested teaching and learning materials, environment set-up, learning activities, and assessment guides. Additionally, it incorporates teaching methods and strategies like inquiry-based learning, problem-solving activities, group discussions, hands-on experiments, multimedia resources, and interactive simulations. The aim is to provide a solid foundation in Chemistry, foster critical thinking and problem-solving skills, and inspire further studies in science.

Suggested Teaching and Learning Materials

The study of Chemistry content requires hands-on experiences, visual aids, and interactive resources to strengthen deep understanding and appreciation. To support the teaching and learning of Chemistry in Form 1, the suggested teaching and learning materials are meant to:

- Enhance learner engagement and motivation in Chemistry
- Develop practical skills and laboratory techniques
- Promote critical thinking, problem-solving, and analytical skills
- Support differentiated instruction and inclusive learning

The suggested teaching and learning materials are either artificial or natural. By utilising these suggested teaching and learning materials, teachers can create a dynamic and supportive learning environment that promotes academic excellence, creativity, and scientific literacy in Chemistry for Form 1 learners.

Learning Environment Set Up

To create an effective learning environment for teaching and learning Chemistry and in deepening understanding of the concepts and application in real life context. The learning environment set-up aims to create a safe, inclusive, and engaging space.

- **Natural Environment**: A natural learning environment is a setting where learners explore and learn naturally, often without explicit instruction or formal teaching, such as in school surroundings
- **Man-Made Environment:** Man-made learning environments are intentionally designed safe spaces, such as classrooms, laboratories, and libraries, designed for formal instruction, hands-on activities, and games and songs
- **Technological Learning Environment:** Access educational apps, games, and software for learning, including game-based platforms, virtual platforms, and simulations, to engage learners and promote learning.

Safety in the Learning Environment

Safety in the learning environment is a requirement in learning Chemistry, as learners are exposed to potential hazards during hands-on experiments. Collaboration between teachers, and learners, is important to create a responsible learning environment that promotes scientific inquiry. Guidelines for maintaining a safe learning environment include laboratory safety rules (protocols), risk identification, personal protective equipment, emergency response plans, chemical handling, storage, and disposal, and learner responsibilities. Prioritizing safety minimizes risks, prevents accidents, and ensures a positive learning experience.

Suggested Teaching Methodology

The effective teaching methodologies in STEM Chemistry include:

- **Conducting experiments**: Demonstrate key principles and encourage curiosity among learners.

- **Collaborative learning**: Pair learners to work together, promoting peer-to-peer teaching, discussion, and problem-solving.
- **Conceptual learning:** Connect chemical concepts to everyday life, industry, or current events, making learning relevant and meaningful.
- **Differentiated instructions:** Tailor teaching to meet diverse learning styles, abilities, and interests of different learners.
- **Feedback and reflection:** Encourage learners to reflect on their learning, providing constructive feedback to guide improvement.
- **Inquiry-based learning**: Encourage learners to explore, investigate, and discover chemical concepts through hands-on experiments and activities.
- **Integration of technology:** Use digital tools, simulations, and visualizations to enhance engagement, understanding, and analysis.
- **Problem-based learning**: Present real-world problems or case studies or scenarios, requiring learners to apply chemical knowledge to develop solutions.
- **Project -based learning:** Assign open-ended projects, allowing learners to design, conduct, and present research or applications of chemical concepts.

By implementing these methodologies, a teacher can create an engaging, inclusive, and effective STEM Chemistry learning environment.

Learning Activities

Learning activities are intentional educational experiences aimed at promoting learning, engagement, and achievement among learners. Facilitated by teachers, they help acquire new knowledge, skills, attitudes, and behaviour change. To create an inclusive environment, teachers should use a "**hook**" or problem posing or scenario or key question or case studies to introduce new learning activities in an interactive and interesting way.

Icons used in this Module

This module utilises icons as visual symbols or graphics to represent instructions, enhancing the learning experience for learners. Icons categorize and organise instructions, making navigation easier for teachers.

 Key Terms  Assessment  Discussion

 Activity  Tips

Time Allocation

The standard minimum learner-teacher contact time for Chemistry at secondary school level is 4 hours per week, translating to Six (6) periods with at least two double periods per week. The duration for a single period is 40 minutes. The contact time at Ordinary Secondary school level is planned in such a way as to give ample time for practical activities.

Assessment

- Formative Assessments: To monitor **learner** progress, identify areas of improvement, and adjust instruction to meet **learner** needs.
- Quizzes: Regular quizzes to assess **learner**s' understanding of concepts.
- Tests: Periodic tests to evaluate **learner**s' knowledge and application of Chemistry concepts.
- Class Discussions: Observing **learner**s" participation and engagement in class discussions.
- Laboratory Reports: Evaluating **learner**s' lab**oratory** reports for accuracy, completeness, and understanding.
- Group Work: Assessing **learner**s' ability to work collaboratively and contribute to group tasks.
- Projects**: Evaluating learner**s' **ability to design, conduct, and present a Chemistry project.**
- Presentations: Assessing learners' ability to communicate Chemistry concepts and ideas effectively

Summative Assessments: To evaluate learner learning at the end of a lesson, sub-topic, topic or term, and to provide a comprehensive picture of learner achievement.

- **Unit Tests**: Comprehensive tests to evaluate learners' understanding of Chemistry concepts at the end of each unit.
- **Mock Exams**: Comprehensive exams to evaluate learners' overall understanding of Chemistry concepts at the end of the semester.
- **Practical Tasks**: Assessing learners' laboratory skills and techniques through practical exams.
- **Project-Based Assessments**: Evaluating learners' ability to design, conduct, and present a Chemistry project.

Key Competences

Competence	Descriptors

Competence	Descriptors
Analytical Thinking	• Identify patterns • Compile data, create mental images and address issues • Evaluate solutions
Collaboration	• Solving puzzle in groups • Play with peers to build relationships • Participate in and express themselves through play activities
Communication	• Use mathematical/scientific language in different situations • Express oneself using different media and symbols • Ask for feedback
Critical Thinking	• Ask and answer simple questions • Classify objects according to their attributes • Manipulate different objects • Solve simple problems in life • Match different things according attributes • Arrange objects according to attributes • Compare similarities or differences between objects • Explore the environment • Differentiate good from bad • Recognize and name items in the environment
Environmental Sustainability	• Dispose trash in the designated place. • Adhere to best practices in environmental management. • Identify a clean environment. • Identify types of waste in local environment
Problem Solving	• Make connections/link with the inner world or social environment • Use numeracy patterns and relations to solve problems • Manipulate numbers, shapes and symbols to complete a task

Topic 1: Introduction to Chemistry

Introduction

This topic will explore the significance of Chemistry in our everyday lives. Chemistry is the study of the fundamental components of matter, examining properties, composition, and reactions of substances that make up our lives. From the air we breathe to the food we eat, Chemistry plays an important role in our daily lives. Introduction to Chemistry is the first topic with four sub-topics namely; Branches of Chemistry, Importance of Chemistry, Safety and Waste Management in the Laboratory and Apparatus and Equipment in Chemistry.

General Competences:

- Collaboration
- Communication
- Critical Thinking
- Environmental Sustainability
- Problem Solving

Sub-Topic 1: Branches of Chemistry

Introduction: Chemistry is a science that is classified into several categories that are referred to as branches. The subtopic "Branches of Chemistry" covers an introduction of what Chemistry is and discusses five key branches of Chemistry namely Inorganic Chemistry, Physical Chemistry, Organic Chemistry, Analytical Chemistry and BioChemistry.

Specific Competence:

- Demonstrate understanding of Chemistry.

Key Terms:

- **Branches of Chemistry**- the areas or groups into which the study of Chemistry is categorised.
- **Chemistry**- the study of matter and its properties.
- **Chemical Changes:** Transformations that occur when matter interacts with other matter or energy.
- **Chemical Reactions:** Processes in which one or more substances are converted into new substances.
- **Properties:** Characteristics of matter, such as color, texture, and melting point.
- **Matter:** Anything that has mass and occupies space.
- **Reactivity** - the ability of a substance to undergo a chemical change.

Key Concepts: Main Branches of Chemistry

1. Analytical Chemistry
2. BioChemistry
3. Inorganic Chemistry
4. Organic Chemistry
5. Physical Chemistry

Learning Activities:

Learning Activity 1: **understanding what Chemistry is**

This activity is about exploring what Chemistry is. The focus is on describing Chemistry as a science that deals with the study of matter and its properties under different conditions. The following activities are designed to help learners develop an understanding of what Chemistry is. There are two sub-activities under this activity.

Learning Activity 1.1: Exploring the Definition of Chemistry

This activity is meant to help learner to understand what Chemistry is and its relevance to everyday life.

Suggested Teaching and Learning Materials:

- **Artificial Materials:** board, markers. papers
- **Natural materials:** water, salt, sugar…

Teacher's Roles:

- Introduction the activity by asking learners what they know about Chemistry.
- Ask learners to write their responses on the pieces of paper
- Ask learners to submit the pieces of paper to you
- Ask one learner to read the all the responses
- Provide learners with the consolidated definition of Chemistry, such as, *Chemistry as a science that deals with the study of matter and its properties under different conditions*
- Use a board to break down the definition and explain each component as follows:
  - **Matter**: *anything that has mass and occupies space*
  - ***Properties**: characteristics of matter, such as color, texture, and melting point*
  - ***Different conditions**: various environments, such as temperature, pressure, and concentration*
- Ask learners to suggest everyday substances or objects
- Show learners examples of everyday substances or objects, (e.g., water, salt, sugar, etc.)
- Ask learners to identify the matter and its properties.

Discussion: Discuss how Chemistry is applied in various fields, such as:

- ***Cooking****: understanding chemical reactions and properties of ingredients*
- ***Medicine****: developing new treatments and understanding the chemical properties of drugs*
- ***Environmental science****: studying the chemical properties of pollutants and their impact on the environment*
- Divide learners into small groups
- Ask learners to discuss the following questions:
    1. *How does Chemistry impact our daily lives?*
    2. *What are some examples of Chemistry in action?*
    3. *Why is it important to study Chemistry?*

- Learners writing their responses on the pieces of paper
- Learners submitting the pieces of paper to the teacher
- Individual learner reading the responses from fellow learners
- Learner deepening understanding of the consolidated definition of Chemistry
- Learners suggesting everyday substances or objects such as water, salt, sugar, as they are identifying matter and its properties.

: Learners discussing how Chemistry is applied in various fields, such as: ***Cooking****,* ***Medicine****,* ***Environmental science****:*

- Collaboratively, learners discussing the provided questions

1. *How does Chemistry impact our daily lives?*
2. *What are some examples of Chemistry in action?*
3. *Why is it important to study Chemistry?*

- Observe learners' participation during the group discussion
- Review learners notes and diagrams for understanding of the definition of Chemistry
- Collect and review student examples of Chemistry in everyday life

Activity 1.2: **Lemon Volcano demonstration/ experiment**

This activity will require learners to do a demonstration which depicts chemical reactions that matter undergoes. Learners are required to conduct simple Chemistry experiments to demonstrate key concepts and principles.

Key Question: What comes into your mind when you hear the word Chemistry?

Suggested Teaching and Learning Materials

- **Natural Materials**: Baking soda and lemon juice
- **Artificial Materials**: Beakers, spatulas and petri dishes

Learning Environment Set-up:

- **Natural Environment:** school surroundings
- **Artificial Environment:** classroom

this activity can be conducted outdoor or indoor depending on your preference

Teacher's Roles:

- Introduce the activity by asking learners the following question "*What comes into your mind when you hear the word Chemistry?"*
- Put learners in small groups
- Provide each group with baking soda, lemon juice and other materials needed
- Instruct learners to add a spatula full of baking soda to lemon juice in a beaker and observe what happens

- Learners adding baking soda to lemon juice in a beaker
- Learners observing what happens and write down observations

- Learners making presentations on their observations to the whole class

- Observe if learners are safely and correctly conducting the activity
- Ask questions such as:
  1. *What is the connection between the observations you made during the demonstration and Chemistry?*
  2. *In your own words, explain what Chemistry is.*
- Evaluate learners' understanding of what Chemistry is

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating

Activity 1.3: **investigating what Chemistry is**

This activity will involve learners working in small groups to investigate through research on what Chemistry is. The investinvestigations will be on matter and some of the properties of matter.

