Chemistry

Senior One

Teacher's Guide

FOREWORD

Dear teacher,

Rwanda Basic Education Board is honoured to present Senior One Chemistry Teacher`s Guide which serves as a guide to competence-based teaching and learning to ensure consistency and coherence in the learning of the Chemistry subject. The Rwandan educational philosophy is to ensure that learners achieve full potential at every level of education which will prepare them to be well integrated in society and exploit employment opportunities.

In line with efforts to improve the quality of education, the government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate their learning process. Many factors influence what they learn, how well they learn and the competences they acquire. Those factors include the relevance of the specific content, the quality of teachers' pedagogical approaches, the assessment strategies and the instructional materials available. We paid special attention to the activities that facilitate the learning process in which learners can develop ideas and make new discoveries during concrete activities carried out individually or with peers. With the help of the teachers, learners will gain appropriate skills and be able to apply what they have learnt in real life situations. Hence, they will be able to develop certain values and attitudes allowing them to make a difference not only to their own life but also to the nation.

This is in contrast to traditional learning theories which view learning mainly as a process of acquiring knowledge from the more knowledgeable who is mostly the teacher. In competence-based curriculum, learning is considered as a process of active building and developing of knowledge and understanding, skills and values and attitude by the learner where concepts are mainly introduced by an activity, situation or scenario that helps the learner to construct knowledge, develop skills and acquire positive attitudes and values.

In addition, such active learning engages learners in doing things and thinking about the things they are doing and they are encouraged to bring their own real experiences and knowledge into the learning processes. In view of this, your role is to:

- Plan your lessons and prepare appropriate teaching materials.
- Organize group discussions for learners considering the importance of social constructivism suggesting that learning occurs more effectively when the learner works collaboratively with more knowledgeable and experienced people.
- Engage learners through active learning methods such as inquiry methods, group discussions, research, investigative activities and group and individual work activities.

- Provide supervised opportunities for learners to develop different competences by giving tasks which enhance critical thinking, problem solving, research, creativity and innovation, communication and cooperation.
- Support and facilitate the learning process by valuing learners' contributions in the class activities.
- Guide learners towards the harmonization of their findings.
- Encourage individual, peer and group evaluation of the work done in the classroom and use appropriate competence-based assessment approaches and methods.

To facilitate you in your teaching activities, the content of this teacher`s guide is self-explanatory so that you can easily use it. Even though this teacher`s guide contains the answers for all activities given in the learner's book, you are requested to work through each question and activity before judging learner's findings.

I wish to sincerely extend my appreciation to REB staff who organized the editing process of this Teacher`s Guide. Special gratitude also goes to lecturers, teachers, illustrators and designers who supported the exercise throughout. Any comment or contribution would be welcome to the improvement of this textbook for the next edition.

Dr. MBARUSHIMANA Nelson

Director General, REB

ACKNOWLEDGEMENT

I wish to express my appreciation to all the people who played a major role in the editing process of this Chemistry Teacher`s Guide for Senior Two. It would not have been successful without their active participation.

Special thanks are given to those who gave their time to read and refine this textbook to meet the needs of competence based curriculum. I owe gratitude to different universities and schools in Rwanda that allowed their staff to work with REB to edit this book. I therefore, wish to extend my sincere gratitude to lecturers, teachers, illustrators, designers and all other individuals whose efforts in one way or the other contributed to the success of this edition.

Finally, my word of gratitude goes to the Rwanda Basic Education Board's staff particularly those from the Curriculum, Teaching and Learning Resources Department who were involved in the whole process of editorial work.

Joan Murungi,

Head of CTLRD

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Content Map

Topic area 1: Scope of Chemistry and particulate nature of matter				
Subtopic area	Introduction to Chemistry and experimental techniques		States of matter and kinetic theory	Classification of substances and separation techniques
	Unit 1 Chemistry and society	**Unit 2** Laboratory safety and apparatus	**Unit 3** States and changes of states of matter	**Unit 4** Pure substances and mixtures
Number of lessons	6	15	8	16
Introduction	This unit deals with application of chemistry in our life and its contribution to our economy.	This unit deals with effective use of laboratory equipment/ materials to carry out experiments.	This unit deals with properties of matter in relation to the physical and chemical phenomena.	This unit deals with separation of mixtures to determine their composition.
Classroom organisation	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work
Equipment and materials required	• Computers & internet • Projectors • Charts	• Laboratory apparatus • Chemicals • Projectors • First aid kit • Fire extinguisher	• candle wax • computer • projector • microscope • smoke cell • aquadag • chemicals	• computers • projectors • centrifuge • videos • separation equipment

Activities	Discussion research work field visit report writing	Research work Presentation Laboratory demonstration Role play Practical experiments	discussion practical experiments Observations and recording Research work	Practical experiments Group activities calculation of percentages
Competences practiced	Team work Communication skills Research Critical thinking Creativity Presentation of findings Problem solving	Team work Communication skills Research Critical thinking Presentation of findings Problem solving Lifelong skills	Team work Communication skills Research Critical thinking Creativity Presentation of findings Problem solving	Team work Communication skills Research Critical thinking Creativity Presentation of findings Problem solving
Cross-cutting issues tackled	Inclusive learning Peace and values education Gender education Environment and sustainability Health education financial education	Inclusive learning Gender education Environment and sustainability Health education	Inclusive learning Peace and values education Health education	Inclusive learning Environment and sustainability Health education
Language practice	• Discussion in groups and pairs • Presentation of findings • Making/ writing notes • field interactions	• Discussion in groups and pairs • Presentation of findings • Making/ writing notes • During practical experiment and role play	• Discussion in groups and pairs • Presentation of findings • Making/ writing notes • During practical experiments	• Discussion in groups and pairs • Presentation of findings • Making/ writing notes • Observations and recording

Vocabulary acquisition	Quality, pharmacy, technician, medicine, refinery, vaccines,	Safety, hazard, reagents, fume chamber, spatula, apparatus, precaution, first aid, burette, pipette, Bunsen burner, luminous, condenser	Matter, melting, freezing, evaporation, condensation, sublimation, diffusion, Brownian motion	Substance, solution, solute, solvent, suspension, filtrate, residue, distillate, distillation, contribution, precipitate
Study skills	• Discussion • Note taking • Performing an experiment • Field visit • Research work	• Research work • Note taking • Recording observations in tabular form. • Performing an experiment • Observing and using first aid kit. • Familiarising with the safety rules and symbols	• Discussion • Research work Note taking • Recording observations in tabular form. • Performing an experiment	• Observation of organisms. • Note taking • Recording observations in tabular form. • Performing an experiment
Revision	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.

Formative Assessments	• To assess knowledge and understanding, let learners do Self-evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self-evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self- evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self-evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.
Learning outcomes	To be able to apply chemistry in daily life and its contribution to Rwanda economy today	To be able to recognise and effectively use laboratory equipments/ materials when carrying out experiments	To be able to relate properties of matter to some physical and chemical phenomena in daily life.	To be able to identify pure substance and mixtures, and be able to separate them to determine their composition

Topic area 2: Atomic structure and the periodic table		
Subtopic area	Atomic and molecular structure	
	Unit 5 Atoms, elements and compounds	**Unit 6** Arrangement of elements in the periodic table.
Number of lessons	18	6

Introduction	This unit deals with the meaning of atoms, elements and compounds, their composition and properties.	This unit deals with classification of elements in the periodic table and the properties of different elements.
Classroom organisation	• Whole class orientation • Group work • Individual work • Pair work	• Discussion • Whole class orientation • Pair work • Individual work
Equipment and materials required	• Charts • Computers and internet	• Charts • Videos • Computers and internet
Activities	• Discussion • Research work • Presentations	• Research work • Discussion • Presentation
Competences practiced	• Team work • Communication skills • Research • Critical thinking • Presentation of findings	• Research • Communication skills • Team work • Critical thinking • Presentation of findings
Cross-cutting issues tackled	• Inclusive learning • Peace and values education • Gender education	• Inclusive learning • Peace and values education • Gender education
Language practice	• Discussion in groups and pairs • Presentation of findings • Making/writing notes	• Discussion in groups and pairs • Presentation of findings • Making/writing notes
Vocabulary acquisition	Atom, element, compound, molecule, symbol, protons, neutrons, electrons, electronic configuration.	Group, period, trend in the periodic table.

Study skills	• Discussion • Note taking • Research work	• Research work • Note taking • Recording observations in tabular form
Revision	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.	• Self-evaluation tests and Test your competence provided in the Student's Book and Extension exercises in the Teacher's Guide.
Formative Assessments	• To assess knowledge and understanding, let learners do Self- evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self- evaluationTests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.
Learning outcomes	• To be able to comprehend the structure of an atom and relate the valence to chemical formulae of substances.	• To be able to use atomic numbers, valence electrons and number of shells to classify the first 20 elements in the periodic table.

Topic area 3: Chemistry and environment				**Topic area 4: Chemical reactions**
Subtopic area	Waste management			Types of reactions
	Unit 7 Water and its composition	**Unit 8** Air composition and pollution	**Unit 9** Waste materials	**Unit 10** Chemical equations
Number of lessons	8	9	4	18

Introduction	This unit deals with water, its sources, composition, purification and uses.	This unit introduces learners to the components of air pollution and its prevention.	The unit will equip learners with knowledge on how to minimise and properly manage waste materials.	The content of this unit will enable learners to write and use balanced chemical equations
Classroom organisation	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work
Equipment and materials required	Apparatus for heating different samples of water	Computer, projector, internet access, videos on determination of percentage of oxygen	Computers, projectors and flip charts	Appropriate chemicals and apparatus, computer, projector and internet access
Activities	• Carrying out experiments • Research activities • Presentations • Writing reports	• Carrying out experiments • Video exposition • Research activities • Presentations • Writing reports	• Case studies • Research activities • Carrying out assessments • Project work • Presentations	• Group work • Field visits • Case studies • Carrying out experiments • Research activities • Presentations • Writing reports
Generic competences covered	• Communication skills • Research skills • Critical thinking • Presentation of findings • Cooperation, interpersonal skills and management	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills

		• Cooperation, interpersonal skills and management	• Cooperation, interpersonal skills and management	• Cooperation, interpersonal skills and management
Cross-cutting issues tackled	• Inclusive learning • Gender education • Environment and sustainability • Health education	• Inclusive learning • Peace and values education • Gender education • Environment and sustainability • Health education	• Environment and sustainability • Inclusive learning • Gender education • Environment and sustainability • Financial education • Peace and values education	• Inclusive learning • Peace and values education • Gender education • Environment and sustainability • Health education
Language practice	• Recording observations • Discussion in pairs and groups • Presentation of findings,	• Recording observations • Discussion in pairs and groups • Presentation of findings, observation and results	• Discussion in groups • Presentation of experimental findings, observations and results • Writing observations	• Discussion in groups and pairs • Presentation of findings • Making/writing notes • Presentation of findings, observation and results
Vocabulary acquisition	Vocabularies on water cycle, terminologies on sources of water.	Terminologies on air pollution such as active part of air, greenhouse effect, recycling etc.	Terminologies on waste management such as recycling, reusing, biodegradable etc.	Terminologies on chemical equations such as reactants, coefficients
Study skills		• Researching on percentage of oxygen in the atmosphere • Observing a video • Writing reports • Recording observations • Performing experiments • Having discussions	• Researching on waste management • Having class discussions • Writing reports • Recording observations • Having discussions • Field excursions	• Practising to balance chemical equations • Recording observations • Performing experiments • Familiarising with various equations • Researching on various types of equations