Key Question: How are fireworks explosions related to Chemistry?

Suggested Teaching and Learning Materials

- **Artificial Materials**: worksheets

Learning Environment Set-up:

- **Artificial Environment**: classroom/computer laboratory

The computer laboratory should have access to internet for this activity to be interesting and effective for research.

Teacher's Roles:

- Introduce the activity by asking the following key question, *'How are fireworks explosions related to Chemistry?'*
- Put learners in small groups
- Give each group a worksheet with a research question (*Each group can have a worksheet with the research question phrased differently*)
- If there is a computer laboratory with working computers that have access to internet, take the learners to the computer laboratory to research online
- If there are no working computers, ask learners to brainstorm and write down their ideas on the research question given
- Consolidate presentations made by learners and clearly guide on what Chemistry is in relation to matter and its properties

- Learners reading and deepening understanding of the research question on the worksheet provided
- Learners researching online or brainstorming on the research question
- Learners making presentations to the class on their findings

- Observe if learners are working collaboratively in groups
- Observe if all group members are participating and communicating effectively

- Analytical Thinking

- Communication
- Collaboration
- Problem solving

Learning Activity 2: **Investigating the main branches of Chemistry**

The study of Chemistry is categorised into several groups referred to as branches of Chemistry. However, there are five key branches of Chemistry that learners will engage in during their study of Chemistry. To effectively teach the branches of Chemistry, you can incorporate various engaging activities. The following are some of the activities that you can use to help learners investigate the main branches of Chemistry which include; Inorganic Chemistry, Physical Chemistry, Organic Chemistry, Analytical Chemistry and Bio-Chemistry.

Teacher may not be required to engage learners in all the four sub-activities.

Learning Activity 2.1: Exploring the Branches of Chemistry

This activity will help learners to discover the main branches of Chemistry and their applications. The learners will engage, communicate and collaborate as they work towards achieving their tasks. Each group will be given a task to investigate on a specific a branch of Chemistry.

Key Question: what do you know about the branches of Chemistry?

Suggested Teaching and Learning Materials

- **Artificial Materials**: board and markers, Blank paper and pencils for note-taking

Learning Environment Set-up:

- **Artificial Environment**: classroom/computer laboratory

The computer laboratory should have access to internet for this activity to be interesting and effective for research.

Teacher's Roles:

- Introduce the activity by asking learners what they know about the branches of Chemistry
- Ask learners to write their responses on pieces of paper
- Let an individual learner read their responses on the pieces of paper.
- Provide a brief overview of the five main branches of Chemistry:
    1. *Inorganic Chemistry*
    2. *Physical Chemistry*
    3. *Organic Chemistry*
    4. *Analytical Chemistry*
    5. *BioChemistry*
- Show learners examples of applications for each branch of Chemistry.
- Use the board to consolidate the key learning points for each branch.
- Have learners take notes on the key learning points
- Divide learners into small groups.
- Assign each group one of the branches of Chemistry.
- Ask each group to create a poster or presentation that:
    1. *Describe the branch of Chemistry*
    2. *Provide examples of applications*
    3. *Explain the importance of the branch in everyday life*
- Have each group present their poster or presentation.
- Encourage the other groups to ask questions

- Learners writing their responses on pieces of paper
- Individual learner reading responses on the pieces of paper.
- Learner participating during the group activity
- Learner taking notes on the key learning points of the branches of Chemistry
- Learners in groups creating posters or presentations

- Observe learner participation during the group activity
- Review learner notes for understanding of the branches of Chemistry
- Evaluate the posters or presentations for accuracy and completeness

- Analytical Thinking
- Communicating
- Collaborating
- Problem solving

Research Activity2.2: Exploring the Branches of Chemistry

This activity is on researching and understanding the applications, principles, and importance of different branches of Chemistry. This activity will help learners deepen their understanding of branches of Chemistry.

Suggested Teaching and Learning Materials

- **Artificial Materials**: Computers or laptops**,** Whiteboard and markers, Printed copies of the branches of Chemistry
- **Technological Materials:** Applications for each branch e.g. images, simulations, videos, documentaries/case studies

Learning Environment Set-up:

- **Artificial Environment**: classroom / computer laboratory
- **Natural Environment**: school surroundings

The computer laboratory should have access to internet for this activity to be interesting and effective for research.

Teacher's Roles:

- Review the branches of Chemistry with the class.
- Explain the objective of the research activity.
- Provide guidelines for the research and presentation.

- Assign each learner or group one of the branches of Chemistry.
- Have learners research the following topics:
    1. *Definition and principles of the branch*
    2. *Applications and importance in everyday life*
    3. *Key concepts and theories*
    4. *Famous Chemists and their contributions*
- Encourage learners to use credible sources, such as academic journals, books, and reputable websites.
- Have each learner or group create a presentation to share their findings.
- Encourage them to include visual aids, such as diagrams, charts, and images.
- Allow time for questions and discussion after each presentation.

- Learner or group researching on one of the branches of Chemistry with a focus on the following topics:
    1. *Definition and principles of the branch*
    2. *Applications and importance in everyday life*
    3. *Key concepts and theories*
    4. *Famous Chemists and their contributions*
- Learners using credible sources, such as academic journals, books, and reputable websites.
- Learners or group creating a presentation which include visual aids, such as diagrams, charts, and images.
- Learners to make their presentations of their findings
- Learners asking questions and discussion after each presentation.

- Evaluate the research and presentation for accuracy and completeness.
- Assess learners' participation and engagement during the research and presentation.
- Review learners' notes and research guidelines for understanding of the branches of Chemistry.

- Analytical Thinking

- Communication
- Collaboration
- Problem solving

Activity 2.3: **Field Trip**

This activity involves taking learners on a field trip to a local laboratory or industry where different branches of Chemistry are applied. For example, pharmaceutical companies for organic Chemistry and laboratories for analytical Chemistry. Learners will take note of the Chemistry related processes that are carried out in the industry/laboratory and relate them to the branches of Chemistry.

Suggested Teaching and Learning Materials

- **Artificial Materials**: note books, pens and worksheets

Learning Environment Set-up:

- **Artificial Environment**: Chemistry laboratory/industrial site
- **Natural Environment**: surroundings of the visited site

Teacher's Roles:

- Organise a visit to a local laboratory or industry
- Prepare a worksheet instructing learners to write down their observations and identifying the branches of Chemistry that are applied at the site visited
- Give learners a task that they should report on after the visit
- Ensure that the site to be visited is safe for learners
- Caution learners on safety before going on the field trip
- Consolidate the reports by learners after their presentations

- Learners paying attention to safety protocols and guidance
- Learners taking notes during the field trip
- Learners preparing a report to present after the field trip
- Learners making a presentation and justifying the branches of Chemistry identified

- Observe learners adhering to safety guidance given
- Evaluate learners' notes taken during the field trip
- Check for factual information and effective communication as learners present their reports or in their submitted reports

- Analytical Thinking
- Communication
- Collaboration
- Problem solving

Activity 2.4: Interactive Simulations

In this activity, the teacher will use online simulations to demonstrate chemical reactions or molecular structures relevant to each branch of Chemistry (Organic, Inorganic, Physical, Analytical and BioChemistry). Online simulations are software applications that stimulate real life events, scenario or environment for educational purposes. These simulations will enable learners relate the branches to the Chemistry that is studied under each branch. The activity is suitable for concluding the subtopic.

Suggested Teaching and Learning Materials

- **Artificial Materials**: laptop, projector

Learning Environment Set-up:

- **Artificial Environment:** classroom, computer laboratory
- **Technological Environment**: online platforms such as Physics Education Technology (PHET) simulations

PHET simulations are interactive, web-based simulations that allow students to explore and learn about various scientific concepts, including physics, Chemistry, biology, and mathematics.

Teacher's Roles:

- Select appropriate online simulations before hand
- Present the simulations showing chemical reactions or molecular structures relevant to each branch of Chemistry (Organic, Inorganic, Physical, Analytical and BioChemistry)
- Ask learners to relate the simulations shown to the branches of Chemistry

- Learners watching the simulations
- Learners relating the simulations shown to the correct branches of Chemistry
- Learners making additional contributions

- Evaluate if learners are able to relate the simulations shown to the correct branch of Chemistry
- Observe relevance of the questions asked by learners

Explanation (Conceptualisation):
Chemistry is a science that studies the composition, properties, and reactions of matter under various conditions. It is divided into several branches, each focusing on a specific aspect of chemical study. Inorganic Chemistry examines inorganic compounds, while Physical Chemistry explores physical principles underlying chemical reactions. Organic Chemistry studies organic compounds found in living organisms, while Analytical Chemistry focuses on analyzing substances using techniques like chromatography and spectroscopy. BioChemistry examines chemical processes within living organisms, including biomolecule structure and function. Understanding these branches can provide insights into the natural world, develop new technologies, and improve daily life.

- Analytical Thinking
- Communication
- Collaboration
- Problem solving

Expected Standard: Understanding of Chemistry demonstrated accordingly

Branches of Chemistry

Ask learners questions such as;

Part A: Multiple Choice

1. What is the primary focus of Chemistry as a science?
   A) Study of living organisms
   B) Soil contamination only
   C) Study of matter and its properties
   D) Study of the universe
   E) Study of the environment

2. Which branch of Chemistry deals with the study of the composition, properties, and reactions of inorganic compounds?
   A) Organic Chemistry
   B) Inorganic Chemistry
   C) Physical Chemistry
   D) Analytical Chemistry
3. What is the main focus of bioChemistry?
   A) Study of the structure and properties of biomolecules
   B) Study of the chemical reactions that occur in living organisms
   C) Study of the interactions between living organisms and their environment
   D) Study of the chemical composition of living organisms

Part B: Short Answer Questions

1. Describe the main differences between inorganic Chemistry and organic Chemistry.
2. What is the importance of analytical Chemistry in everyday life? Provide at least two examples.
3. Explain the concept of physical Chemistry and its relevance to modern technology.
4. A learner visited a nearby clinic after experiencing headache for two days. After conducting a few tests, it was found that the had malaria. A drug called Coartem was prescribed for treatment.
   (a) Which branch of Chemistry was applied to conduct the test for malaria?
   (b) Which branch of Chemistry was applied in the manufacturing of Coartem?

5. Which branch of Chemistry…
   (a) brings together concepts of physics and Chemistry?
   (b) looks at the study of chemical reactions that occur in living organisms?

Part C: Essay Question
Choose **one** of the main branches of Chemistry (inorganic Chemistry, physical Chemistry, organic Chemistry, analytical Chemistry, or bioChemistry) and describe its significance, applications, and current research trends.


The key learning points under sub-topic ***Branches of Chemistry*** include the following:

- **Chemistry** is the study of matter and its properties under different conditions.
- **Matter** is anything that has mass and occupies space.
- **Properties** of matter include physical properties (e.g. color, texture, melting point) and chemical properties (e.g. reactivity, flammability).
- **Analytical Chemistry** focuses on the qualitative and quantitative analysis of substances to determine their composition and structure. It encompasses a wide range of techniques including distillation, extraction, spectrometry, separation, electrophoresis and chromatography.
- **BioChemistry** is the study of chemical reactions that occur in living organisms. It focuses on key molecules such as lipids, proteins, carbohydrates, neurotransmitters, and nucleic acids, and tries to explain them in chemical terms.
- **Inorganic Chemistry** involves the study of the properties and behaviour of inorganic compounds including metals, minerals, ceramics, crystal structures, catalysts, and most elements in the Periodic Table.
- **Organic Chemistry** is the study of carbon-containing compounds. This branch focuses on the structure, properties, reactions, and synthesis of organic molecules, primarily those composed of carbon and hydrogen.
- **Physical Chemistry** combines principles of physics with chemical systems to understand how matter behaves. It examines the physical properties and changes of substances during chemical reactions.

Note: *Applications of the branches of Chemistry range from analytical laboratories in physical Chemistry to the synthesis of materials such as plastics in organic Chemistry among many others*.

Sub-Topic 2: Importance of Chemistry

Introduction:
This subtopic explores how Chemistry is an essential part of everyday life, and Chemistry related careers. Understanding Chemistry helps individuals make informed decisions and appreciate the science behind daily activities.

Specific Competence:

- Relate the importance of Chemistry to everyday life

:

- **Career** - A professional journey is a person's long-term professional development, often involving education, skill development, and various jobs in a chosen occupation, reflecting their interests, goals, and employment.
- **Food Chemistry:** study of chemical composition, properties, and reactions of food components
- **Medicines** - drugs that are specifically formulated and used for treating health conditions
- **Personal care products:** cosmetics, toiletries, and other products used for personal hygiene and grooming.
- **Pollutant** - any substance that causes pollution e.g. oil spills, garbage, carbon monoxide, particulate matter (particle pollution) etc.
- **Pollution** - the contamination of the environment by harmful substances
- **Sustainability:** practices and processes that minimise harm to the environment and promote human well-being.
- **Volatile organic compounds (OVCs)** - these are chemicals that easily evaporate into a gas or compounds that have a high vapor pressure and low water solubility
- **Waste generation** - this is the amount of materials discarded over a period of time

Key Concepts

- Chemistry Improves Human Life
- Chemistry and the Environment
- Chemistry and Technology
- Chemistry and Society

Learning Activities:

Learning Activity 1.0: **Exploring the importance of Chemistry.**
This activity is designed to help learners explore the importance of Chemistry.

Activity 1.1: Researching the Role of Chemistry in Everyday Life
In this activity, learners will research the role of Chemistry in everyday life by examining personal care products, food, medicine or other Chemistry related products.

HOOK: Have you ever stopped to think about the air you breathe, the water you drink, or the food you eat?

Suggested Teaching and Learning Materials:

- **Artificial Materials:**
  - Samples of personal care products (e.g., shampoo, lotion, sunscreen)
  - Labels from food products including ingredient lists
  - Information sheets on common medications such as ibuprofen or cough syrup

Learning Environment Set-up:

- **Artificial Environment:** classroom / Chemistry laboratory

Teacher's Roles:

- Introduce the activity by using a hook such as "*Have you ever stopped to think about the air you breathe, the water you drink, or the food you eat?"*
- Facilitate the group discussions by providing guidance and prompting questions that encourage deeper thinking about the Chemistry behind everyday products
- Distribute worksheets and explain how to effectively use them to organise research and findings
- Monitor group progress and provide support as needed, ensuring that all learners engage with the material

To formulate a worksheet, start by selecting relevant Chemistry related items such as household cleaners, medicinal drugs or beverages. Structure the worksheet into clear sections (A, B, C ...) with distinct headings for each category. Develop targeted questions that prompt research on key chemical properties, effects, and applications.

- Learners in small groups researching on assigned topics related to personal care products, food, medicine or other Chemistry related products
- Learners using worksheets to gather information, focusing on key chemical principles and their relevance to everyday products
- Learners presenting their findings to the class, ensuring they can explain the Chemistry involved in the products researched

- Evaluate the completed worksheets for clarity, depth of understanding, and relevance of the information gathered
- Assess group presentations based on how well learners articulate their findings and the connections they make to Chemistry
- Use a rubric that includes criteria for content accuracy, presentation skills, and engagement during discussions

Explanation (Conceptualisation):
Chemistry is a fundamental science that plays a significant role in our daily lives, influencing various fields such as healthcare, environmental science, and technology. It is the backbone of healthcare, enabling the development of new medicines and treatments. Chemists study the chemical composition of the atmosphere, oceans, and soil to understand the impact of human activities on the environment. In technology, Chemistry drives advancements in materials and technologies, such as electronics, energy storage devices, and renewable energy sources. These advancements are crucial for our well-being, sustainability, and progress. Overall, Chemistry is essential for our well-being, sustainability, and progress.

- Analytical Thinking
- Collaboration
- Communication
- Critical Thinking

Activity 1.2: Exploring Chemistry career opportunities
In this activity, learners will identify and describe various career paths in Chemistry and their significance to society.

HOOK: Do you want to make a difference in people's lives through innovative solutions? Then a career in Chemistry might be the perfect fit for you!

Suggested Teaching and Learning Materials

- **Artificial Materials**: Online Resources (Career profiles and industry reports),
- **Technological Materials:** Simulations, Videos (Documentaries or short clips related to various Chemistry fields)

Learning Environment Set-up:

- **Natural Environment:** school surroundings
- **Artificial Environment**: classroom
- **Technological Environment**: simulations, or video documentaries or short clips related to various fields of Chemistry

Teacher's Roles:

- Introduce the activity by asking a question, *what careers are related to Chemistry*?
- Divide learners into small groups
- Use the think pair-share strategy
- Provide the artificial materials such as the ones suggested above
- Ask learners to identify and describe Chemistry related careers

- Learners Identifying and describing Chemistry related careers, focusing on the roles, responsibilities, required qualifications, and relevance to societal needs
- Learners presenting findings various career paths in Chemistry and their significance to society

- Observe learner Identifying and describing Chemistry related careers, focusing on the roles, responsibilities, required qualifications, and relevance to societal needs
- Evaluate learners' findings on various career paths in Chemistry and their significance to society

Teacher may take learners outside the school to go and experience real world application of Chemistry in a local industry or factory

Explanation (Conceptualisation):

The following are some of the Chemistry related career paths ways:

- **Academic and Research Positions:** Discuss the roles of chemists in education and research development
- **Agricultural Chemistry:** Understand the role of Chemistry in enhancing agricultural practices sustainably
- **Analytical Chemistry:** Highlight methods for substance analysis and their applications in quality control
- **Biotechnology:** Highlight innovations in biopharmaceuticals and Genetically Modified Organisms (GMOs)
- **Chemical Engineering:** Discuss process design and the importance of safety in large-scale production
- **Cosmetic Science:** Discuss formulation principles and regulatory compliance
- **Environmental Science:** Understand the impact of pollutants and the importance of sustainable practices.
- **Food Chemistry:** Focus on the safety and quality of food production
- **Forensic Science**: Emphasize analytical techniques used in crime scene investigation and the role of Chemistry in law enforcement

- **Materials Science:** Explore the application of Chemistry in developing new materials and their technological implications
- **Nutritional Science:** Discuss the chemical composition of food and its health impacts
- **Petrochemicals:** Emphasize the refining processes and energy efficiency improvements
- **Pharmaceuticals:** Focuses on drug development, regulations surrounding drug safety, and the importance of quality control
- **Public Health**: Emphasize the chemical aspects of health and disease prevention
- **Regulatory Affairs**: Understand the significance of compliance with health and safety regulations
- **Toxicology:** Discuss the importance of studying toxic substances for public safety

The list of career opportunities provided above is not exhaustive. You are encouraged to add to the list.

- Analytical Thinking
- Communication
- Collaboration

Activity 3: Evaluating the impact of chemical processes and products on the environment and human health

In this activity, learners will evaluate the impact of chemical processes and products on the environment and human health. Learners will watch videos on different types of pollution showing their impact on the environment and human health.

HOOK: "The Hidden Dangers of Chemicals: Uncovering the Impact on our Surroundings and Our Bodies

Suggested Teaching and Learning Materials

- **Artificial materials**: videos showing different types of pollution

Learning Environment Set-up

- **Natural Environment**: school surroundings

- **Artificial environment:** Chemistry laboratory/classroom
- **Technological Environment:** online platforms

Teacher ‘s Roles

- Introduce the activity by posing a hook such as "*The Hidden Dangers of Chemicals: Uncovering the Impact on our Surroundings and our Bodies”*
- Ask learners to watch videos on different types of pollution showing their impact on the environment and human health.
- Put learners in small groups
- Ask learners to discuss the impact of chemical pollution on environment and human health, including specific examples and case studies.
- Ask learners to make presentations on the impact of pollution on the environment and human health
- Consolidate the ideas shared by learners

- Learners watching videos on different types of pollution showing their impact on the environment and human health.
- Learner discussing the impact of chemical pollution on environment and human health, including specific examples and case studies.
- Learners making presentations on the impact of pollution on the environment and human health

- Observe learners as they are watching the videos
- Evaluate learner discussing the impact of chemical pollution on environment and human health, including specific examples and case studies.

Explanation (Conceptualisation):

Chemical pollution has significant environmental and human health impacts. It contributes to air and water pollution, soil degradation, and biodiversity loss. It also exacerbates respiratory issues like asthma, increases cancer risk, and can harm brain development and function. Chemicals like pesticides and heavy metals can cause neurological damage and reproductive issues. Specific chemicals include pesticides, heavy metals, volatile organic compounds, and endocrine disruptors. To reduce these impacts, sustainable Chemistry, green Chemistry, regulatory policies, and public awareness are essential. Sustainable Chemistry focuses on designing products and processes that minimise harm to human health and the environment, while green Chemistry focuses on reducing waste and using renewable resources. Regulatory policies aim to limit chemical emissions and promote sustainable practices.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Problem solving

Learning Activity 3.0: Designing solutions to real-world problems using Chemistry
In this activity, learners will identify real-world problems caused by Chemistry and design solutions to them.

Suggested Teaching and Learning Materials

- **Artificial Material**: charts, markers, Bostic, rulers

Learning Environment Set-up

- **Natural Environment**: School surroundings
- **Artificial Environment**: Chemistry laboratory/Classroom / Library

Teacher ‘s Roles

- Introduce the activity
- Put learners in small groups
- Provide the materials
- Ask learners to identify real-world problems caused by Chemistry
- Ask learners to design solutions to the identified problems
- Ask learners to present the designed solutions
- Consolidate on the presentation by learners

- Identify real-world problems caused by Chemistry
- Design solutions to the identified problems
- Present the designed solutions

- Evaluate learners discuss the environmental and human health impacts of chemical pollution, and explain how sustainable Chemistry and green Chemistry can help reduce these impacts.
- Evaluate learners as they describe the role of regulatory policies and public awareness in reducing chemical pollution, and provide examples of successful initiatives.

Explanation (Conceptualisation):

Chemical pollution has significant environmental and human health impacts. It contributes to air and water pollution, soil degradation, and biodiversity loss. It also exacerbates respiratory issues like asthma, increases cancer risk, and can harm brain development and function. Chemicals like pesticides and heavy metals can cause neurological damage and reproductive issues. Specific chemicals include pesticides, heavy metals, volatile organic compounds, and endocrine disruptors. To reduce these impacts, sustainable Chemistry, green Chemistry, regulatory policies, and public awareness are essential. Sustainable Chemistry focuses on designing products and processes that minimise harm to human health and the environment, while green Chemistry focuses on reducing waste and using renewable resources. Regulatory policies aim to limit chemical emissions and promote sustainable practices.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Problem solving

Expected Standard: The importance of Chemistry to everyday life related correctly

The Role of Chemistry in Everyday Life

Ask learners questions such as:

Part A: Multiple Choice Questions

1. What is the primary role of Chemistry in everyday life?

    A) To develop new materials and products
    B) To improve human health and the environment
    C) To provide energy and food
    D) All of the above

2. Which of the following personal care products relies heavily on Chemistry?
    A) Soap
    B) Toothpaste
    C) Shampoo
    D) All of the above
3. What is the impact of chemical processes on the environment?
    A) They have no impact
    B) They have a positive impact
    C) They have a negative impact
    D) It depends on the process

Part B: Short Answer Questions

1. Describe the role of Chemistry in food production and processing.
2. Evaluate the impact of chemical products on human health. Provide at least two examples.
3. Explain how Chemistry can be used to design sustainable solutions to real-world problems.