Revision		Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.	Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.	Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.
Formative Assessments		• To assess knowledge and understanding, let learners do Self-evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self-evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solvingabilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self- evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solving abilities as they carry out group discussions • Ask probing questions on attitude change.
Learning outcomes		To be able to: a) Assess the components of air b) Analyse the causes of air pollution and prevention	To be able to minimise and properly manage waste materials	To be able to write and use chemical equations

Subtopic area	Acids, bases and salts		Oxygen and oxides
	Unit 11 Acids and bases and pH	**Unit 12** Inorganic salts and their properties	**Unit 13** Preparation of oxygen and its properties
Number of lessons	9	15	12
Introduction	The unit will equip learners with knowledge on how to extract indicators from flowers and use them to test the observable properties of acids and bases in common domestic substances	This unit will enable learners to analyse properties of different types of salts	The unit will equip learners with knowledge on how to prepare oxygen and other gases and apply different methods of gas collection.
Classroom organisation	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work	• Whole class orientation • Group work • Individual work • Pair work
Equipment and materials required	Flowers (e.g. hibiscus, red cabbages etc.) and common indicators	Appropriate chemicals and apparatus, computer, projectors and internet access	Appropriate chemicals and apparatus, computer, projectors and internet access
Activities	• Case studies • Research activities • Carrying out assessments • Project work • Presentations	• Group work • Field visits • Case studies • Carrying out experiments • Research activities • Presentations • Writing reports	• Group work • Field visits • Case studies • Carrying out experiments • Research activities • Presentations • Writing reports

Generic competences covered	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills • Cooperation, interpersonal skills and management	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills • Cooperation, interpersonal skills and management	• Communication skills • Research skills • Critical thinking • Creativity and innovation • Presentation of findings • Problem solving • Lifelong skills • Cooperation, interpersonal skills and management
Cross-cutting issues tackled	• Inclusive learning • Peace and values education • Gender education • Environment and sustainability • Health education	• Inclusive learning • Peace and values education • Gender education • Environment and sustainability • Health education	• Inclusive learning • Peace and values education • Gender education • Environment and sustainability • Health education
Language practice	• Discussion in groups • Presentation of experimental findings, observations and results • Writing observations	• Discussion in groups and pairs • Presentation of findings • Making/writing notes • Presentation of findings, observation and results	• Discussion in groups • Presentation of experimental findings, observations and results • Writing observations
Vocabulary acquisition	Terminologies such as alkalis, decantation, pH scale, electrode and probe.	Terminologies such as monobasic, normal salt, dibasic	Terminologies such as oxidation, redox, reduction, upward collection, overwater collection, downward delivery etc.

Study skills	• Researching on acids, bases and pH • Writing reports • Recording observations • Performing various experiments	• Researching on inorganic salts and their properties • Recording observations • Performing experiments • Familiarising with various organic salts	• Researching on the various ways of preparing oxygen • Practising to prepare oxygen • Note taking • Recording observations • Familiarising with various uses of oxygen
Revision	Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.	Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.	Self-evaluation tests and Test your competence provided in the Student's Book and Extended exercises in the Teacher's Guide.
Formative Assessments	• To assess knowledge and understanding, let learners do Self-evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solvingabilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self-evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solvingabilities as they carry out group discussions • Ask probing questions on attitude change.	• To assess knowledge and understanding, let learners do Self-evaluation Tests in the student's book • Gauge learner's communication, co-operation, critical thinking and problem solvingabilities as they carry out group discussions • Ask probing questions on attitude change.

Learning outcomes	To be able to: a) Prepare an indicator and use it to test the acidity and alkalinity of solutions of common domestic substances b) Be aware of the dangers associated with handling acids and bases	To be able to analyse properties of different types of salts	To be able to: a) Prepare oxygen b) Collect the gas c) Carry out tests to investigate presence of oxygen d) Show how oxygen reacts with other substances e) Prepare other gases to demonstrate different methods of gas collection

Part I: Introduction

Section 1: Basic information

1.1 Organisation of the book

This teacher's guide is organised into two main sections. Part 1 is the general introduction section detailing pedagogical issues. Part 2 is the main topics area. It gives the details of the expected learning units as organised in the learner's book. The main elements of Part 2 are:

- Topic Area page - detailing the various Subtopic Areas and the units covered under the topic area.
- Unit heading – this is accompanied by some text in the pupil's book to motivate the learners. Also, the total number of lessons per unit is given.
- Key Unit Competence: This is the competence, which will be achieved once students have met all the learning objectives in the unit.
- Outline of main sections in the unit – is a quick summary of the subtopics covered under the unit.
- Learning Objectives: The content in this area is broken down into three categories of learning objectives, that is, knowledge and understanding; skills; attitudes and values.
  - Knowledge and understanding: As in the existing curriculum, knowledge and understanding is very important.
  - Skills: It is through the skills that students apply their learning and engage in higher order thinking. These skills relate to the upper levels of Bloom's taxonomy and they lead to deep rather than surface learning.
  - Attitudes and values: Truly engaging with the learning requires appropriate attitudes and values that relate to the unit.
- Links to other subjects: It is important for learners to gain an understanding of the interconnections between different subjects so that learning in each subject is reinforced across the curriculum. This platform does exactly that. It prepares the teacher to pass this information to the learners so that they are aware!
- Assessment Criteria: This is meant to evaluate whether learners have succeeded in achieving the Key Unit Competence(s) intended. This section will help the teacher in assessing whether the unit objectives have been met.
- Background information: This is the introduction part of the unit. It aims at giving insights to the teacher on the subject matter.
- Additional information for the teacher: This section gives more information than what the syllabus recommends for purposes of preparing the teacher to answer

tough questions from learners.

- Learning Activities: These are given per lesson and have these sub-sections:
  - Lesson titles
  - Specific objectives of the lesson
  - Materials and learning resources
  - Teaching methodology
  - Suggested teaching/learning approach
  - Generic competencies covered
  - Cross-cutting issues covered
  - Special needs and multi-ability learning
  - Formative assessment
  - Extended exercises/activities for fast learners and remedial (reinforcement) exercises/ activities for slow learners.
  - Answers to self-evaluation exercises

These are repeated across all lessons until the end of the unit followed by the answers or tips on the test your competence questions at the end of every unit.

1.2 The Structure of the syllabus

The Chemistry subject is taught and learned in secondary school education as a core subject. At every grade, the syllabus is structured in Topic Areas, and then further broken down into Units. The units have the following elements:

- Unit is aligned with the Number of Lessons.
- Each Unit has a Key Unit Competency whose achievement is pursued by all teaching and learning activities undertaken by both the teacher and the learners.
- Each Unit Key Competency is broken into three types of Learning Objectives as follows:
  - Type I: Learning Objectives relating to Knowledge and Understanding. These are associated with Lower Order Thinking Skills or LOTS.
  - Type II and Type III: These Learning Objectives relate to acquisition of skills, Attitudes and Values. They are associated with Higher Order Thinking Skills or HOTS. – These Learning Objectives are actually considered to be the ones targeted by the present reviewed syllabus.
- Each Unit has a Content area which indicates the scope of coverage of what a teacher should teach and learner should learn in line with stated learning objectives.
- Each Unit suggests Learning Activities that are expected to engage learners in an interactive learning process as much as possible (learner-centered and participatory approach).
- Finally, each Unit is linked to Other Subjects, its Assessment Criteria and the Materials (or Resources) that are expected to be used in teaching and learning process.

In all, the syllabus of Chemistry for secondary level has got three Topic Areas namely:

- Scope of Chemistry and particulate nature of matter
- Atomic structure and the Periodic Table
- Chemistry and the environment

As for units, there are a total of 13 units in Senior 1 (S1).

1.3 Background Information on new curriculum

The goal to develop a competence-based society, the globalisation process, and particularly the growth of the world market and competition at the global level, as well as a shift from knowledge-based to competence-based curriculum necessitated a comprehensive review of the national curriculum to address the required skills in the Rwandan education system.

It is against this background that the Chemistry syllabus at secondary level was reviewed to ensure that the syllabus is responsive to the needs of the learner with a shift from knowledge-based learning to competence-based learning.

Competence-based learning refers to systems of instruction, assessment, grading, and academic reporting that are based on students demonstrating that they have acquired and learned the prerequisite knowledge, skills and attitudes as they progress through their education. Apart from being integrative, the newly revised syllabus guides the interaction between the teacher and the learner in the learning process. It further puts greater emphasis on skills a learner should acquire during each unit of learning. As a competency-based syllabus, it elaborates on the three aspects of knowledge, skills and attitudes in Chemistry.

1.4 Rationale of Teaching and Learning Chemistry

Teaching Chemistry to learners is critical for establishing a foundation for further success in Chemistry and for coping with the demands of the 21st century. Furthermore, Chemistry education constitutes an unequalled important added value. Not only in developed countries but also in developing countries such as Rwanda. The love and interest in Chemistry begins in primary school where young children tend to be more curious and motivated to learn. The inclusion of Science and Elementary Technology and ICT in the Primary School reflects the importance of Science and Technology in many aspects of our daily lives, at work, at school and at home. As integrated science and ICT, it provides a very good foundation for the study of science subjects, such as Chemistry, in the post-primary setting. Most importantly, it cultivates a positive attitude towards Chemistry and provides learners with opportunities to experience the excitement of working as a chemist.

Above all, the rationale of teaching and learning of Chemistry is embedded in the need for learners to have a greater awareness of the role of Chemistry in everyday life. Chemistry, at secondary school, enables the learner to develop competences, which have great impact on the society in general. Teaching Chemistry at secondary school is further justified in that it helps to develop cultural and democratic notions of scientific literacy.

Learners have to be prepared early for active and responsible citizenship. With this regard, Chemistry strives to equip learners to understand and situate scientific and technological developments in their cultural, environmental, economic, political and social contexts. At the centre of teaching and learning of Chemistry, hands on activities will play a key role, which in turn, should contribute significantly towards improving learner's achievement, motivation, technological literacy and test scores.

1.5 Types of Competences and their acquisition

Competences are statements of the characteristics that students should demonstrate which indicate they are prepared and have the ability to perform independently in professional practice. The two types of competences envisaged in this curriculum are basic and generic competences.

a) Basic competences

Basic competences are addressed in the stated broad subject competences and in objectives highlighted year on year basis and in each of units of learning. They include:

1) Literacy

- Reading a variety of texts accurately and quickly.
- Expressing ideas, messages and events through writing legible texts in good hand-writing with correctly spelt words.
- Communicating ideas effectively through speaking using correct phonetics of words.
- Listening carefully for understanding and seeking clarification when necessary.

2) Numeracy

- Computing accurately using the four mathematical operations.
- Manipulating numbers, mathematical symbols, quantities, shapes and figures to accomplish a task involving calculations, measurements and estimations.
- Use numerical patterns and relationships to solve problems related to everyday activities like commercial context and financial management.
- Interpreting basic statistical data using tables, diagrams, charts and graphs.

3) ICT and digital competences

- Locating, extracting, recording and interpreting information from various sources.
- Assessing, retrieving and exchanging information via internet or cell phones.
- Using cell phones and internet for leisure and for money transactions.
- Using computer keyboard and mouse to write and store information.
- Using information and communication technologies to enhance learning and teaching (all subjects).