Part C: Case Study

Choose a real-world problem, such as climate change, water pollution, or disease. Research and design a solution to the problem using Chemistry. Your solution should include:

1. A clear description of the problem and its impact on the environment and human health.
2. A detailed explanation of the chemical processes and products involved in your solution.
3. An evaluation of the potential benefits and drawbacks of your solution.

Importance of Chemistry

- Chemistry plays a vital role in our daily lives, from personal care products to food and medicine.
- Chemistry helps us understand the world around us, from the air we breathe to the water we drink.
- Chemistry is essential for solving real-world problems, such as climate change, disease, and sustainable energy.

Role of Chemistry in Everyday Life

- Personal care products: Chemistry is used in the development of cosmetics, soaps, and toiletries.
- Food: Chemistry is used in food production, processing, and preservation.
- Medicine: Chemistry is used in the development of pharmaceuticals and medical treatments.
- Energy: Chemistry is used in the development of sustainable energy sources, such as solar and wind power.

Impact of Chemical Processes and Products on the Environment and Human Health

- Environmental impact: chemical processes and products can pollute the air, water, and soil, harming ecosystems and human health.
- Human health impact: exposure to chemicals can cause health problems, such as cancer, respiratory disease, and reproductive issues.
- Sustainability: Chemistry can help develop sustainable solutions to reduce the environmental impact of chemical processes and products.

Sub-Topic 3: Safety and Waste Management in the Laboratory

Introduction

Safety and Waste Management in the Laboratory are essential because they ensure safety and environmental protection by guiding the proper handling of hazardous materials and waste. These protocols help prevent contamination and promote sustainability, fostering a safe working environment while supporting scientific research and public health.

Specific Competences:

- Apply laboratory safety
- Manage waste in the laboratory

- **Chemical** - any substance used or produced in chemical reactions that can be hazardous or non-hazardous
- **Contaminated paper** - paper that has been in contact with chemicals
- **Disposa**l - the systematic process of safely removing and managing waste materials in accordance with regulatory guidelines to protect human health and the environment.
- **First Aid** - immediate care given to a person who is injured or suddenly becomes ill, before professional medical help is available
- **Glass ware** - items made of glass used in laboratory experiments
- **Laboratory waste** - any materials discarded from laboratory activities, including chemicals, biological samples, and contaminated items that require special handling and disposal
- **Paper** - any material used for documentation, packaging, or laboratory notes
- **Personal Protective Equipment (PPE):** gear worn to protect oneself from chemical splashes, spills, and other hazards.
- **Precautions** - safety measures and protocols implemented to prevent accidents, protect personnel, and ensure the proper handling and disposal of hazardous materials

- **Sustainable waste management** - practices that minimize waste generation and promote the recycling and safe disposal of materials to reduce environmental impact and conserve resources
- **Storage:** proper handling and storage of chemicals, equipment, and other laboratory materials.
- **Waste Disposal:** safe and responsible disposal of laboratory waste.

Learning Activities:

Learning Activity 1: **Applying safety practices in the laboratory**

Applying safety practices in the laboratory is vital for protecting health, preventing accidents, and ensuring compliance. Effective precautions, first aid, proper storage, and sustainable waste management enhance safety, foster a responsible research environment, and minimize environmental impact. There are several sub activities which learners will engage in as they apply safety practices in the laboratory.

Activity 1.1: Applying precautions in the laboratory as safety practices

In this activity will help learners explore the importance of laboratory safety rules. This activity will help appreciate that laboratory safety precautions which are in place to protect not only them, but also others and the environment. By following these precautions, learners can minimise the risks associated with laboratory work and ensure a safe working environment for yourself and others.

Suggested Teaching and Learning Materials

- **Natural Materials**: water
- **Artificial Materials**: test tubes, reagent bottles, concentrated sulphuric acid, ethanol, any drink, food, gloves, safety googles, laboratory coats, chart containing safety rules.

Learning Environment Set-up:

- **Natural Environment:** School surroundings
- **Artificial Environment:** Chemistry laboratory / classroom

SCENARIO: Imagine that you are working in a laboratory with a team of students on a Chemistry experiment. One of your teammates, Chisambo, is not wearing gloves while handling a toxic chemical. Chisambo claims that the chemical is not that hazardous and that gloves are not necessary.

1. What are the potential risks to Chisambo, yourself and the Environment if Chisambo continues to handle chemical without gloves?
2. How would you Chisambo and explain the importance of wearing gloves while handling hazardous chemicals?
3. What laboratory safety rules are in place to protect against this type of situation and how can you ensure that they are followed?

T

- learners in small groups
- Ask the learners to brainstorm on the questions in the s
- Let learners present their responses to the whole class
- Consolidate the presentations of the responses from the learners by adding an exp understanding.

- Learners in small groups brainstorming on the questions in the scenario
- Learners presenting their responses to the whole class

Ask learners further questions such as;

- suppose Chisambo refuses to wear gloves and continues to handle the chemical without proper protection. What steps would you take to address the situation and ensure a safe working environment?
- Consider a scenario where you are working alone in the laboratory and you accidentally spill a hazardous chemical on your skin. What would you do to respond to the situation and minimise harm to yourself and the environment?

Explanation (Conceptualisation):

To ensure safety in a laboratory, follow these precautions: read the manual, wear PPE, tie back hair, handle chemicals with care, label and date chemicals, use fume hoods, and dispose of waste properly. Familiarize yourself with the location of emergency equipment, such as fire extinguishers and safety showers, and understand emergency procedures for responding to fires and chemical spills. Report any

incidents or near-misses to the laboratory supervisor or safety officer. Proper disposal of waste and proper handling of chemicals are also crucial.
The following are some of the laboratory safety rules:

- Enter a laboratory only when a teacher says so
- Always wear flat and closed shoes
- Wear protective clothes
- Do not run or play in the laboratory
- Do not perform any experiment without permission from the teacher
- Do not drink, eat or taste anything in the laboratory
- Never hold bottles by the neck. Always hold the bottom
- Never point the mouth of a test tube containing a substance being heated towards another person or yourself.
- Always add acid to water and not water to acid
- When smelling a substance, do not hold it very near the nose. Hold it about 20cm from the nose and with the hand wave the vapour towards the nose and sniff carefully.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Problem solving

Activity 1.2: Applying first aid in the laboratory as a safety practice
This activity focuses on the importance of first aid in laboratory settings, emphasising the need for learners to respond quickly and effectively in emergency situations. This activity aims to equip learners with the knowledge, skills, and confidence to handle various emergency situations, ensuring the safety of themselves and their colleagues. learners will demonstrate common First Aid situations and actions.

Suggested Teaching and Learning Materials

- **Natural Materials**: water, air
- **Artificial Materials**: first aid box with full kit, mat, broom handle

Learning Environment Set-up:

- **Natural Environment:** school surroundings
- **Artificial Environment**: Chemistry laboratory / classroom

PROBLEM POSING: You are working in a laboratory with a group of learners when one of your classmates, Misozi, accidentally spills a chemical on her skin. The chemical is a strong acid that can cause severe burns. Misozi immediately cries out in pain and starts to panic.

Questions to Consider

1. What are the immediate steps you should take to assist Misozi?
2. How would you assess the severity of Misozi's injury?
3. What first aid procedures would you apply to help alleviate Misozi's symptoms?
4. How would you ensure that the laboratory is safe and secure while attending to Misozi's injury?
5. What would you do if Misozi's condition worsens or she experiences severe symptoms such as difficulty breathing or dizziness?

Teacher's Roles:

- Introduce the activity by posing a problem stated above
- Put learners in small groups
- Ask learners to discuss the questions
- Let learners make their presentations of their responses
- Consolidate their responses by adding an explanations

Learners' Tasks:

- Learners discussing the questions from the posed problem
- Learners making their presentations of their responses

Ask questions such as:

- Why is it important to have a first aid plan in place in the laboratory?
- What are some common laboratory accidents or injuries that require first aid, and how can you prevent them?
- Evaluate learners as they provide responses

Explanation (Conceptualisation):

Laboratory accidents can result in chemical splashes, cuts and lacerations, burns, and eye injuries. First aid procedures include flushing the affected area with water, removing contaminated clothing and jewelry, neutralising the chemical, applying pressure to stop bleeding, cleaning the wound, applying antibiotic ointment, and covering the wound with a bandage. For burns, cool the burn with cool water, remove clothing and jewelry, apply topical antibiotic ointment, and cover the burn with a non-stick dressing. For eye injuries, flush the eye with water, remove contact lenses, and apply a topical antibiotic ointment. General first aid principles include assessing the situation, calling for help, providing comfort, and documenting the incident. A laboratory first aid kit includes basic supplies like bandages, gauze pads, antiseptic wipes, medical tape, an eye wash station, burn cream, and neutralizing agents. Regular training and preparedness are essential for laboratory personnel, including first aid training, an emergency response plan, a safety manual, and regular drills. Regular drills ensure laboratory personnel are prepared to respond to emergencies.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Problem solving

Activity 1.3: Laboratory First Aid Simulation
This activity is about applying first aid in the laboratory as a safety practice. A simulation scenario will be used to assess how much learners know about applying first aid in different situations. However, this activity focuses on how to apply first aid principles and practices in a simulated laboratory setting.

Suggested Teaching and Learning Materials

- **Natural Materials**: water
- **Artificial Materials**: First aid kit, Laboratory coat and gloves, Simulated injury scenarios (e.g., chemical splash, cut, burn), First aid guide or manual

Learning Environment Set-up:

- **Artificial Environment**: Chemistry laboratory, classroom

Teacher's Roles:

- Divide learners into small groups.
- Assign each group a simulated injury scenario.
- Provide each group with a first aid kit, laboratory coat, and gloves.
- Instruct each group to simulate the injury scenario and apply first aid principles and practices.
- Observe and provide feedback on each group's performance.
- After all groups have completed the simulation, hold a class discussion to review the key takeaways and answer any questions.

Examples of Simulated Injury Scenarios which learners might use include the following;

- ***Chemical Splash****: A learner accidentally spills a chemical on their skin.*
- ***Cut:*** *A learner cuts themselves on a broken piece of glassware.*
- ***Burn****: A learner suffers a burn from a hot surface or equipment.*

- *learners are aware of the simulated nature of the activity and do not attempt to practice first aid on real injuries.*
- *Provide a safe and controlled environment for the simulation.*

- Learners in small groups simulating injury scenario.
- Learners in each group to simulating the injury scenario and applying first aid principles and practices.
- Learners participating in a class discussion to provide takeaways.

- Observe learner participation and engagement during the simulation.
- Evaluate learner understanding of first aid principles and practices through a written quiz or class discussion.
- Review learner performance in applying first aid procedures during the simulation.

Explanation (Conceptualisation):

First Aid procedures include flushing a chemical splash with water, neutralizing the chemical, applying pressure to cut, cleaning the wound, applying antibiotic ointment, and covering the wound with a bandage. For burns, cool the burn with cool water, remove clothing and jewelry, apply topical antibiotic ointment, and cover the burn with a non-stick dressing.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating
- Problem solving

Activity 1.4: Laboratory Storage Safety

Proper storage of laboratory materials is an important component of maintaining a safe and healthy laboratory environment. Improperly stored chemicals, equipment, and other materials can pose significant risks to learners, including exposure to hazardous substances, fires, and explosions. This activity will help learners to understand the importance of proper storage of laboratory materials and to identify potential hazards associated with improper storage.

Suggested Teaching and Learning Materials

- **Natural Materials**: water
- **Artificial Materials**: Laboratory Storage Safety Checklist, Scavenger hunt worksheet, Laboratory storage areas (e.g., chemical storage rooms, equipment storage areas), concentrated sulphuric acid, aqueous sodium hydroxide, aqueous ammonia, ethanol, concentrated hydrochloric acid, beakers, measuring cylinders, pipettes, burettes, conical flasks, spirit lamps, Bunsen burners.

Learning Environment Set-up:

- **Artificial Environment**: Chemistry laboratory/classroom

Teacher's Roles:

- Divide learners into small groups of 3-4.
- Provide each group with a Laboratory Storage Safety Checklist and a scavenger hunt worksheet.
- Instruct each group to conduct a scavenger hunt in the laboratory storage areas to identify potential safety hazards.
- The scavenger hunt worksheet should include items such as:
  - Chemicals stored in incompatible locations
  - Equipment stored in a way that blocks emergency exits
  - Improperly labeled storage containers
  - Expired or outdated chemicals

- For each item found, the group should record the location and a brief description of the hazard on the scavenger hunt worksheet.
- After the scavenger hunt, have each group present their findings to the class.
- As a class, discuss the potential consequences of each hazard and develop strategies for correcting them.

- Each group of learners conducting a scavenger hunt in the laboratory storage areas to identify potential safety hazards.
- Learners recording the location for each item found and a brief description of the hazard on the scavenger hunt worksheet. The group should record the location
- Each group of learners presenting their findings to the class.
- The class discussing the potential consequences of each hazard and developing strategies for correcting them.

Learners should use clearly labelled containers and ensure that all chemical storage complies with safety regulations.

- Evaluate completed scavenger hunt worksheet
- Observe participation in class discussion and presentation of findings
- Evaluate written reflection on the importance of laboratory storage safety
- Check if learners are storing chemicals and equipment correctly

Explanation (Conceptualisation):

Storing chemicals according to their compatibility and hazard classification is crucial to prevent accidents and minimize risks. Chemicals can be categorized into corrosives, flammables, toxics, and reactives, reducing the risk of chemical reactions, fires, and explosions. Proper labeling helps prevent misidentification of chemicals and facilitates emergency response.

Securing hazardous materials in locked cabinets or designated areas prevents unauthorized access and minimizes accidents. Storing volatile substances in well-ventilated areas or fume hoods minimizes inhalation risks and flammable vapor accumulation. Maintaining an updated inventory of all materials helps track usage and expiration dates, reducing accident risk and waste.

Equipment storage should be done in designated areas, ensuring that equipment does not block emergency exits or aisles. Regular inspections of chemicals and equipment for damage or wear help identify potential hazards and prevent accidents. Proper disposal of expired or outdated chemicals prevents accidents, minimizes environmental impact, and ensures compliance with regulations.

In conclusion, proper storage, labeling, securing hazardous materials, storing volatile substances in well-ventilated areas, maintaining an updated inventory, storing equipment in designated areas, conducting regular inspections, and disposing of expired or outdated chemicals are essential for maintaining a safe and compliant laboratory environment.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating
- Problem solving

Learning Activity 2: Laboratory Waste Classification and Management

In this activity, learners will classify laboratory waste and explore appropriate waste management practices. To understand the importance of proper laboratory waste classification and management, and to develop skills in identifying and handling different types of laboratory waste.

HOOK: What do you think are the consequences of improper laboratory waste management?

Suggested Teaching and Learning Materials

Artificial Materials: waste classification guide, a waste sorting game, case studies, whiteboard, markers, examples of waste, waste classification labels, chart paper, markers for group work, reference materials, and videos showing different types of laboratory waste.

Learning Environment Set-up

- **Artificial Environment:** Chemistry laboratory /classroom
- **Technological Environment**: Virtual laboratory or videos

Teacher's Roles

- Introduce the activity using the hook such as *What do you think are the consequences of improper laboratory waste management?*
- Review the laboratory waste classification guide, which outlines the different categories of laboratory waste, including:
  - Chemical waste
  - Biological waste
  - Radioactive waste
  - Recyclable waste
  - Non-hazardous waste
- Discuss with learners the characteristics and examples of each type of waste.
- Divide learners into small groups and provide each group with a set of waste sorting cards or a waste sorting game board.
- Each card or game piece represents a different type of laboratory waste.
- Instruct the groups to sort the waste into the correct categories.
- After the game, review the correct answers and discuss any common misconceptions.
- Provide learners with case studies of laboratory waste management scenarios, such as:
  - A laboratory generates a large amount of chemical waste. How should it be disposed of?
  - A researcher accidentally contaminates a sample with radioactive material. What steps should be taken to clean up the spill?
- Ask learners to work in groups to discuss and develop a plan for managing the waste in each scenario.
- After completing the case studies, hold a class discussion to reflect on the importance of proper laboratory waste classification and management.
- Ask learners to share their thoughts on the following questions:
  1. *Why is it important to properly classify and manage laboratory waste?*
  2. *What are the potential consequences of improper waste management?*
  3. *How can laboratory personnel ensure that waste is properly managed?*

- *Ensure that learners are aware of the potential hazards associated with laboratory waste.*
- *Provide personal protective equipment (PPE) such as gloves and safety glasses for students to wear during the waste sorting game or simulation.*

- Learners discussing the characteristics and examples of each type of waste.
- Learners into small groups sorting out the waste sorting cards into the correct categories.
- Learners working on case studies of laboratory waste management scenarios,
- Learners discussing and reflecting on the importance of proper laboratory waste classification and management.
- Learners sharing their thoughts on the following provided questions:

1. *Why is it important to properly classify and manage laboratory waste?*
2. *What are the potential consequences of improper waste management?*
3. *How can laboratory personnel ensure that waste is properly managed?*

- Observe group collaboration and engagement during the classification exercise
- Observe learners' participation in class discussions and activities
- Evaluate completion of the waste sorting game or simulation
- Evaluate the written reflection on the importance of proper laboratory waste classification and management

Explanation (Conceptualisation):

Laboratory waste classification includes chemical, biological, radioactive, recyclable, and non-hazardous waste. Proper waste sorting and management are crucial for preventing contamination and ensuring proper disposal. Improper waste management can lead to environmental contamination, health risks, and regulatory fines. Best practices include proper waste sorting, storage, transportation, and disposal, as well as regular training and inspections. Assessment involves participation in class discussions, completing a waste sorting game or simulation, and writing reflections. Modifications are made for different learning styles, such as visual learners, auditory learners, and kinesthetic learners. Safety considerations include awareness of potential hazards, providing personal protective equipment (PPE), and ensuring proper training and equipment for handling laboratory waste. By following these guidelines, students can effectively manage and dispose of laboratory waste, ensuring compliance with regulations and preventing environmental contamination.

- Critical thinking
- Collaboration
- Communication

Expected Standards:

- Laboratory safety applied accordingly
- Waste in the laboratory managed accordingly

 Ask Assessment questions such as:

Scenario: In 2016, a tanker truck carrying crude oil overturned on the Great North Road in Zambia, spilling thousands of liters of oil into the surrounding environment. The spill affected nearby water sources, including the Kafue River, and posed a significant threat to local wildlife.

Part A: Multiple Choice

1. What was the primary cause of the 2016 oil spill on the Great North Road in Zambia?

   A) Natural disaster (e.g., flood, earthquake)
   B) Human error (e.g., driver fatigue, equipment failure)
   C) Sabotage or intentional damage
   D) Unknown/Other (please specify)

2. Which of the following was a potential environmental impact of the oil spill?
   A) Soil contamination only
   B) Water pollution only
   C) Air pollution only
   D) All of the above (soil, water, and air pollution)

Part B: Short Answer

3. Describe the potential health risks associated with oil spillage, particularly for local communities near the affected area.
4. Outline the steps that should be taken to respond to an oil spill, including containment, cleanup, and mitigation measures.

Part C: Essay

5. Discuss the economic and environmental implications of oil spillage in Zambia, using the 2016 Great North Road incident as a case study. Be sure to address the impact on local ecosystems, human health, and the economy.
6. The teacher asked Form 1 learners to store the following laboratory materials in the Chemistry laboratory: highly inflammable substances, acids and bases, clean glassware.
   (a) What safety practices should be followed?
   (b) What is the appropriate way to label chemical containers?
   (c) How should incompatible chemicals be stored to prevent reactions?
   (d) What factors should be considered when deciding the location of storage?
   (e) What is the importance of using secondary containment for hazardous materials?

7. You are a laboratory technician working in a research laboratory. Your laboratory generates various types of waste, including chemical, biological, and radioactive materials. Your supervisor has asked you to develop a plan for managing the laboratory waste. Develop a comprehensive plan for managing laboratory waste, including:

   (a) Classification of laboratory waste into different categories (chemical, biological, radioactive, etc.)
   (b) Proper storage and handling procedures for each type of waste
   (c) Labeling and signage requirements for waste storage areas
   (d) Procedures for disposing of hazardous waste
   (e) Training requirements for laboratory personnel on waste management procedures

Safety Practices in the Laboratory:

- Wearing personal protective equipment (PPE)
- Following standard operating procedures (SOPs)
- Labeling chemicals and equipment
- Storing chemicals and equipment in designated areas
- Knowing the location of emergency equipment
- Following proper first aid procedures in case of accidents or exposure to hazardous material

Laboratory Waste Management:

- Classifying laboratory waste into: Chemical waste, Biological waste, Glassware waste, Paper waste, Non-hazardous waste, Recyclable materials
- Handling waste carefully to prevent accidents and contamination
- Categorizing waste into designated categories
- Labeling waste containers
- Storing waste in designated areas
- Disposing of waste according to regulatory guidelines and institutional policies
- Following proper procedures for disposing of hazardous waste, including chemical, biological, and radioactive materials.

Sub-Topic 4: Apparatus and Equipment in Chemistry

Introduction

This sub-topic will cover various laboratory apparatus used in Chemistry, including their functions, how they are used in experiments, and their significance in understanding chemical processes. Understanding these tools is crucial for anyone entering the field of Chemistry, as they directly relate to conducting experiments and collecting data in a safe and efficient manner.

Specific Competences:

- Use apparatus and equipment in Chemistry
- Measure quantities precisely and accurately

- **Apparatus/equipment:** a collection of tools and devices used in scientific experiments and research to perform specific tasks, facilitate procedures, and collect data
- **Laboratory equipment** includes a beaker, burette, pipette, test tube, flask, and crucible for measuring and mixing chemicals. **Heating and cooling equipment** includes a Bunsen Burner, Hot Plate, thermometer, ice bath, and water bath.
- **Measurement equipment** includes balance, spectrophotometer, pH Meter, and conductivity meters.
- **Safety equipment** includes gloves, goggles, lab coat, fume hood, and safety shower.

Key Concepts

- Glassware and Equipment
- Heating and Cooling Equipment
- Measurement and Analysis Equipment
- Safety Equipment

Learning Activities:

Learning Activity 1: Exploring the uses of Laboratory Apparatus and Equipment

This activity is designed to help learners how to use various laboratory apparatus and equipment in Chemistry laboratory. There are various sub activities which learners will engage in as they demonstrate the use of different laboratory apparatus and equipment.

Activity 1.1: Demonstrating the use of various laboratory apparatus and equipment in Chemistry-related activities.

In this activity, learners will demonstrate the use of various laboratory apparatus and equipment in Chemistry-related activities.

HOOK: You discover an unknown substance in the lab. How would you use various laboratory apparatus and equipment to identify its composition and properties?

Suggested Teaching and Learning Materials

- **Natural Materials**: water
- **Artificial Materials**: Beakers, Burette, Bunsen burner, Flask, Crucible, stop watch, Laboratory Thermometer, electronic balance, measuring cylinder, hot plate, pipette, beaker, , test tube, wash bottle, clamp and stand, separating funnel, safety goggles, mortar and pestle, filter paper, pH meter, Gloves, Lab coat

Learning Environment Set-up:

- **Artificial Environment:** Chemistry laboratory

Teacher's Roles:

- Introduce the activity by reviewing the different types of laboratory apparatus and equipment used in Chemistry.
- Divide the learners into small groups
- assign each group to a station with a specific apparatus or equipment.
- At each station:
    - *Demonstrate the proper use of the apparatus or equipment.*
    - *Have learners practice using the apparatus or equipment under supervision.*
- Discuss the safety precautions and potential hazards associated with each apparatus or equipment

- *Wear gloves, goggles, and lab coats at all times when handling chemicals and equipment.*
- *Ensure proper ventilation when using the Bunsen burner and hot plate.*
- *Handle equipment with care to avoid breakage and injury.*

- Station 1 (Measuring Volumes): learners using a burette and pipette to measure the volume of a liquid.
- Station 2 (Heating and Cooling): let learners using a Bunsen burner and hot plate to heat a substance, and an ice bath and water bath to cool a substance.
- Station 3 (Measuring pH): Ask learners to using a pH meter to measure the acidity of a solution.