4) Citizenship and national identity

- Relating the impact of historical events on past and present national and cultural identity.

- Understanding the historical and cultural roots of Rwandan society and how the local infrastructure functions in relation to the global environment.
- Demonstrating respect for cultural identities and expressing the role of the national language in social and cultural context.
- Advocating for the historical, cultural and geographical heritage of the nation within the global dimension.
- Showing national consciousness, a strong sense of belonging and a patriotic spirit.
- Advocating for a harmonious and cohesive society and working with people from diverse cultural backgrounds.

5) Entrepreneurship and business development

- Applying entrepreneurial attitudes and approaches to challenges and opportunities in school and in life.
- Understanding the obligations of the different parties involved in employment.
- Planning and managing micro projects and small and medium enterprises.
- Creation of employment and keeping proper books of accounts.
- Risk-taking in business ventures and in other initiatives.
- Evaluating resources needed for a business.

6) Science and technology

- Apply science and technology skills to solve practical problems encountered in everyday life including efficient and effective performance of a given task.
- Develop a sense of curiosity, inquisitiveness and research to explain theories, hypotheses and natural phenomena
- Reason deductively and inductively in a logical way.
- Use and experiment with a range of objects and tools of science and technology and draw appropriate conclusions.

b) Generic competences

The generic competences are competences that must be emphasised and reflected in the learning process. They are briefly described below and teachers must ensure that learners are engaged in tasks that help them to acquire the competences.

1. **Critical thinking and problem solving skills**: The acquisition of such skills will help learners to think imaginatively, innovatively and broadly and be able to evaluate and find solutions to problems encountered in their surroundings.
2. **Creativity and innovation**: The acquisition of these skills will help learners to take initiatives and use imagination beyond knowledge provided in the classroom to generate new ideas and construct new concepts.
3. **Research skills**: This will help learners to find answers to questions based on existing information and concepts and use it to explain phenomena from gathered information.

4. **Communication in official languages:** Teachers, irrespective of them not being language teachers, should ensure proper use of the language of instruction by learners (which is English at Secondary school level). The teachers should communicate clearly and confidently and convey ideas effectively through spoken and written English by applying appropriate grammer and relevant vocabulary.
5. **Cooperation, interpersonal management and life skills**: This will help the learner to cooperate in a team in whatever task assigned and to practise positive ethical moral values and while respecting rights, feelings and views of others. Perform practical activities related to environmental conservation and protection. Advocate for personal, family and community health, hygiene and nutrition and responding creatively to a variety of challenges encountered in life.
6. **Lifelong learning**: The acquisition of such skills will help learners to update knowledge and skills with minimum external support. The learners will be able to cope with evolution of knowledge advances for personal fulfillment in areas that are relevant to their improvement and development.

Chemistry as a subject and developing the competences

The national policy documents, based on national aspirations, identify some 'basic competences' alongside the 'Generic competences" that will develop higher order critical thinking skills and help the student learn Chemistry for application in real life. The nature of learning activities which are mainly inquiry oriented contribute to the achievement of those competences. Through observation, experimentation and presentation of information during the learning process, the learner will not only develop deductive and inductive skills but also acquire cooperation and communication, critical thinking and problem-solving skills. This will be realised when learners make presentations leading to inferences and conclusions at the end of learning unit. This will be achieved through learner group work and cooperative learning of Chemistry, which in turn will promote interpersonal relations and teamwork.

The manipulation of apparatus and data during class experiments and undertaking of project work by learners will involve analytical and problem-solving skills directed towards innovation, creativity and research activities by learners.

The acquired knowledge in learning Chemistry should develop a responsible citizen who adapts to scientific reasoning and attitudes and develops confidence in reasoning independently. The learner should show concern of individual attitudes, environmental protection and comply with the scientific method of reasoning. The scientific method should be applied with the necessary rigor and intellectual honesty to promote critical thinking while systematically pursuing the line of thought.

1.6 Cross-cutting issues to be infused during learning

These are emerging issues which need to be incorporated in the learning process. Each of the cross-cutting issues has its own important programme of learning reflecting key national priorities. This learning is integrated into the syllabuses of subjects across the curriculum rather than each issue having a dedicated timetable slot of its own. As a result of this integration, the learning activities in the units of subjects across the curriculum incorporate all the learning associated with the cross-cutting issues. The eight cross-cutting issues are:

a) Peace and Values Education

The need for Peace and Values Education in the curriculum is obvious. Peace is clearly critical for society to flourish and for every individual to focus on personal achievement and their contribution to the success of the nation. Values education forms a key element of the strategy for ensuring young people recognise the importance of contributing to society, working for peace and harmony and being committed to avoiding conflict.

b) Financial Education

Financial education makes a strong contribution to the wider aims of education. It makes learning relevant to real life situations. It aims at a comprehensive financial education program as a precondition for achieving financial inclusion target and improves the financial capability of Rwandans. Financial education has a key role of not only improving knowledge of personal but also transforming this knowledge into action. It provides the tools for sound money management practices on earnings, spending, saving, borrowing and investing. Financial education enables people to take appropriate financial services both formal and informal that are available to them and encourages financial behaviours that enhance their overall economic well-being.

c) Standardisation Culture

Standardisation Culture develops learners' understanding of the importance of standards as a pillar of economic development and in the practices, activities and lifestyle of the citizens. It is intended that the adoption of standardisation culture should have an impact upon health improvement, economic growth, industrialisation, trade and general welfare of the people. While education is the foundation and strength of our nation, standards are one of the key pillars of sustainable economic development.

d) Genocide Studies

Genocide Studies provides young people with an understanding of the circumstances leading to the genocide and the remarkable story of recovery and re-establishing national unity. Genocide Studies helps learners to comprehend the role of every individual in ensuring nothing of the sort ever happens again.

The intent of a cross-cutting curriculum around the topic of genocide is to fight against genocide, genocide denial, and genocide ideology; and to equip students with a more fundamental and comprehensive understanding of the

genocide, thereby preventing further human rights violations in the future and enabling Rwanda's population of young people to more competently and thoughtfully enter the workforce. So, it needs to be emphasized.

e) **Environment and sustainability**

The growing awareness of the impact of the human race on the environment has led to recognition of the need to ensure our young people understand the importance of sustainability as they grow up and become responsible for the world around them. Hence Environment and Sustainability is a very important cross-cutting issue. Learners need basic knowledge from the natural sciences, social sciences and humanities to understand and interpret principles of sustainability. They also need skills and attitudes that will enable them in their everyday life to address the environment and climate change issue and to have a sustainable livelihood.

f) **Gender education**

There is a strong moral imperative to afford every individual their basic human rights and gender inequality results in women and girls being treated less favourably than men.A strongly negative impact of unequal treatment, which affects the nation as a whole, is the fact that it results in women being held back and their talents and abilities not being fully realised.With a good understanding of the principles of Gender Equality, it is intended that future generations will ensure that the potential of the whole population is realised.

g) Comprehensive sexuality education (HIV/AIDS, STI, Family planning, Gender equality and reproductive health)

Comprehensive sexuality education, which is age appropriate, gender sensitive and life skills based can provide young people with the knowledge and skills to make informed decisions about their sexuality and life style. Preparing young people for the transition to adulthood has been one of humanity's greatest challenges with human sexuality and relationships at its core. Few young people receive adequate preparations for their sexual lives. This leaves them potentially vulnerable to coercion, abuse and exploitation. Unintended pregnancy and sexually transmitted infections (STIs) including HIV/AIDS. Many young people approach adulthood faced with conflicting and confusing messages about sexuality and gender. This is often exacerbated by embarrassment, silence, disapproval and open discussion of sexual matters by adults (parents, teachers) at very time when it is most needed.

Comprehensive sexuality education supports a rights-based approach in which values such as respect, acceptance tolerance, equality, empathy and reciprocity are inextricably linked to universally agreed human rights.A clear message concerning these dangers and how they can be avoided, from right across the curriculum, is the best way to ensure that young people understand the risks and know how to stay healthy.

h) **Inclusive Education**

Inclusive education involves ensuring all learners are engaged in education and that they are welcomed by other students so that everyone can achieve their potential. Inclusive practice embraces every individual regardless of gender or ability including those with learning difficulties and disabilities. The utmost focus of inclusive curriculum is on ensuring participation in education of learners with different learning styles and other difficulties. To be successful, it entails a range of issues including teacher's positive attitudes, adapting the learning resources, differentiation of teaching and learning methods and working together. Overally, the benefits of an inclusive curriculum extend to all learners.

1.7 Special needs education and inclusivity

All Rwandans have the right to access education regardless of their different needs. The underpinnings of this provision would naturally hold that all citizens benefit from the same menu of educational programs. The possibility of this assumption is the focus of special needs education. The critical issue is that we have persons/ learners who are totally different in their ways of living and learning as opposed to the majority. The difference can either be emotional, physical, sensory and intellectual learning challenges traditionally known as mental retardation. These learners equally have the right to benefit from the free and compulsory basic education in the nearby ordinary/mainstream schools. Therefore, the schools' role is to enrol them and also set strategies to provide relevant education to them. The teacher therefore is requested to consider each learner's needs during teaching and learning process. Assessment strategies and conditions should also be standardised to the needs of these learners. Also, ensure that you include learners with special educational needs in classroom activities as much as possible.

The special needs children can fall in any of the following common categories:

- Physical difficulties
- Visual difficulties
- Hearing difficulties
- Mental difficulties
- Genocide traumatized learners

The teacher should identify such cases and help facilitate the affected learners learning. For example, learners with visual and hearing difficulties should sit near the teacher's table for easy supervision and assistance. The following are some suggestions on how to support special needs learners in your class.

(a) Learners with physical difficulties

In this group of learners, the affected areas are normally some body parts, especially the limbs. There may be partial or total loss of use of the limbs. In case the legs are affected, the learners will need assistance during activities that involve movement. This could be during a nature walk and other activities that learners have to stand for some reason. The teacher should organise for the learner's ease of movement around.

The learner should also be given time to catch up with the others.

In case the hands are affected, the learners should be given more time to finish their work. In both cases, the learners should not be pressurised to do things that can cause injury or ridicule.

(b) Learners with visual difficulties

These learners normally have problems with their eyesight. They should sit in a position where they are able to see the chalkboard without straining

Note: The learner could be either longsighted or short sighted.

The material to be observed should be brought closer to the learner and a magnifying lense used where necessary. The teacher should use large diagrams, charts and labels. In some cases, the learners can be allowed to touch and feel whatever they are looking at. Other learners can assist by reading aloud. The lighting system in the classroom can also be improved.

The teacher should read aloud most of the things he/she writes on the chalkboard.

(c) Learners with hearing difficulties

The affected part in this case is the ear.

The learner should have hearing aids. The teacher should use as many visual aids as possible. They should also project their voice and always talk while facing the learners. Use of gestures and signs while talking helps the learner figure out what the teacher is saying as well.

(d) Learners with speech difficulties

A common example in a normal class is the stammerer. They always speak with a lot of difficulties. The teacher should be patient with them and encourage such learners to express themselves in their own way. Such learners should be given more written exercises.

(e) Learners with mental difficulties

The teacher should try to identify the nature and level of the mental difficulty. Learners with mental difficulties should then be given special assistance and attention at an individual level. They can be given special tests or assessments. In general, all the learners with difficulties should be reinforced promptly. This encourages and motivates them. The teacher and the rest of the class should never ridicule learners with any of the difficulties. Note that generally, people with any kind of disability can be very sensitive to any kind of negative comments or criticism.

Remind them that 'Disability is not inability'.

The teacher should avoid giving privileges where the learners do not deserve them. Treat them fairly but not with undue favours. In extreme cases it can be recommended for the learners to join a special school.

(f) Genocide traumatised learners

Studies have shown that learners from families that were affected by genocide suffer post-traumatic stress disorder (PTSD). As such, they need to be treated as a special case. As a teacher, you need

to be careful when dealing with such learners. Also, the teacher needs to be in control especially when the topic under discussion touches on genocide issues. Any language that may elicit emotional reactions from learners either by fellow learners or by the teacher him or herself should be avoided.

Section 2: Preparing to teach and the teaching process

2.1 Understanding the teaching process

Although the process of teaching aims at guiding the learners on how, rather than what to learn, the process of discovering or finding out cannot exist without content or something to be found out. For example, a teacher cannot teach about classification without something to classify, for instance. On the other hand, nothing can be classified without knowledge of the materials to be classified. It is, therefore, necessary for the teacher to strike a balance between giving some scientific information and guiding the learners to discover on their own through investigations.

Problem-solving in Chemistry

In order to apply problem solving, learners need certain skills. The process of problem solving can be seen as a continuous chain through the following steps:

1. Identifying the problem
2. Collecting information and making relevant observations
3. Making predictions, building a theory or a hypothesis
4. Designing experiments
5. Carrying out or doing the experiments
6. Recording the results
7. Analysing results
8. Making conclusions after comparing predictions with results
9. Communicating or reporting and exchange of information

Most often we do not consciously think about each of these steps every time we try to solve a practical problem. The approach we use to solve our daily problems many times becomes a habit. It is during the early years of our lives that basic patterns of behaviour are established. Therefore, it is very important for learners to master the skills of problem-solving. These skills should be applied many times over to solve problems at the learner's own level of understanding and interest.

Among the basic skills necessary for carrying out the process of scientific problem-solving are:

- Asking questions
- Collecting relevant information
- Making predictions
- Constructing and collecting apparatus and materials
- Sorting and classifying
- Recording of information and results
- Reporting and exchange of information (communication)

Let us briefly discuss each of them.

(a) Asking questions

Learners should be encouraged to ask any question(s) which arise from their work. It is the responsibility of the teacher to help the learners to find answers to their questions or problems through their own observations and experiments.

Instead of giving answers directly, the teacher should help to put the learners in a situation whereby they can find out the answers for themselves. Sometimes, the nature of the learners' questions

makes this impossible. In such a case, the teacher should give an honest answer and research to find the answer.

(b) Collecting information

We can use all our senses to learn more about the world around us. Learners should be encouraged to observe keenly, listen, feel, smell and even taste with caution. Sometimes information can be obtained from suitable reference materials and experts. Whatever the source, careful gathering of information is a major step in problem-solving. It may also lead to discovery of new problems which will need solving.

(c) Making predictions or hypotheses

Predicting is not the same as guessing. We make a prediction only after careful consideration of the information available to us. In other words, because we observed that certain things took place in the past, we suppose that certain other things will happen in the future. For example, if the position of the shadow of a flag post is marked on the ground at 9.00 am, 10.00 am and 11.00 am in the morning, then the learners can predict where the shadow will fall at noon with some level of accuracy.

(d) Construction and collection of apparatus and materials

Experiments in Chemistry most often require apparatus, equipment and other materials. These can be acquired through collection and construction using locally available materials.

(e) Sorting and classifying

Learners should be given an opportunity to group things in ways they themselves believe are suitable. The process of sorting and arranging things gives learners valuable practice in decision-making.

Through classifying, patterns may emerge which may help to solve problems and unveil new ones.

(f) Recording of information

Learners should be encouraged to keep a record of what they do as well as what they observe. These records may be in the form of drawings, charts, models or reports. When records are analysed, conclusions and appropriate decisions can be made.

(g) Drawing conclusions

A skillful teacher can help the learners to look for simple cause and effect relationships based on observations made or the results obtained from an experiment analysed.

A conclusion may be the solution to a problem and sometimes may lead to new problems.

(h) Reporting and exchange of information (Communication)

Learners should be made to realise that they can learn from one another. They should be encouraged to exchange information through reports, displays and discussions.

The conclusions made from an investigation should be communicated to other people who may use it to solve a practical problem.

2.2 Important attitudes in learning of Chemistry

a) In learners

There are certain useful attitudes, which the teacher should help to develop in the learners as they carry out investigations in Chemistry. Chemistry as a problem-solving discipline is expected to make an impact on a learner's general behaviour.

The nature of the scientific method demands learners to be honest with themselves as they record results and make unbiased conclusions. They should be aware of the danger involved in making generalisations out of limited information. They should be open-minded and able to distinguish between propaganda and truth.

Some of the attitudes that learners should develop include:

- Practical approach – to problem solving. Learners should seek answers to their questions and problems by carrying out investigations wherever possible.
- Responsibility – A learner should be responsible enough to effect tasks apportioned and take good care of apparatus during and after an investigation.
- Cooperation – Learners will often be working in groups while carrying out investigations and need therefore to cooperate with all other members of the group.
- Curiosity – Learners should have a curious attitude as they observe things and events around them. This is the first step towards solving a problem.
- Self-confidence – Learners should have the will to attempt to solve a problem. The feeling of self-confidence can be strengthened in young learners if they experience many small successes that win approval and encouragement from the teacher. The problems which learners attempt to solve should not be so difficult that they lead to frustration.
- Honesty – As they make observations, record, analyse results and draw conclusions.
- Patience – Learners should be patient for the results of an experiment which may take time to manifest.

b) In teachers

- Engage students in variety of learning activities
- Apply appropriate teaching and assessment methods
- Adjust instructions to the level of the learner
- Creativity and innovation
- Makes connections/relations with other subjects
- Show a high level of knowledge of the content
- Develop effective discipline skills manage adequately the classroom
- Good communicator
- Guide and counsellor
- Passion for children teaching and learning.

2.3 Philosophy of teaching Chemistry

In the teaching of Chemistry, two definite approaches or techniques

have been used. The first is the passive traditional approach where the teacher is the central figure around whom all other things revolve. In this setup, the teacher talks and issues commands. The learners sit and listen. The teacher treats the learners like an 'empty pot' waiting for information to be poured into it. A small amount may enter, some will stay in while the rest evaporates. This teacher-centred approach has no place in our schools today.

In the second approach, which we call the dynamic or activity-oriented approach and which is being advocated for, the learners are active participants in the learning process. They are the doers and the materials and apparatus they work with are the tellers. The teacher's role is that of a guide and facilitator in the learning process. Chemistry is a practical subject and learners will understand it best by doing.

(a) Learner's role in learning Chemistry

Learning takes place only when the learner has internally digested and assimilated the material to be learnt. As such, learning is a highly personal and individual process. It therefore means that a learner must be actively engaged in the learning exercise.

For active participation in learning, the learner must:

(a) Develop the curiosity, powers of observation and enquiry by exploring the local environment.

(b) Raise questions about what is observed.

(c) Suggest solutions to those questions and carry out investigations to search for answers.

(d) Manipulate a variety of materials in search of patterns and relationships while looking for solutions to problems.

The competence-based approach considers the learning process to involve the construction of meaning by learners. Simply, it emphasises the need for children to think about scientific activity in order to make sense of and understand the Chemical concepts being introduced. In this new dispensation, learners are in the driver's seat, which implies they will construct their knowledge by posing questions, planning investigation, conducting their own experiments, analysing and communicating results. More specifically, when engaging in inquiry, learners will describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. By so doing, the learners will take ownership of the learning process.

Learners' activities are indicated against each learning unit reflecting their appropriate engagement in the learning process. Even though they do not necessarily take place simultaneously in each and every Chemistry lesson and for all levels, over time learners get involved in the following activities:

- Observing and, where possible, handling and manipulating real objects;
- Pursuing questions which they have identified as their own even if introduced by the teacher;

- Taking part in planning investigations with appropriate controls to answer specific questions;
- Using and developing skills of gathering data directly by observation or measurement and by using secondary sources;
- Using and developing skills of organising and interpreting data, reasoning, proposing explanations, making predictions based on what they think or find out;
- Working collaboratively with others, communicating their own ideas and considering others' ideas;
- Expressing themselves using appropriate scientific terms and representations in writing and talk;
- Engaging in lively public discussions in defense of their work and explanations;
- Applying their learning in real-life contexts;
- Reflecting self-critically about the processes and outcomes of their inquiries.

During this reciprocal interaction, what learners will acquire is not only content knowledge, but a number of skills including how to approach a problem, identify important resources, design and carry out hands-on investigations, analyse and interpret data, and perhaps most importantly, recognise when they have answered the question or solved the problem.

(b) Teacher's role in learning and teaching

The teacher is one of the most important resources in the classroom. The teacher's role is central to the successful implementation of the learning programme in the school. The role of the teacher will remain critical however, instead of being the "sage on the stage", the teacher will rather be "the guide on the side" who acts as facilitator in a variety of ways which include:

- Encouraging and accepting student autonomy and initiative;
- Using raw data and primary sources, along with manipulative, interactive, and physical materials;
- Using cognitive terminology such as classify, analyse, predict, and create when framing tasks.
- Allowing student responses to drive lessons, shift instructional strategies, and alter content;
- Familiarising themselves with students' understandings of concepts before sharing their own understandings of those concepts;
- Encouraging students to engage in dialogue, both with the teacher and one another;
- Engaging students in experiences that pose contradictions to their initial hypotheses and then encouraging discussion;
- Providing time for students to construct relationships and create metaphors
- Nurturing students' natural curiosity.
- Organising the classroom to create a suitable learning environment.
- Preparing appropriate materials for learning activities.
- Motivating learners to make them ready for learning.

- Co-ordinate learners' activities so that the desired objectives can be achieved.
- Assessing learners' activities and suggest solutions to their problems.
- Assist learners to consolidate their activities by summarising the key points learnt.

From time to time, the teacher should interact with the learners individually or in groups to diagnose their weaknesses and frustrations, appraise their efforts, imagination and excitement. This will assist and guide them in the task of learning. The teacher must make an effort to teach learners how to team up but still have each learner directly involved in working with materials, consulting with the teacher and with fellow learners. Remember that whatever you do during the class, the interests of the learner remain paramount!

Therefore the teacher should allow and encourage the learners to:

- Explore their local environment.
- Ask questions about things and events.
- Make observations.
- Perform simple investigations and experiments to seek answers to their questions.
- Talk to each other and to the other learners about their experiences, interests, problems, successes and even frustrations.
- Play and make models of things that interest them.

There is no doubt that scientific knowledge is increasing at such a rapid rate that it is impossible for any teacher to teach, or any child to learn, all the information available on any particular topic, within the time allocated. As an alternative, we should take on a strategy that is practical and time-saving. It involves equipping the learners with skills, which they can use to find out information, and solutions to problems in science and in their daily lives. We therefore advocate the teaching of science as a process, combined with providing basic science facts, which are appropriate in content to the age and stage of mental development of children under your charge. The scientific skills which the teacher must endeavor to introduce and promote in his /her learners include:

observing, comparing, classifying (sorting), recording, predicting, experimenting, measuring, controlling variables, collecting data, recognising patterns and relationships, analysing and interpreting data, making conclusions (inferring) and communicating.