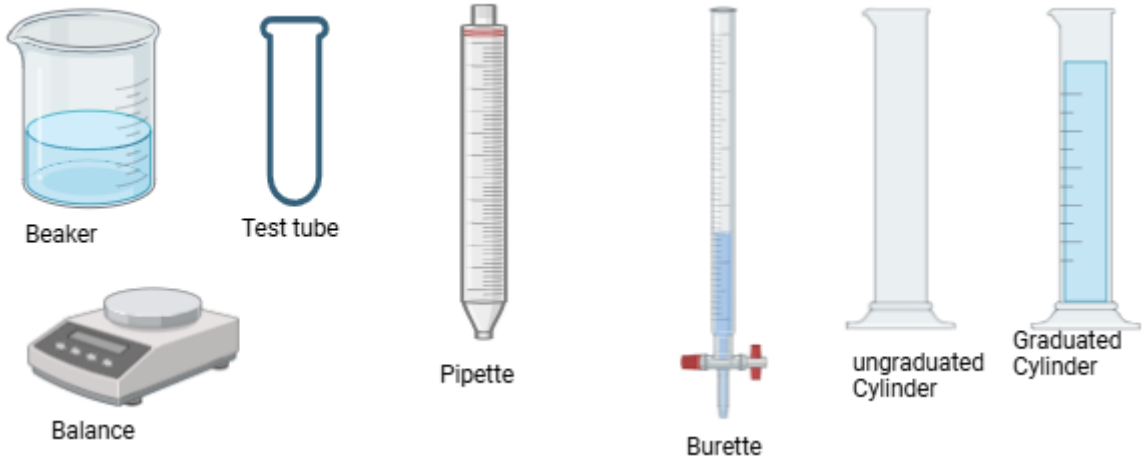
- Observe learners during the activities and assess their ability to properly use the apparatus and equipment.
- Review learner lab reports and assess their understanding of the apparatus and equipment used.
- Evaluate learner participation and engagement during the activities.

Explanation (Contexualisations)
Review the different apparatus and equipment used in the activities and discuss their importance in Chemistry-related activities.
Some apparatus/equipment found in the Chemistry laboratory include the following**:**

- **Beaker:** A cylindrical glass container with a spout used for mixing, heating, and holding liquids. Beakers typically have volume markings for measurement, though they are not highly precise
- **Burette:** A long, graduated glass tube with a tap at the bottom used for delivering precise volumes of liquid, particularly in titration experiments. Burettes allow for controlled dispensing of liquid
- **Crucible:** A small, heat-resistant container used for heating solid substances to high temperatures. Crucibles are often made of ceramic or metal and are used in procedures where materials need to be melted or subjected to very high heat
- **Erlenmeyer Flask:** A conical flask with a flat bottom, a broad base, and a narrow neck. It is used for mixing, swirling, and heating liquids. The shape minimizes evaporation and allows for easier stirring
- **Fume Hoods:** Ventilated enclosures used to safely handle hazardous chemicals and vapours. Fume hoods filter and expel toxic or noxious fumes from the lab environment, protecting users
- **Funnel:** A funnel is a conical tool used to channel liquids or fine-grained substances into containers with small openings. They can come in various sizes and materials, including plastic and glass
- **Measuring Cylinder:** A tall, cylindrical container used for accurately measuring the volume of liquids. It has volume markings along the side and is typically made of glass or plastic
- **Pipette:** A slender tube used to measure and transfer fixed volumes of liquid. Pipettes can be manual or automatic (micropipettes) and are essential for experiments requiring accuracy in liquid measurements
- **Reagent Bottle:** A container, usually made of glass or plastic, used to store and dispense chemicals and reagents. It is typically equipped with a stopper or a cap to protect contents from contamination

- **Safety Goggles:** Protective eyewear designed to shield the eyes from chemical splashes, flying debris, and other hazards encountered in the laboratory
- **Spatula:** A flat, typically stainless steel or plastic tool used for transferring solid chemicals or powders. Spatulas come in various sizes and shapes, making them suitable for different laboratory tasks
- **Stands:** Laboratory stands, often referred to as ring stands or retort stands, are used to support laboratory apparatus. They are useful for holding items such as beakers, flasks, or burettes securely in place while experiments are conducted
- **Test Tube:** A small, cylindrical glass tube used to hold, mix, or heat small amounts of substances during experiments. Test tubes can be closed with a stopper or left open for reactions and observations
- **Thermometer:** An instrument used to measure temperature, typically in degrees Celsius or Fahrenheit. In Chemistry labs, thermometers can be used in both solids and liquids
- **Volumetric Flask:** A flat-bottomed flask with a long neck and a precise volume mark. It is used for preparing solutions and is designed to contain a specific volume when filled to the mark.

Some of the apparatus in diagrammatic form are the following:



- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating
- Problem solving

Learner Activity 2: Demonstrating accuracy and precision in measuring quantities such as time, temperature, mass/weight and volume

In this activity, is designed to help learners demonstrate accuracy and precision in measuring quantities such as time, temperature, mass/weight, and volume using various instruments.

HOOK: Why do you think accurate measurements are important in our everyday life?

Suggested Teaching and Learning Materials

- **Natural Materials:** Sand or Rice
- **Artificial Materials**: Burettes, Measuring cylinders, Graduated beakers, Pipettes, Distilled water or other liquids for measurement, notebook, Markers for labeling, Digital balances stopwatch, pen

Learning Environment Set-up:

- **Artificial environment**: Chemistry laboratory/classroom

Teacher's Roles

- Divide learners into pairs and give each pair a stopwatch or timer.
- Have learners measure the time it takes for a small object (e.g., a pen) to roll down a ramp or a short distance.
- Repeat the measurement several times and record the results.
- Calculate the average time and discuss the accuracy and precision of the measurements
- Then ask learners to work in three stations on rotational basis

Station 1: Temperature Measurement

- Fill a container with hot water and
- Ask learners to measure the temperature of hot water using a thermometer.
- Let learners record the temperature readings and calculate the average temperature.
- Discuss with learners the accuracy and precision of the temperature measurements.

Station 2: Mass/Weight Measurement

- Fill a container with sand or rice and have learners measure the mass/weight using a balance or scale.
- Let learners record the mass/weight readings and calculate the average mass/weight.
- Discuss with learners the accuracy and precision of the mass/weight measurements.

Station 3: Volume Measurement

- Fill a container with water and have learners measure the volume using measuring cups and spoons.
- Have learners record the volume readings and calculate the average volume.
- Discuss with learners the accuracy and precision of the volume measurements.

Note: *You are advised to create more stations depending on the situation and number of learners in the class*

Learners doing the tasks in three stations on rotational basis.

Station 1: Temperature Measurement

- Learners measuring the temperature of hot water using a thermometer.
- Learners recording the temperature readings and calculating the average temperature.
- Learners discussing the accuracy and precision of the temperature measurements.

Station 2: Mass/Weight Measurement

- Learners recording the mass/weight readings using the scales and calculating the average mass/weight.
- Learners discussing the accuracy and precision of the mass/weight measurements.

Station 3: Volume Measurement

- Learners recording the volume readings and calculate the average volume.
- Learners discussing the accuracy and precision of the volume measurements.

- Observe learners during the measurements and assess their ability to use the instruments accurately and precisely.
- Review their calculations and recorded results for accuracy and precision.
- Have learners reflect on their measurements and discuss ways to improve accuracy and precision.

Explanation (contexualisations)

Accurate time measurement is crucial in scientific experiments, and techniques for minimizing errors include using stopwatches or timers, understanding temperature scales, using thermometers, and calibrating them. Mass/weight measurement involves units like grams, kilograms, and pounds, and using balances or scales. Volume measurement involves units like milliliters, liters, and cubic centimeters, and using measuring cups, spoons, and cylinders. The precision of measurements is critical in chemical experiments as inaccuracies can lead to erroneous results. Different measuring instruments have varying levels of accuracy; understanding their appropriate use is essential for effective scientific practice. Engaging in hands-on activities enhances learners' grasp of scientific concepts and fosters a deeper appreciation for laboratory techniques

Collaboration

- Communication
- Critical thinking
- Manipulating

Expected Standards:

- Apparatus and equipment in Chemistry used accordingly
- Quantities in Chemistry measured precisely and accurately

 Ask Assessment questions such as:

Scenario Questions:

1. A pharmaceutical company requires precise measurements of time, temperature, mass, and volume to manufacture a new medication. Describe how you would ensure accurate measurements in this scenario.
2. A food processing company requires precise measurements of temperature and mass to ensure the quality and safety of their products. Describe how you would minimize errors in measuring these quantities.
3. A chemist needs to mix two substances that react violently when combined. What laboratory equipment would you recommend to minimize the risk of injury, and how would you ensure safe handling of the substances?
4. A researcher is studying the effects of pH on a chemical reaction. What laboratory equipment would you recommend to measure and control the pH, and how would you ensure accurate results?

- Familiarity with common laboratory apparatus and equipment, such as beakers, flasks, pipettes, and Bunsen burners
- Understanding of the proper use and handling of laboratory equipment
- Ability to assemble and use laboratory equipment for various Chemistry-related activities
- Knowledge of laboratory safety protocols and procedures
- Understanding of the importance of cleaning and maintaining laboratory equipment
- Understanding of the concepts of accuracy and precision in measurement
- Familiarity with various measurement instruments, such as thermometers, balances, and spectrophotometers
- Ability to measure time, temperature, mass/weight, and volume accurately and precisely
- Understanding of the sources of error in measurement and how to minimize them
- Ability to record and report measurement data accurately and precisel

Topic 2: Matter

Introduction

This is the second topic in the Chemistry syllabus which will cover the following subtopics**:** States and Basic units of matter, Kinetic theory of matter and heating and cooling curves of matter. Everything with mass that takes up space is considered to be matter. This includes the air we breathe, the stars in the sky, the basic material that constitutes everything in our environment. There are various states of matter, and each state is made up of fundamental units that define its characteristics.

General Competences:

- Analytical Thinking
- Collaboration
- Communication
- Environmental Sustainability
- Problem Solving

Key Concepts:

- Properties of Matter
- Classification of Matter
- Changes in Matter
- Structure of Matter
- Conservation of Matter

Sub-Topic 1: States and Basic units of Matter

Introduction

Matter exists in various forms known as states of matter. These states are based on the arrangement of the fundamental building blocks of matter, which are atoms, molecules, and ions. This subtopic examines the various states and basic units of matter.

Specific Competence:

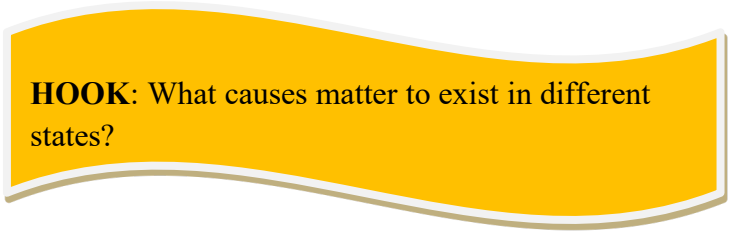
- Demonstrate conceptual understanding of states and basic units of matter

- **Atom** – smallest particle of an element that cannot be split by any chemical means
- **Ion** – an electrically charged atom
- **Matter** – anything that has mass and occupies space
- **Molecule** – the smallest particle of an element or compound that exists independently
- **States of matter** – different forms of matter such as solid, liquid, gas, plasma…

Learning Activities:

Activity 1: Investigating the states of matter and exploring its basic units

In this activity, learners are expected to investigate the states of matter and explore its basic units. The investigation the states of matter (solid, liquid, gas, plasma) and their characteristics.