These skills, used in conjunction with the introduction of basic science facts will form a firm foundation which learners can build more as they learn both inside and outside of school.

Education at school is about children learning. The process of organizing learners' learning so as to achieve the aims and objectives of the curriculum involves bringing together the needs and characteristics of the learners. To do this, the skills, knowledge and experience of the teacher are all required within a given situation.

2.4 Teaching resources

These refer to things that the teacher requires during the teaching process. They include:

- The classroom
- Textbooks
- Wall charts and wall maps
- Materials and apparatus
- Various tools and equipment
- Models
- Resource persons
- Social facilities such as health centres, other learning institutions, community organisations, etc
- Enterprises such as agricultural farms, industries, among others.

a) Classroom as a learning environment

Classroom generally refers to the place where learning takes place. Pupils learn from everything that happens around them, such as the things that they hear, see, touch, taste, smell and play with. It is therefore important for the teacher to make his classroom an attractive and stimulating environment. This can be done by:

- Carefully arranging the furniture and desks
- Putting up learning and teaching aids on the walls. Examples are wall charts or pictures or photographs.
- Displaying models
- Providing objects for play for example toys.
- Having a display corner in the classroom where learners display their work.
- Securing a storage area

The materials in the classroom should get the learners thinking and asking questions about what is around them and encourage them to do worthwhile activities.

Classroom organisation

A well-organised classroom is an asset to good Science teaching but there is no one correct style to suit all classrooms and situations. However, the teacher should consider the following factors when organising the classroom:

(a) Furniture should be well arranged so as to allow free movement of learners and the teacher.

(b) Set a corner for storing materials so as not to obstruct learners or distract them.

(c) The number of learners in the class and their ages.

(d) Learners should be reasonably spread out so that they do not interfere with one another's activities.

(e) The series of lessons or activities going on for a number of days or weeks such as individual or group work or whole class.

(f) Classroom itself, that is, positions of windows, doors such that learners face the lighted areas of the room.

(g) Personal preferences. But these should be in the interest of the learners especially where you normally stand, you should be able to communicate with all learners, and also have a general view of all learners in the class.

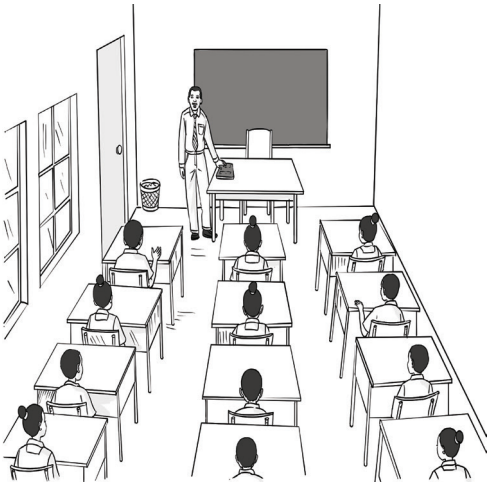


Fig. 1: Sample classroom setting

Grouping learners for learning

Most of the Chemistry activities are carried out in groups and therefore the teacher should place 2 or 3 desks against each other and then have a group of learners sitting around those desks.

In certain activities, the teacher may wish to carry out a demonstration. In this case, the learners should be sitting or standing in a semi-circle, or arranged around an empty shape of letter "U" such that each learner can see what the teacher is doing clearly and without obstruction or pushing. If the learners are involved in individual work, each learner can work on the floor or on the desk or a portion of the desk if they are sharing. In this case, they need not face each other.

Grouping learners for learning has increasingly become popular in recent years. In fact, the shift from knowledge-based to competence curriculum will make grouping the norm in the teaching process. Grouping learners can be informed by one or all of the following:

(a) Similar ability grouping.
(b) Mixed ability grouping.
(c) Similar interests grouping.
(d) Needs grouping.
(e) Friendship grouping.
(f) Sex grouping.

In Chemistry, groupings are commonly those of types (a), (b), (c) and (d). Grouping learners has several advantages such as:

(a) The individual learner's progress and needs can easily be observed.
(b) The teacher-learner relationship is enhanced.
(c) A teacher can easily attend to the needs and problems of a small group.
(d) Materials that were inadequate for individual work can now easily be shared.
(e) Learners can learn from one another.
(f) Cooperation among learners can easily be developed.
(g) Many learners accept correction from the teacher more readily and without feeling humiliated when they are in a small group rather than the whole class.
(h) Learners' creativity, responsibility and leadership skills can easily be developed.
(i) Learners can work at their own pace.

The type of "grouping" that a teacher may choose depends on:

(a) The topic or task to be tackled.
(b) The materials available.
(c) Ability of learners in the class (fast, average, slow).

However, the teacher must be flexible enough to adjust or change his/her type of grouping to cope with new situations.

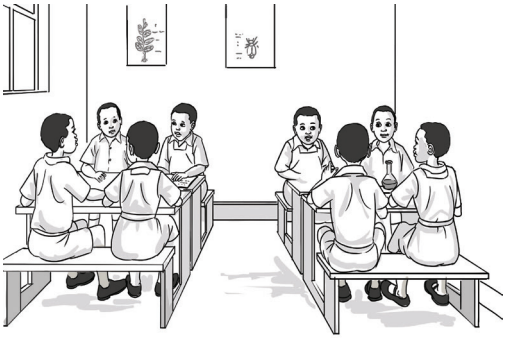


Fig. 2: Sample grouping in a classroom setting

There is no fixed number of learners that a group must have. This again will be dictated by such factors as the task to be done, the materials, characteristics of learners in your class, size and the space available. However, groups should on average have between four to seven learners. You can also resort to pair work depending on the nature of the content being taught at the time.

There is no one method or approach to teaching that is appropriate to all lessons. A teacher should, therefore, choose wisely the method to use or a combination of methods depending on the nature of the topic or subtopic at hand.

Safety in the classroom

Learners in secondary school need to be aware of the safety measures they should consider when handling potentially dangerous objects. The teacher is therefore advised to take strict safety precautions whenever learners are in class or outside the classroom.

Some areas that need consideration as far as safety is concerned include:

- During tasting and smelling things
- When using tools and equipment
- During experiments, demonstrations involving use of fire or harmful chemicals
- When handling glass apparatus
- When handling sharp or pointed objects like machete, pair of scissors, razorblade, knife, etc.
- During nature walks and field visits. Learners should avoid handling poisonous plants and harmful animals, etc.

Remember, according to Rwanda laws, the teacher is responsible for the safety of the children during the period he or she is handling them.

(b) Apparatus and materials

For learners to study Chemistry through the activity method, a number of materials and apparatus are required. The important role played by materials in learning has been felt for centuries. This is noted for instance in the old Chinese proverb that says:

- What I hear I forget
- When I see I remember
- When I do I understand

Since Chemistry is largely a practical subject, materials help the teacher to convey his/ her points, information or develop skills, simply and clearly, and to achieve desired results much faster.

Most of the materials that a teacher requires for Chemistry activities can be collected from the local environment.

Many others can be improvised while some will have to be purchased. Whether collected, improvised or purchased, there are certain materials that are valuable to have around almost all the time. These include:

- Tools: Knife, hammer, chisel, screwdriver, saw, magnifiers, machetes, strings, cloth etc.
- Containers: Tins, gourds, bottles, coconut shells, jars, shells, calabashes a cartons etc.
- Powders: Salt, sugar, flour, soap, powder, ash e.t.c.
- Liquids: Water, kerosene, methylated spirit, used engine oil, cooking oil, ink etc
- Colours: for example, from flowers, leaves, roots and stems, charcoal and chalk.
- Soils: Clay, loam, sand and gravel.

Others include pieces of wood and sticks of various sizes, wires, ropes, nails, pins, thorns, grass stalks, growing plants like peas, beans, maize, seeds and cuttings of various plants.

Improvisation

If each learner is to have a chance of experimenting, cheap resources must be made available. Expensive, complicated apparatus may not always be available in most schools. Such sophisticated equipment made by commercial manufacturers are usually expensive and majority of schools cannot afford them. The teacher is therefore advised to improvise using locally available materials as much as possible. Improvisation should however not be regarded as a cheap substitute of proper laboratory equipment. Many of the great masters of Science used improvised apparatus and many great discoveries have been made using improvised equipment.

Timing of topics and the local weather pattern

Certain topics are best studied during a particular weather condition than at other times. For instance, rapid growth of plants is best observed during the rainy season. Soil erosion by water and siltation are best studied during the rainy season. Certain insects appear only during the dry weather while others emerge with the onset of the rains. Nature walks and visits are best done when the weather is sunny and dry. The teacher should therefore think ahead while making the scheme of work so that the prevailing weather pattern is considered. This will ensure that suitable activities for learning Chemistry are planned for with the weather in mind.

However, a good scheme of work should be sufficiently flexible to cope with unexpected situations and can be altered or modified to suit certain circumstances.

c) Resource persons

A resource person refers to anybody with better knowledge on a given topic area. Examples include health practitioners such as doctors, nurses and laboratory technologists, agricultural extension officers, environmental specialists among others. Depending on the topic under discussion, the teacher can organize to invite a resource person in that area to talk to learners about the topic. The learners should be

encouraged to ask as many questions as possible to help clarify areas where they have problems.

d) Models

A model refers to a three-dimensional representation of an object and is usually much smaller than the object. Several models are available commercially in shops. Examples include model of the heart, skin, lungs, eye, and ears, among others. These can be purchased by schools for use during practicals.

2.5 Teaching methods

There is a variety of possible ways in which a teacher can help the pupils to learn. These include:

(a) Direct exposition
(b) Discovery or practical activity
(c) Group, class or pair discussion
(d) Project method
(e) Educational visit/ field trips
(f) Teacher demonstration
(g) Experimentation

The particular technique that a teacher may choose to use is influenced by several factors such as:

- The particular group of learners in the class
- The skills, attitudes and knowledge to be learned
- Learning and teaching aids available
- The local environment
- The teacher's personal preference
- The prevailing weather
- The requirements of the Chemistry syllabus

(a) Direct exposition

This is the traditional way of teaching whereby the teacher explains something while the learners listen. After the teacher has finished, the learners may ask questions. However, remember that in competence-based curriculum, this technique should be used very minimally.

(b) Guided Discovery

In this technique, the teacher encourages learners to find out answers to problems by themselves. The teacher does this by:

- Giving learners specific tasks to do
- Giving learners materials to work with
- Asking structured or guided questions that lead learners to the desired outcome

Sometimes learners are given a problem to solve and then left to work in an open-ended manner until they find out for themselves.

With the introduction of the new curriculum, this is the preferred method of teaching.

(c) Group or class discussion or pair work

In this technique, the teacher and learners interact through question and answer sessions most of the time. The teacher carefully selects his questions so that learners are prompted to think and express their ideas freely, but along a desired line of thought. Discussion method should take learners from known to unknown in a logical sequence; and works well with small groups of learners. The disadvantage of this method is that some learners maybe

shy or afraid to air their opinions freely in front of the teacher or their peers. This may give them more confident learners a chance to dominate the others. However, the method should be embraced as it intends to eliminate the lack of confidence in learners. Further, it is hoped that it will help improve interpersonal and communication skills in learners.

(d) Project method

In this approach, the teacher organizes and guides a group of learners or the whole class to undertake a comprehensive study of something in real life over a period of time such as a week or several weeks.

Learners using the project method of studying encounter real-life problems which cannot be realistically brought into a normal classroom situation. A project captures learners' enthusiasm, stimulates their initiative and encourages independent enquiry. The teacher, using the project method, must ensure that the learners understand the problem to be solved and then provides them with the necessary materials and guidance to enable them carry out the study. In upper primary, a teacher can use the project method for topics, which cannot be adequately studied during the normal time-tabled school lessons.

Disadvantages

If a project is not closely supervised, learners easily get distracted and therefore lose track of the main objective of their study. Studying by the project method does not work well with learners who have little or no initiative.

(e) Educational visits and trips/ nature walks

This is a lesson conducted outside the school compound during which a teacher and the learners visit a place relevant to their topic of study. An educational visit/nature walk enables learners to view their surroundings with a broader outlook that cannot be acquired in a classroom setting. It also allows them to learn practically through first-hand experience. In all "educational visit/nature walk lessons", learners are likely to be highly motivated and the teacher should exploit this in ensuring effective learning. However, educational visits are time-consuming and require a lot of prior preparation for them to succeed. They can also be expensive to undertake especially when learners have to travel far from the school.

(f) Demonstration lessons

In a demonstration, the teacher shows the learners an experiment, an activity or a procedure to be followed when investigating or explaining a particular problem. The learners gather around the teacher where each learner can observe what the teacher is doing. It is necessary to involve the learners in a demonstration, for example by:

- Asking a few learners to assist you in setting up the apparatus.
- Requesting them to make observations
- Asking them questions as you progress with the demonstration.

This will help to prevent the demonstration from becoming too teacher-centred.

When is a demonstration necessary?

A teacher may have to use a demonstration, for example when:

- The experiment/procedure is too advanced for learners to perform.
- The experiment/ procedure is dangerous
- The apparatus and materials involved are delicate for learners to handle.
- Apparatus and equipment are too few

2.6 Planning to teach

The two most important documents in planning to teach are the schemes of work and the lesson plan.

a) Scheme of work

A scheme of work is a collection of related topics and subtopics drawn from the syllabus and organised into lessons week by week for every term. It is also a forecast or plan that shows details under these subheadings:

- Week
- Key unit competency
- Lesson
- Learning objectives
- Learning resources and reference materials
- Teaching methods and techniques
- Observations/self-evaluation
- Comments from school director (DOS)

In addition, the schemes of work shows the day when a specific lesson will be taught and how long it is intended to take.

- Week - Refers to the week in the term e.g. 1, 2, 3 etc.
- Key unit competency - Gives the competence learners are expected to achieve at the end of the unit.
- Lesson - Refers to the lesson being taught in that week e.g. lesson 1, 2, 3 and 4, etc. This shows which is a single and which is a double lesson.
- Date - The day when the lesson will be taught.
- Subtopic - A subset of the topic which is a smaller component of the unit e.g. under the topic plants, one could have 'parts of a plant' as a subtopic.
- Objective - What learners are expected to achieve at the end of the lesson.
- Learning resources - Any materials that will be used by the learner and the teacher for learning and teaching.
- References - Books or other materials that will be consulted or used in the teaching process. Books that learners will use should also be shown here; indicating the actual pages.
- Observations/self-evaluation - This should be a brief report on the progress of the lesson planned in the scheme of work. Such reports could include: 'taught as planned'. 'Not taught due to abrupt visit by Country Director of Education.' 'Children did not follow the lesson, it will be repeated on... (Specific date).
- Comments from director of school – Space left for comments by the school director.

Below is a sample scheme of work for your farmiliarisation.

Scheme of work

Academic year: 2016

Term: I

School: Musanze Secondary School

Subject: Chemistry

Teacher's name: Joan Twagira

Class: Senior 1

Week	Key unit Competences	Periods	Specific objectives	Resources & References	Teaching methods & techniques	Observations/ self-evaluation
I	Learners should be able to assess the application of Chemistry in our daily life and its contribution to our economy today.	1&2: Importance of Chemistry	Learners should be able to: Explain the need to study Chemistry in secondary schools. Explain the reasons for studying Chemistry in secondary schools.	Computers, internet connection, projector and learner's book	Guided discovery Case studies Research activities Question and answer session Group discussion	

Week	Key unit Competences	Periods	Specific objectives	Resources & References	Teaching methods & techniques	Observations/ self-evaluation
2	Learners should be able to assess the application of Chemistry in our daily life and its contribution to our economy today.	3 & 4: Chemistry related careers	Learners should be able to identify Chemistry related careers.	Learner's book, dictionaries, computers, internet connectivity.	Group Discussions Guided discovery Research activities Case studies	

3		5 & 6: Contribution of Chemistry to the Rwandan economy	Learners should be able to state the contribution of Chemistry to the Rwandan economy.	Learner's book, internet connectivity, reference books, a nearby farm, charts showing the various ways Chemistry is contributing to Rwandan economy		
Comments from School Director/ DOS						

b) Lesson plan

A lesson plan is a detailed outline of how the teacher intends to carry out a specific lesson.

Important sub-headings of a Lesson Plan

1. **Administrative details**

   Date…… Subject…….

   Class…….

   Time……. Roll…….....

2. **Topic area**

   Broad area that is to be studied, taken from the syllabus.

3. **Subtopic area**

   A smaller topic of the topic about which a lesson will be taught.

4. **Key unit competence**

   This is/are the competence(s) that the learner is expected to achieve at the end of the unit.

5. **Learning Objectives**

   These represent what the teacher anticipates pupils to achieve by the end of the lesson. Objectives should be clear and specific. They should also be stated in behavioural terms, that is, in a way that the outcome can be seen, displayed or measured. In learning Chemistry, one should distinguish between knowledge, skill and attitude objectives.

6. **Learning/teaching resources**

   Any materials and apparatus that the learners and the teacher will use during the lesson.

7. **References**

   Any resources consulted or used by the teacher to prepare the lesson as well as any books that the pupils will use during the lesson.

8. Introduction

This is the start of the lesson. The teacher should motivate the learners by creating learning situations that interest learners e.g. posing a problem, telling an amusing but relevant story or episode, showing an object or picture that arouse their interest. The introduction should link what the learners have already learnt with what they are going to learn.

9. Presentation/lesson development

This should mainly include the activities that learners and the teacher will perform in order to achieve the stated objectives; as well as the questions that learners will answer as they do the various activities.

It is convenient to distinguish between the learners' and teacher's activities under two columns.

10. Summary/conclusion: (Consolidation)

This is the step in which the lesson activities are tied up or consolidated to emphasise the main points, summarise the lessons or make conclusions. The summary should correspond to the objectives stated for that lesson.

11. Comments/self-evaluation:

Teacher should write remarks on whether the objectives were achieved or not and what he or she intends to do to improve on the weak points noted during the lesson.

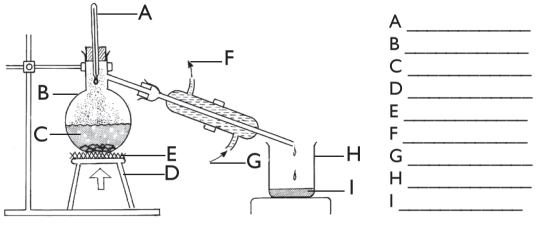
COMPETENCE – BASED LESSON PLAN

School Name: KAWE GIRL'S HIGH SCHOOL **Teacher's name**: PATRICK MUJUNI

Term	Date	Subject	Class	Unit N°	Lesson N°	Duration	Class size
I	2 /03/ 2016	CHEMISTRY	S1	4	6 of 16	80 minutes	40

Type of special educational needs and number of learners	-Learners with low vision (2) -Learners with auditory/hearing problems (1) -Learners with language difficulty (3).
Topic area:	Scope of chemistry and particulate nature of matter.
Sub-topic area:	Classification of substances and separation techniques.
Unit title	Pure substances and mixtures
Key Unit Competence:	To be able to separate mixtures and determine their composition.
Title of the lesson	Simple distillation
Instructional objective	Using a thermometer, round-bottomed flask, Liebig condenser, rubber tubes, source of heat, rubber stopper, banana beer ("Urwagwa") conical flask/beaker, tap water and retort stand, learners should be able to separate properly components of a solution into pure substances.
Plan for this class (location: in / outside)	Laboratory work in groups of five.
Learning materials (for all learners)	Thermometer, round-bottomed flask, Liebig condenser, rubber tubes, source of heat, rubber stopper, banana beer("Urwagwa") conical flask/beaker, tap water, retort stands and its accessories, salt solution, projector, computer and its accessories, a memory stick/ DVD containing the video to be used in the lesson.
References	Whitten, Davis & Peck (1996): General Chemistry (pages 29-38). LONGHORN Senior 1 Chemistry, (pages 65-66) https://www.youtube.com/watch?v=xxNfJLMNS4E

Timing for each step	Description of teaching and learning activity		Competences and cross cutting issues to be addressed
	Using the materials/apparatus provided, procedure and experimental set up, learners perform experiments to separate ethanol from banana's beer (Urwagwa). They make a report and then present their findings.		
	Teacher activities	**Learner activities**	
Introduction / 10 minutes	Teacher asks questions about the previous lesson concerning evaporation and sublimation as methods of separating mixtures: Examples 1. What is a mixture? 2. Describe how these processes can be used to separate mixtures: Filtration and decantation. 3. Explain how sublimation and evaporation can be used to separate mixtures with examples.	Learners respond to the teacher's questions and also ask questions about the previous lesson for clarification. Learners discuss the importance of evaporation and sublimation as methods of separating mixtures.	Problem solving, communication and cooperation as learners think about and discuss the importance of evaporation and sublimation methods of separating mixtures.
Development of the lesson 60 minutes	Teacher assists learners to: form groups of 5 considering learner's of different abilities. Provides experimental procedure, materials/ apparatus to guide learners how to carry out the experiment. Facilitates the learners to harmonize their findings. **Note:** Avail big print of procedures to help learners with low vision. Encourage both female and male students to equally participate during the experiment and presentations.	Form groups Read the procedure and check the materials to be used in the experiment. Perform the experiment and write a report. NOTE: Learners with low vision to be given procedures in large print or brail for blind learners. Present findings in groups. The gifted learners help to harmonize the groups' presentations. During presentation, learners with low vision and hearing difficulties will occupy front seats. **Study questions:** **Question 1:** Discuss and suggest the dangers of taking alcohol especially the substandard alcohol. **2.** Discuss the contribution of distillation process in Rwandan economy.	Communication and cooperation and critical thinking as learners carry out the experiment, discuss the results and write and present their reports. Standardization culture will be developed as learners discuss the dangers of substandard alcohol consumption Financial education as learners talk about contribution of distillation to Rwanda economy

Conclusion/ 10 minutes	Showing video about distillation on large scale or use the available text books in the library. Teacher briefly highlights the key points related to the presentation land clarifies misconceptions met during the lesson. Facilitates to make conclusion of the lesson. Gives home work Learners with difficulty using English should always be provoked to suggest some answers. Write the home work on black board or provide worksheets containing the home work	Learners watch the video, listen, comment and compare with their findings from the experiment. https://www.youtube.com/watch?v=xxNfJLMNS4E **Key notes:** **Distillation** is the heating of liquid to form vapour and condense the vapour to form the liquid again. It is mostly used in beer making industry Dangers associated with substandard alcohol consumption: **Rape/sexual abuse, homicides, poverty in families, family violence/abuse, etc.** Contribution of distillation in Rwandan economy: **Water purification, alcoholic beverages, petroleum products, perfume** **&food flavourings** Write the homework in their exercise books: 1. Define distillation and examples of mixtures that can be separated by distillation. 2. Label the parts of the diagram below.  3. Discuss the dangers caused by excessive consumption of alcohol.	
Teacher self-evaluation	**In case of incomplete experiment for one of the groups, the teacher should make arrangements to cover it again with students.**		

This teacher's book has been written to help you guide learners to learn Chemistry in the most enjoyable and captivating manner. You are reminded to always arouse the curiosity of learners as you teach. Some things that you may do before you go for a lesson include:

- Go through the expected learning outcomes – this should help guide the manner of teaching.
- Read through the unit for the lesson in advance to get an overview of the content required.
- Form a mental picture of the teaching situation and the ways in which you will interact with learners when dealing with the suggested activities.
- Collect the materials that will be needed during the lesson in advance.
- In some cases, try out the suggested activities/experiments in advance to avoid embarrassments like - the experiment failing to work during the lesson.