Suggested Teaching and Learning Materials

- **Natural Materials**: rock, Ice, metal, water, oil, and **g**ases (air), wood
- **Artificial Materials**: Graduated measuring cups/measuring cylinders/beakers, Balloons Thermometer, Bunsen burner or hot plate, model or diagram (structure of atoms and molecules), plastic

Learning Environment Set-up set up:

- **Natural Environment:** School surroundings
- **Artificial Environment**: Chemistry laboratory/Classroom

Teacher's Roles:

- Introduce the activity using the hook "*What causes matter to exist in different states*?"
- Discuss with learners the states of matter: solid, liquid, gas, plasma
- Show examples of each state using water: ice (solid), water (liquid), and steam (gas).
- Use a thermometer to measure the temperature of each state.
- Discuss the characteristics of each state, such as shape, volume, and density.
- Then, introduce the concept of atoms and molecules as the basic units of matter.
- Use a model or diagram to illustrate the structure of atoms and molecules.
- Discuss how atoms combine to form molecules and how molecules interact with each other.
- Use a balloon to demonstrate how molecules can move and interact with each other.
- Divide learners into small groups and provide each group with various objects (e.g., metal, wood, plastic).
- Ask each group to explore the properties of their assigned object, such as its texture, density, and ability to conduct heat.

- Have each group present their findings to the class.

- Learners discussing with the teacher the states of matter: solid, liquid, gas, plasma and the characteristics of each state, such as shape, volume, and density.
- Learners with the teacher discussing how atoms combine to form molecules and how molecules interact with each other.
- Learners into small groups exploring the properties of their assigned object, such as its texture, density, and ability to conduct heat.

- Observe learners during the exploration activity to assess their understanding of the states of matter and basic units of matter.
- Review learners notes and diagrams for accuracy and completeness.
- Administer a quiz or test to assess learners' understanding of the concepts.

Explanation (Contexualisations)

Matter exists in four main states: solids, liquids, gases, and plasma. Solids have a fixed shape and volume, with particles closely packed and fixed. Liquids have a fixed volume but take the shape of their container, with particles close together but free to move. Gases have neither a fixed shape nor volume, with particles widely spaced and free to move. Plasma is a high-energy state where atoms are ionized and electrons move. Matter is composed of fundamental particles, including atoms, molecules, and ions. The arrangement of particles determines the state of matter. Each state has distinct physical properties, with solids being rigid and resistant to changes, liquids being fixed and variable, and gases being variable and expandable. Understanding these states is crucial in fields like Chemistry, physics, and engineering.

- Matter exists in different forms such as solid, liquid, gas, plasma…
- The different forms of matter are referred to as states of matter
- Matter is built up by fundamental particles which can be atoms, molecules or ions
- The existence of matter in different states is as a result of the differences in the arrangement of particles in them
- Different states of matter have different physical properties such as fixed shape and volume (solids), fixed volume and variable shape (liquids), variable shape and volume (gases)

- Analytical Thinking

- Communication
- Collaboration
- Observation
- Manipulating

Expected Standard: The conceptual understanding of matter demonstrated correctly.

 Ask Assessment questions such as:

Short Answer Questions:

1. A substance has a fixed shape and volume. What state of matter is it in?
2. Describe the differences in particle arrangement and motion between a solid, liquid, and gas.
3. A liquid is heated and turns into a gas. What is the process called, and what energy change occurs?
4. Explain why a solid maintains its shape, while a liquid takes the shape of its container.
5. Describe a real-world scenario where a substance changes from one state of matter to another.
6. How do the properties of a substance, such as its melting point and boiling point, relate to the arrangement and motion of its particles?

- Solids have a fixed shape and volume, with particles arranged in a regular, three-dimensional pattern.
- Liquids take the shape of their container, with particles arranged randomly and moving freely.
- Gases have neither a fixed shape nor a fixed volume, with particles arranged randomly and moving rapidly.
- Plasma is a high-energy state of matter, where atoms are ionized and electrons are free to move.
- Changes in temperature and pressure can cause a substance to change from one state of matter to another.
- Atoms are the building blocks of matter, consisting of protons, neutrons, and electrons.
- Molecules are groups of atoms bonded together, with the atoms sharing electrons.
- Ions are atoms or molecules that have gained or lost electrons, resulting in a net positive or negative charge.
- Elements are substances consisting of only one type of atom, while compounds are substances consisting of two or more different elements.
- The arrangement and bonding of atoms and molecules determine the properties of a substance.

Sub-Topic 2: Kinetic Theory of Matter

Introduction

A key idea in Chemistry that describes how matter behaves at the molecular and atomic level is the kinetic theory of matter. According to this theory, matter is made up of tiny, constantly moving particles. The theory explains how these particles affect the characteristics and behaviour of matter through interactions with one another and with their environment.

Specific Competence:

- Demonstrate the conceptual understanding of the Kinetic Theory of Matter

:

- **Brownian motion** – random movement of particles of matter suspended in fluids
- **Collision** – interaction of particles of matter
- **Diffusion** – movement of particles from a region of their high concentration to a region of their low concentration
- **Kinetic energy** – energy associated with motion/movement
- **Kinetic Theory of Matter** – this theory states that matter is made of particles that are in constant motion
- **Particle motion** – movement of particles in matter
- **Temperature** - the degree of hotness or coldness of a substance
- **Thermal energy** – heat energy

Key Concepts:

- Assumptions of Kinetic Theory
- Key Principles of Kinetic Theory
- Behavior of Gases
- Implications of Kinetic Theory

Learning Activities:

Learning Activity 1: Exploring the Kinetic Theory of Matter

Here are some learner's activity ideas to explore the principles of the kinetic theory of matter.

HOOK: Have you ever wondered why a solid changes to a liquid and then into a gas?

Activity 1.1: Exploring the Principles of the Kinetic Theory of Matter
This activity will help learners explore the motion and arrangement of particles of matter.

Suggested Teaching and Learning Materials

- **Natural Materials**: water ice
- **Artificial Materials**: source of heat, heat resistant beakers, Graph paper, Pencils, Marbles or small balls, Stopwatch or timer, Thermometer, Balloons
- **Technological Materials** Simulation software or online tools (e.g., PhET Interactive Simulations)

Learning Environment Set-up:

- **Artificial Environment**: Chemistry laboratory/classroom

Teacher's Roles:

- Use simulation software to model the behavior of particles at different temperatures.
- Divide learners into small groups and assign each group a computer with simulation software.
- Have learners explore the simulation, observing how particles behave in different states (solid, liquid, gas, plasma).
- Ask learners to record their observations and answer guided questions.
- Divide learners into small groups and provide each group with marbles or small balls.
- Have learners design an experiment to demonstrate collisions between particles.
- Ask learners to measure and record the distance traveled by the marbles after collision


: *Where computers may not available or internet maybe a challenge you can carry out the activity as prescribed below or use any other suitable activity*

- Put learners in small groups
- Introduce the activity
- Provide the materials
- Ask learners to draw and describe motion and arrangement of particles in ice
- Ask learners to heat and measure the temperature of the ice, and observe what happens
- Ask learners to draw and describe the motion and arrangement of particles in the new state of matter formed
- Ask learners to heat measure the temperature of the new state of matter, and observe what happens

- Ask learners to draw and describe the motion and arrangement of particles in the new state of matter formed

Care and caution to be taken as there will be open flames, and heat-resistant glassware must be used.

- Learners exploring the simulation and observing how particles behave in different states (solid, liquid, gas, plasma).
- Learners recording their observations and answer guided questions.
- Divide learners into small groups and provide each group with marbles or small balls.
- Learners designing an experiment to demonstrate collisions between particles.
- Learners measuring and recording the distance traveled by the marbles after collision

- Observe learner participation during the simulation and experiment activities.
- Review learner observations and answers to guided questions.
- Evaluate learners understanding through a quiz or test.
- Have learners reflect on what they learned about the kinetic theory of matter.
- Administer a quiz or test to assess student understanding.

Explanation (Contexualisations)

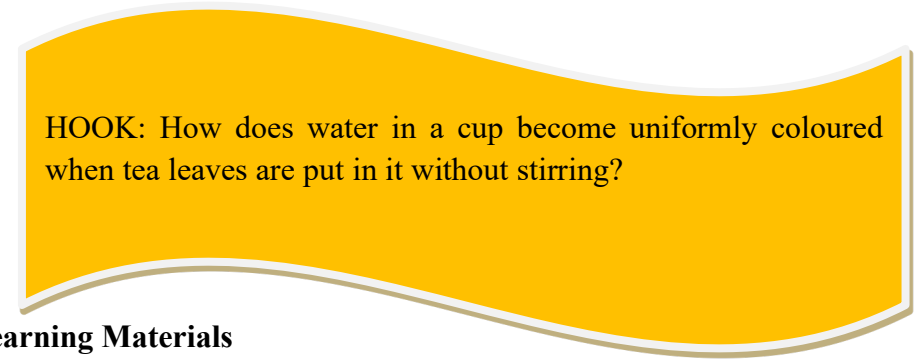
The arrangement of particles in a substance determines its state of matter. As temperature increases, particles gain kinetic energy, causing them to move faster and further away from each other. This weakens inter-particle forces. Conversely, when temperature decreases, particles lose kinetic energy and move closer together. Solids have a fixed position in space, while liquids have close particles but freedom to move. Gases have a wide space and high kinetic energy, allowing them to move rapidly and randomly.

Physical properties of states of matter vary, with solids having fixed shape and volume, liquids having fixed volume, variable shape, and gases having variable shape and volume. Changes in temperature and pressure can cause changes in particle arrangement, leading to changes in the state of matter.

- Analytical Thinking

- Communication
- Collaboration
- Observation
- Manipulating
- Problem solving

Activity 1.2: Exploring the principles of the kinetic theory of matter in terms of diffusion of particles in fluids.
This activity will help learners explore the concept of diffusion in liquids.



Suggested Teaching and Learning Materials

- **Natural Materials**: water
- **Artificial Materials**: crystals of potassium permanganate (or sodium dichromate), straws, beakers, measuring cylinders

Learning Environment Set-up:

- **Natural Environment:** school surroundings
- **Artificial Environment**: Chemistry laboratory/classroom

Teacher's Roles:

- Introduce the activity by "*How does water in a cup become uniformly coloured when tea leaves are put in it without stirring?"*
- Put learners in small groups
- Provide the materials suggested to the learners
- Ask learners to measure the volume of water for example, 200cm^3 into a clean beaker
- Ask learners to place a crystal of the potassium permanganate at the bottom of the beaker using a straw
- Ask learners to observe and describe what happens

Chemicals must not be handled with bare hands

- Learners measuring the volume of water into a clean beaker
- Learners Placing a crystal of the potassium permanganate at the bottom of the beaker using a straw
- Learners observing and describing what happens

- Observe learners measuring the volume of water into a clean beaker
- Evaluate learners placing a crystal of the potassium permanganate at the bottom of the beaker using a straw

Explanation (Contexualisations)

Diffusion is the movement of particles from high concentration to low concentration, resulting in a uniform distribution throughout a space. This process is driven by the random motion of particles, a fundamental property of matter. This uniform distribution supports the particle theory of matter, which asserts that matter is composed of constant motioning particles, demonstrating that matter is dynamic and interactive.

- Communication
- Analytical Thinking
- Collaboration
- Observation
- Manipulation
- Problem solving

Activity 1.3: Demonstrating Brownian motion of particles in fluids

This activity will help learners to demonstrate Brownian motion in gases.

HOOK: What caused the perfume to spread throughout the room?

Suggested Teaching and Learning Materials

- **Natural Materials**: Source of smoke
- **Artificial Materials**: Microscope(s), smoke box (or transparent beakers can be used), source of light, convex lens in a holder, worksheet, pollen grains

Note: *Alternatively, virtual demonstrations or videos can be used.*

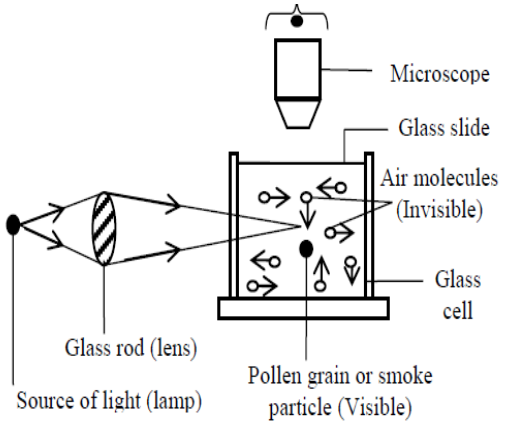
Learning Environment Set-up:

- **Natural Environment:** school surroundings
- **Artificial Environment**: Chemistry laboratory /classroom

Teacher's Roles:

- Introduce the activity by posing a hook such as "*What caused the perfume to spread throughout the room?"*
- Put learners in small groups
- Provide the materials
- Ask learners to assemble materials and apparatus with your guidance
- Ask learners to observe what happens in the smoke box using the microscope
- Ask learners to draw a diagram to illustrate what they observed happening in the smoke box

- Learner assembling materials as shown in the diagram below;



- Learners observing what happens in the smoke box using the microscope
- Learners drawing a diagram to illustrate what they are observing happening in the smoke box

- Observe learners assembling materials as shown in the diagram below;
- Evaluate learners' drawings to illustrate what they observed happening in the smoke box

Explanation (Contexualisations)

The kinetic theory of matter suggests that matter particles are in continuous motion, with Brownian motion being a random and unpredictable movement in fluids. This random movement, known as Brownian motion, is crucial for the diffusion process. As particles move randomly, they mix with each other, leading to uniform distribution and allowing them to move from higher concentration areas to lower concentration areas, thereby enabling diffusion. This theory supports the kinetic theory and facilitates diffusion.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating
- Problem solving

Expected Standard: The conceptual understanding of the kinetic theory of matter demonstrated correctly

 Ask Assessment sample questions such as:

Multiple Choice Questions

1. What is the relationship between temperature and kinetic energy?
   A) Temperature decreases as kinetic energy increases
   B) Temperature increases as kinetic energy decreases
   C) Temperature increases as kinetic energy increases
   D) Temperature remains constant as kinetic energy increases

2. What is the primary evidence for the kinetic theory of matter?

   A) Diffusion
   B) Brownian motion
   C) Phase changes
   D) Both diffusion and Brownian motion

3. What happens to the particles of a substance as its temperature increases?

   A) They slow down and come closer together
   B) They speed up and move further apart
   C) They remain stationary
   D) They change direction

Essay Questions

4. Explain the principles of the kinetic theory of matter, including the relationship between temperature and kinetic energy, motion and arrangement of particles, collision, and diffusion.
5. Discuss the evidence for the kinetic theory of matter, including diffusion and Brownian motion. Provide examples to illustrate your answer.
6. Describe the behaviour of particles in different states of matter (solid, liquid, gas) and explain how the kinetic theory of matter accounts for these differences.

Case Study Questions

7. A container of gas is heated, causing the particles to move faster and spread out. Describe the changes that occur in the arrangement and motion of the particles.

8. A drop of food coloring is added to a glass of water, and the coloring slowly spreads throughout the water. Explain this phenomenon in terms of the kinetic theory of matter.
9. A balloon is filled with air and then placed in a warm environment. Describe the changes that occur in the arrangement and motion of the particles in the air inside the balloon.

- Temperature is a measure of the average kinetic energy of particles in a substance.
- Kinetic energy is the energy of motion, and particles in a substance are in constant motion.
- The arrangement and motion of particles in a substance determine its state of matter (solid, liquid, gas, plasma).
- Particles in a substance collide with each other and with the walls of their container.
- Diffusion is the random movement of particles from an area of higher concentration to an area of lower concentration.
- Diffusion is evidence of the kinetic theory, as it shows that particles are in constant motion.
- Brownian motion is the random movement of particles suspended in a fluid, and it provides evidence for the kinetic theory.
- The kinetic theory explains the behaviour of gases, including the ideal gas law.
- The kinetic theory also explains the process of phase changes, such as melting and boiling.

Sub-Topic 3: Heating and Cooling Curves of Matter

Introduction

When a substance goes through a phase transition such as melting or boiling, the relationship between temperature and time is represented graphically. These graphs are referred to as heating curves or cooling curves. In this subtopic learners will be constructing and interpreting heating and cooling curves.

Specific Competences:

- Construct the heating and cooling curves
- Interpret the heating and cooling curves

- **Boiling point** – The temperature at which the saturated vapor pressure of a liquid is equal to the atmospheric pressure
- **Condensation point** – the temperature at which a gas changes to liquid
- **Freezing point** – The temperature at which liquid changes to solid
- **Latent heat** – Heat energy supplied to or removed from a substance in order for the substance to change its state without changing its temperature
- **Melting point** – The temperature at which a solid change to liquid
- **Phase transition** – change of state

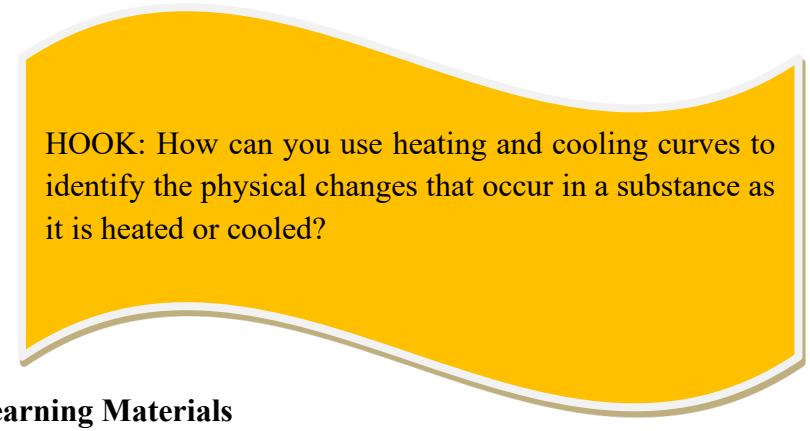
Key Concepts

- Heating Curve
- Cooling Curve
- Key Features heating and cooling curse
- Interpretation heating and cooling curse

Learning Activities:

Activity 1: Constructing and Interpreting heating and cooling curves.

This activity will engage learners in constructing and interpreting heating and cooling curves**.**



Suggested Teaching and Learning Materials

- **Natural Materials**: pure (distilled) water ice
- **Artificial Materials**: Source of heat, heat resistant beakers, wire gauzes, glass rods, cork stoppers with two holes, thermometers, stop watches, clamp stands, tripod stands

Learning Environment Set-up:

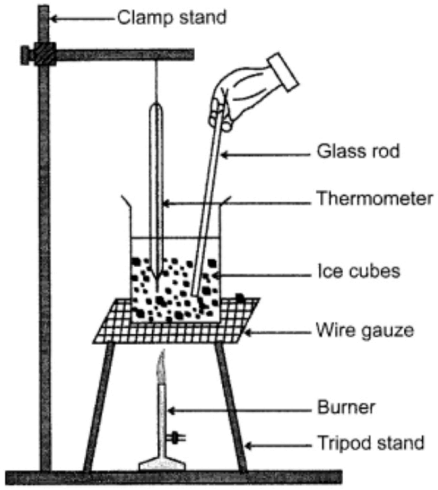
- **Natural Environment:** school surroundings
- **Artificial Environment**: Chemistry laboratory /classroom

Teacher's Roles:

- Introduce the activity by posing a key Question "*How can you use heating and cooling curves to identify the physical changes that occur in a substance as it is heated or cooled?"*
- Put learners in small groups
- Provide the suggested materials
- Ask learners to arrange the apparatus as shown on the worksheet
- Ask learners to heat the ice until the it melts and eventually the water boils
- Ask learners to measure and record the values of temperatures against time, noting the melting and boiling points
- Ask learners to construct the graph of temperature against time
- Ask learners to label on the graph the sections when the water was solid, liquid and gaseous. Also label the melting and boiling points
- Ask learners to construct a cooling curve assuming the water vapour was cooled until the vapour condensed and eventually the water freezes
- Ask learners to label on the cooling curve the sections when the water was vapour, liquid and also label the condensation and freezing points

Care and caution to be taken as there will be open flames, and heat-resistant glassware must be used.

- Learners arranging the apparatus as shown on the worksheet



- Heat the ice until the it melts and eventually the water boils
- Measure and record the values of temperatures against time, noting the melting and boiling points
- Construct the graph of temperature against time
- Label on the graph the sections when the water was solid, liquid and gaseous. Also label the condensation and freezing points
- Construct a cooling curve assuming the water vapour was cooled until the vapour condensed and eventually the water freezes

- Evaluate learners arranging the apparatus as shown on the worksheet and heating the ice until the it melts and eventually the water boils
- Observe learners measuring and recording the values of temperatures against time, noting the melting and boiling points
- Evaluate learners Constructed the graph of temperature against time
- Evaluate learners interpretation of the labelled graph the sections when the water was solid, liquid and gaseous. Also labelled the condensation and freezing points
- Evaluate learners constructed cooling curve assuming the water vapour was cooled until the vapour condensed and eventually the water freezes

Explanation (Contexualisations)

Heating and cooling curves are graphical representations of the temperature changes that occur in a substance as it is heated or cooled. By constructing and interpreting these curves, one can determine the melting point, boiling point, and latent heat of fusion or vaporization of

a substance. The curves also provide information on the physical states of a substance (solid, liquid, gas) and the energy changes that occur during phase transitions. Accurate interpretation of heating and cooling curves requires an understanding of the physical changes that occur in a substance and the potential sources of error in constructing the curves.

- Analytical Thinking
- Communication
- Collaboration
- Observation
- Manipulating

Expected Standards

- Heating and cooling curves constructed correctly
- Heating and cooling curves interpreted correctly

 Ask Assessment sample questions such as:

1. What is the purpose of constructing a heating curve for a substance?

    A) To determine its melting point
    B) To determine its boiling point
    C) To study the changes in its state
    D) All of the above
2. What is represented by the plateau region on a heating curve
    A) Melting point
    B) Boiling point
    C) Phase transition
    D) Temperature increase

3. What can be determined from the slope of a heating curve?

    A) Melting point

B) Boiling point
C) Rate of energy transfer
D) Specific heat capacity

Short Answer Questions

4. Describe the main features of a heating curve for a pure substance.

5. Explain the significance of the melting point and boiling point on a heating curve.

6. How does the shape of a heating curve change when a substance undergoes a phase transition

Essay Questions

7. Describe and explain the construction of a heating curve for a pure substance. How does the curve illustrate the changes in state that occur as the substance is heated?

8. Compare and contrast the heating and cooling curves for a pure substance. How do the curves illustrate the reversibility of phase transitions?

9. Discuss the significance of heating and cooling curves in understanding the thermal properties of substances.

Graph-Based Questions

10. Sketch and label the heating curve for a pure substance, indicating the melting point, boiling point, and any other significant features.

11. Interpret the heating curve for a substance, identifying the phase transitions that occur and the corresponding temperatures.

12. Compare the heating and cooling curves for a substance, explaining any differences or similarities between the two curves.

- Understanding the phases of matter (solids, liquids, gases)
- Identifying key points (melting point, boiling point, freezing point, condensation point)
- Recognising phase transitions (solid-liquid, liquid-gas, gas-liquid)
- Plotting temperature against time to create heating and cooling curves
- Identifying phase changes (plateaus on the curve)
- Determining melting and boiling points from the curve

- Analysing energy changes (slope of the curve indicates rate of energy transfer)
- Comparing heating and cooling curves to understand thermal properties and behaviour
- Identifying anomalies or irregularities in the curves

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