Remember: The suggested teaching activities in this book are just a guide. You may not need to follow them to the letter. Feel free to incorporate other innovative teaching methods that will help in delivering the intended content optimally.

Section 3: Assessment and evaluation methods

Assessment is the process of evaluating the teaching and learning processes through collecting and interpreting evidence of individual learner's progress in learning and to make a judgment about a learner's achievements measured against defined standards. Assessment is an integral part of the teaching and learning processes. In the new competence-based curriculum assessment must also be competence-based; whereby a learner is given a complex situation related to his/her everyday life and asked to try to overcome the situation by applying what he/she learned.

3.1 Types of assessment

The two types of assessment that will be employed in the new curriculum is formative and summative assessment.

a) Formative and continuous assessment (assessment for learning)

Formative or continuous assessment involves formal and informal methods used by schools to check whether learning is taking place. When a teacher is planning his/her lesson, he/she should establish criteria for performance and behaviour changes at the beginning of a unit. Then at the of end of every unit, the teacher should ensure that all the learners have mastered the stated key unit competences basing on the criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject matter and the generic competences described in the syllabus and from this, the teacher will gain a picture of the all-round progress of the learner. The teacher will use one or a combination of the following:

- Observation to judge the extend of skills acquisition
- Written tests
- Oral questions
- Project work
- Attitude change – this can be done by asking probing questions and checking body language as learners respond to the questions.

(i) Written tests

Under this, learners are given questions or tasks and are required to respond in writing. Examples of written tests are: short answer type questions, structured type questions, filling blanks, multiple choice questions, true-false questions and matching items.

(ii) Practical work or Activity

In this category, learners are required to perform a task or solve a problem practically. The teacher then assesses the finished work by looking at the materials used, procedures followed, whether it works or not or whether it is finished. He or she then awards marks accordingly.

(iii) Observation

This involves the teacher observing learners as they perform a practical task to assess acquisition of skills and attitude change. The teacher checks ability of the learner to measure, classify, communicate findings, etc. He or she also assesses the learner's curiosity, patience, team and cooperation spirit among others.

(iv) Oral questions or interviews

Asking learners questions which require a verbal response such as naming parts of human body, a system or short explanations of a process such as digestion can also be used to assess a learner's level of competence.

(v) Drawing

This involves asking learners to draw something they have observed or learnt about. They can also collect data and draw graphs and interpret the graph and give conclusions. This helps to assess their skill in communication through recording.

(vi) Project work

In a project, learners undertake a comprehensive study of something in real life over a period of time such as several weeks or even months after which they present a report. In project work, let learners begin from planning stage (come up with a schedule of events), execute the plan, analyse the results and look back (reflect on the challenges encountered during the project and come up with solutions to those challenges (problem-solving skills).

A teacher can use one or several of these assessment methods depending on the subtopic being studied or the purpose for which assessment is required.

When should the teacher assess learning progress?

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered. The general criteria to use to gauge learner achievement in the various generic competency areas is given in the table below.

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
COMM – Communication in English
Green – Good I
& C – Interpersonal skills & cooperation
Yellow – Excellent
CT – Critical Thinking
Blue – Average R S – Research Skills
LL – Lifelong skills
PS – Problem solving skills
C & I – Creativity & Innovation

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored here and in the various tests given to assess skills acquisition and attitude change.

b) Summative assessment (assessment of learning)

When assessment is used to record a judgment of a competence or performance of the learner, it serves a summative purpose. Summative assessment gives a picture of a learner's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether learning objectives have been achieved and to use the results for the ranking or grading of learners, for deciding on progression, for selection into the next level of education and for certification. This assessment should have an integrative aspect whereby a student must be able to show mastery of all competencies.

It can be internal school based assessment or external assessment in the form of national examinations. School based summative assessment should take place once at the end of each term and once at the end of the year. School summative assessment average scores for each subject will be weighted and included in the final national examinations grade. School based assessment average grade will contribute a certain percentage as teachers gain more experience and confidence in assessment techniques and in the third year of the implementation of the new curriculum it will contribute 10% of the final grade, but will be progressively increased. Districts will be supported to continue their initiative to organize a common test per class for all the schools to evaluate the performance and the achievement level of learners in individual schools. External summative assessment will be done at the end of S6.

Item writing in summative assessment

Before writing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on, the number of questions in each level of Bloom's taxonomy and the marks allocation for each question. In a competency based curriculum, questions from higher levels of Bloom's taxonomy should be given more weight than those from knowledge and comprehension level.

Before developing a question paper, the item writer must ensure that the test or examination questions are tailored towards competency based assessment by doing the following:

- Identify topic areas to be tested on from the subject syllabus.
- Outline subject matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.

- Prepare a table of specifications.
- Ensure that the verbs used in the formulation of questions do not require memorization or recall answers only but testing broad competencies as stated in the syllabus.

Structure and format of the examination

There will be 2 papers in Chemistry subject to be examined. Paper 1 will consist of both semi-structured and extended questions and paper 2 is practical. Duration of the exam will depend on the paper's items and it should range between 2hrs 30 mins - 3hrs.

Paper	Component	Time	Weight
Paper 1	Multiple choice, structured short answer and extended questions	2hrs 30 mins	70%
Paper 2	Practical skills: the paper to consist of experiments drawn from different topic areas of the syllabus	3 hrs	30%

3.2 Record Keeping

This is gathering facts and evidence from assessment instruments and using them to judge the student's performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used shall generate data in the form of scores which will be carefully be recorded and stored in a portfolio because they will contribute for remedial actions, for alternative instructional strategy and feed back to the learner and to the parents to check the learning progress and to advice accordingly or to the final assessment of the students.

This portfolio is a folder (or binder or even a digital collection) containing the student's work as well as the student's evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as papers and assignments), but also it is a record of the activities undertaken over time as part of student learning. The portfolio output (formative assessment) will be considered only as enough for three years of Advanced level. Besides, it will serve as a verification tool for each learner that he/she attended the whole learning before he/she undergoes the summative assessment for the subject. The results from the portfolio will contribute 50% on summative assessment of each year.

3.4 Reporting to parents

The wider range of learning in the new curriculum means that it is necessary to think again about how to share learners' progress with parents. A single mark is not sufficient to convey the different expectations of learning, which are in the learning objectives. The most helpful reporting is to share what students are doing well and where they need to improve.

Part II: Units Section

Chemistry and Society

(Number of Periods - 15)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to assess the application of Chemistry in our daily life and its contribution to our economy today.

Unit outline

- Definition of Chemistry
- Reasons why we study Chemistry
- Applications of Chemistry
- Contribution of Chemistry to the economy of the country

Learning objectives

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is, knowledge and understanding, skills acquisition and attitude and values. At the end of the lesson, the learner should have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 1.1 Knowledge, skills and values to be attained

Knowledge and understanding	Skills	Attitudes and values
By the end of this unit, the learner should be able to: • Explain the importance of Chemistry in daily life. • Explain the reasons for studying Chemistry in secondary schools. • Identify Chemistry related careers. • State the contribution of Chemistry to the Rwandan economy.	By the end of this unit, the learner should be able to: • Link Chemistry applications to culture and work. • Write a standard report on field visits and findings of research. • Present the findings of the research and field study in convincing way.	By the end of this unit, the learner should: • Appreciate the need to study Chemistry in secondary schools. • Appreciate the importance of Chemistry in our lives and the contribution of Chemistry to the social and economic development of our country. • Develop a culture of cooperation and working in a team. • Develop self confidence to deliver presentations.

Links to other subjects

The contents in this unit can be applied in farming whereby fertliliser application is studied. In Geography, electrolytic reduction, a concept in Chemistry is applied in mining while manufacture of quality goods and provision of quality services is an important area in economics.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the 'test your competence' at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting high achievers and remedial exercises.

To assess skills acquisition – you may ask learners to do a research and present their findings in a convincing way. Also, particular questions have been suggested in the 'test your competence' 1 that target assessing skills acquisition.

To assess attitude change – you may ask probing questions aimed at finding out what careers learners would like to pursue. Their attitude can then be gauged by finding out if the kind of careers they have given are Chemistry related. Also, specific questions have been provided in the 'test your competence 1' which target attitude change and societal values.

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered.

The general criteria to use to gauge the various generic competences are given in the table below.

Table 1.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives.

Background information

Many of the natural and industrial processes rely on Chemistry for explanation hence it is an important area of study in both lower and higher levels of study. Chemistry is the study of structure,composition and properties of substances under different conditions. Emphasize the need for taking Chemistry seriously in the course of your lessons. You should also motivate the learners and help them change their attitude towards Chemistry.

This unit is about the importance of Chemistry to the society. Chemistry prepares learners for certain career courses such as medicine and dentistry. Knowledge obtained from Chemistry is applied in the industrial manufacture of certain products. Employment provided by these industries and consumption of their products has an overall effect on economic growth

Additional information for the teacher

Everything in life is made of chemicals. We are made of chemicals ourselves. So is our dog, our desk, the Sun among others. Drugs are also made of chemicals. Food is made from chemicals too. Emphasize this fact to learners

Many of the changes we observe in the world around us are caused by chemical reactions. Examples include changing colors of leaves, cooking food and even the cleaning and burning processes. Knowing some chemistry can help us make day-to-day decisions that affect our lives.

Other careers in chemistry:

(a) Career in Business or Management

Chemistry or engineering degree works wonders with an MBA, opening doors into management of labs, engineering firms, and industry. Chemists with a nose for business may start their own companies or work as sales representatives or technicians for instrument companies, consulting firms, pharmaceutical companies, personal care products companies, etc…

(b) Technical Writer

Technical writers can work on instructional manuals, patents, and research proposals among others. Remember all those lab reports you slaved over and how hard you worked at communicating complex science concepts to friends in other fields? A degree in chemistry hones the organizational and writing skills needed for a technical writing career path. Chemistry major covers all the bases of science, since they take courses in biology and physics in addition to chemistry.

(c) Software Designer

In addition to spending time in a lab, chemistry majors can work on computers, both using and writing programs to help with calculations. An undergraduate degree in chemistry can be the springboard for advanced studies in computer science or programming. Or, the learner may be in a position to design software, models, or simulations

straight out of school, depending on their skills.

The list is endless for careers in chemistry, such as:

Agrochemistry , Analytical Chemistry, Astrochemistry ,Atmospheric Chemistry , Biochemistry, Biotechnology , Ceramics Industry , Chemical Information Specialist, Chemical Sales, Consumer Products , Environmental Chemistry, Environmental Law, Ethnobotany, Forensic Science, Geochemistry, Government Policy , Hazardous Waste Management, Metallurgy, Military Systems, Oceanography, Paper Industry, Patent Law, Perfume Chemistry, Petroleum and Natural Gas Industry, Plastics Industry among others.

1.1 Definition of Chemistry

1.2 Importance of Chemistry

PERIODS 1 and 2: Definition of Chemistry and importance of Chemistry

Refer to the learner's book

Specific objective

By the end of these lessons, learners should be able to define Chemistry, explain why we study Chemistry in secondary schools and identify Chemistry related careers.

Materials and learning resources

High cost	Low cost/no cost
Real objects; soap, a packet of milk, plastic utensils and soda	Chalkboard
High cost	**Low cost/no cost**
	Learner's book
	Chart on Chemistry related careers

Teaching methodologies

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

The two lessons will be taught in two periods. This will involve mainly activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested Teaching/Learning activities/approaches

- Introduce the unit by emphasizing the need to take Chemistry seriously and the benefits of Chemistry in the society.
- Tell the learners that some of the things that we use everyday are manufactured through chemical processes**.** The learners should appreciate the study of Chemistry.
- Let learners name some things that they know. Let them brainstorm on their uses and whether it is important to have them.
- Let the learners work in pairs and do Activity 1.1, and 1.2 in learner's book. Let them appreciate the fact that many substances around us are chemical substances and are studied in Chemistry. As they work in pairs, they learn to co-operate with their friends and listen to their opinion. This will improve their **co-**

operation and **interpersonal skills**.

- Guide the learners to answer the study questions in the activities. This will enhance their **critical thinking** and **problem solving skills**.
- Put the materials you brought for study on the table, ask the students to differentiate them based on their physical appearances.
- Now you can define the meaning of Chemistry to the whole class.
- In the second lesson, let the learners carry out activity 1.3 as you guide them on how to answer the study questions. Let them know that Chemistry is important for one to pursue certain careers.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with visual or hearing difficulties can sit in front of the class. Also encourage both gender to embrace the study of Chemistry because both male and female learners have the ability to do well. The teacher ensures equal presence, equal participation and equal achievement for all categories of leaners in his/her class.
- **Peace, values and gender education** - Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Research skills** – as learners find out in advance things made through. chemical processes.
- **Communicating in English** – as learners discuss the questions in Activity 1.2 & 1.3 and answer teacher's guiding questions.
- **Critical thinking** – As learners think about their findings in activity 1.2 and 1.3.

Formative assessments

- Ask diagnostic questions and self assessment test 1.1 to assess knowledge and understanding.
- Assess skills acquisition by asking learners to look for the meaning of Chemistry from the dictionary.
- Assess attitudes and values by finding out if they appreciate role played by chemistry in the industry.
- Gauge learners language competence during class discussion in activity 1.2 and 1.3 encourage them to discuss in English even if some of them may have difficulties to express themselves, they will learn from each other.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during group activities.

Table 1.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted with visual aids such as charts. The slow learners may also be allowed more time to search the meaning of Chemistry from other books and reading materials. • Slow learners to be guided on how to search information from the dictionary and the internet. • Give slow learners a chart showing various careers and ask them to identify them.	• The teacher should ensure learners with special needs are spread across the groups so that they interact fully with other learners. • Learners with visual and hearing problems can be allowed to sit in front of the class. • The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 1.1

1. Assess the opinion of every learner and correct accordingly. Guide them on how to choose their career. Help them change their attitude where necessary.
2. Learners should give relevant answers. For exampe, Chemistry provides us with the knowledge of recycling of waste and proper waste disposal.

1.3 Applications of Chemistry in Industry

PERIOD 3 and 4:Applications of Chemistry

Refer to the learner's book

Specific objective

By the end of these lessons, learners should be able to explain various areas where Chemistry is applied.

Materials and learning resources

High cost	Low cost
Chlorine, toothpaste, soda, tissue paper	Chalk board notes
	Learner's book
	Chart on the applications of Chemistry

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Questions and answers
- Discussions

Preparation for the lesson

The two periods will be taught in one lesson. It will involve mainly activities by the learners as the teacher is engaging learners in a discussion regarding

the activities and assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching/learning activities/approaches

- Introduce the lesson by emphasizing the fact that industrial processes applies knowledge obtained from the study of Chemistry.
- Tell the leaners that some of the products that we use everyday are manufactured through the application of knowledge obtained from the study of chemistry. Learners should appreciate the study of Chemistry.
- Let learners name some products that they always buy from shops. Let them brainstorm on their uses and whether it is important to have them.
- Let learners work in pairs and do Activity 1.4 in the learner's book. Guide the learners to answer the study questions in the activity. As they work in pairs, encourage them to co-operate with their friends and listen to their opinion. This will improve their **co-operation** and **interpersonal skills**. They should discover the application of Chemistry in the manufacturing processes.
- Put the materials you brought for study on the table. Ask the students to differentiate them based on their physical appearances.
- In the second lesson, let the learners provide answers to self evaluation test 1.2 as you guide them accordingly.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with visual or hearing difficulties can sit in front of the class.
- **Peace, values and gender education** – Let the learners see the need to accommodate other people's views in a discussion.
- **Standardization culture** – Encourage learners to develop a habit of buying quality products.
- **Environment, conservation and sustainability** – Let the learners know the importance of reusing and recycling plastic products. Also encourage them to separate degradable waste such as remains from foods stuff from non-biodegradable waste such as plastic and glass bottles at their homes.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Research skills** – as learners find out in advance the contribution of Chemistry to the economy of Rwanda.
- **Communicating in English** – as learners discuss the questions in Activity 1.4

- **Critical thinking** – As learners think about their findings in the activity 1.4

Formative assessments

- Use self evaluation test 1.2 to assess knowledge and understanding.
- Assess skills acquisition by asking learners questions linking applications of Chemistry to culture and work.
- Asssess attitudes and values by finding out if they appreciate the fact that Chemistry knowledge is applied in the manufacture of many materials and in many processses.
- The way they answer questions in activity 1.4, will help you gauge their attitudes towards Chemistry.
- Gauge learners language competence during class discussion of activity 1.4
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners.

Table 1.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted using visual aids such as charts. The charts should have a range of products manufactured using chemistry knowledge. • The teacher may organize for a visit to a nearby pharmacy or water treatment for them to see the products Made using the knowledge of chemistry..	• The teacher should ensure learners with special needs are spread across the groups so that they interact fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 1.2

a. Evaluate every learner based on how they are able to link manufacture of chlorine and its effects on disease causing microorganisms found in water.

b. Assess answer based on how the learners are able to link Chemistry knowledge to the industrial manufacture of fertiliser.

c. Let learners demonstrate that they know how to choose quality fuel for vehicles.

d. Application of Chemistry in the manufacture of medicine must be brought out clearly.

1.4 Contribution of Chemistry to the economy of Rwanda

PERIOD 4 and 5: Contribution of Chemistry to the economy of the country

Refer to the learner's book

Specific objective

By the end of these lessons, learners should be able to state the contribution of Chemistry to the economy of Rwanda.

Materials and learning resources

High cost	Low cost/no cost
Computers and projectors	Chalkboard notes
High cost	**Low cost/no cost**
	Learner's textbook
	Chart on contribution of Chemistry to the economy of Rwanda

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

The two lessons will be taught in one period. It will involve mainly activities by the learners. The teacher will then engage learners in a discussion on how Chemistry has contributed to the economy of Rwanda and assess learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching/learning activities/approaches

- Introduce the lesson by finding out if learners have any idea of what economy means.
- Let the learners brainstorm numerous areas of Rwandan economy.
- Let learners create link between Chemistry to the economy by naming some of the manufactured products in shops.
- In the second lesson, take the learners to the field. Encourage them to ask questions as they relate their observations with what they learnt in class on the contribution of Chemistry to the economy.
- After the visit allow each group to do a presentation of the report from the field visit. As you guide them through presentations, encourage them to improve their **communication skills**.
- Assess communication skills and confidence then award marks accordingly.

Cross cutting issues

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties should be allowed to sit in appropriate positions in the classroom.
- **Environment, conservation and sustainibility** – Let the learners know that some chemical processes have adverse effect to the environment.
- **Peace, values and gender education** – Encourage both girls and boys to study Chemistry.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners engage in class discussion.
- **Research skills** – as learners brainstorm and link Chemistry to the economy.

- **Communicating in English** – as learners discuss in the class
- **Critical thinking** – Let learners think of the impacts of not having Chemistry as an area of study to the economy.

Formative assessments

- Use some of the questions in the 'test your competence 1' to assess knowledge and understanding of the contribution of Chemistry to the economy of Rwanda.
- During presentation after the field visit observe and listen to learners to assess if they are able to communicate effectively and encourage them to improve.
- Assess skills acquisition by asking learners to write a standard report on the field visit and present it in a convincing way.
- Asssess attitudes and values by finding out if they appreciate the fact that Chemistry knowledge is applied in the manufacture of many materials and in many processes.
- The way they answer questions in the unit competence, will help you gauge their attitudes towards contribution of Chemistry to the economy of Rwanda.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share out responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on how they have scored on the table for assessment criteria.

Table 1.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later.	• The teacher should ensure learners with special needs are spread across the groups so that they participate fully with other learners.
• Slow learners can be assisted using visual aids such as charts.This will enable them internalize the requisite knowledge. • Slow learners to be guided on how to search information from the internet.	• Learners with sight problems can be allowed to sit at convenient positions. • The fact that disability is not inability should be driven home well.

Table 1.6 Additional excercises

Remedial excercises for slow learners	Extended exercises for fast learners
1. Name some of the chemical products used in the kitchen while at home. 2. What are some of the soaps and detergents used at home?	1. Account for the contribution of Chemistry to our society. 2. Establish the link between Chemistry and Geography.

Table 1.7 Answers to additional exercises

Answers to remedial exercises	Answers to extended exercises
1. Table salt, cooking fat and soap 2. Learners to give names of the local soaps.	1. Learners to explain the application of Chemistry knowledge in hospital and industries. 2. Electrolysis, a concept in Chemistry is applied in mining.

Consolidation activities

1. *Almost everything in life is made up of chemicals. Name five things that are made up of chemicals.*

   Ans: Food, medicine, charcoal, salt, cigarette, alcohol, wood, etc.

2. *Musisi observes that a blacksmith mixes metals, heats them in a furnace to produce other stronger metals for use in a steel company. What branch of chemistry is involved here?*

   Ans: Metallurgy

3. *Chemists can also work as software designers. Describe what the job will entail.*

   Ans: Writing programs aimed at solving complex chemistry problems using a computer.

4. *Does rusting of a nail constitute a chemical reaction? Why*

   Ans: Yes. It involves a reaction between iron and oxygen to form iron (III) oxide.

5. *Explain how chemistry contributes to the growth of Rwanda economy in the following sectors:*

   a) Transport industry

   b) In commerce

   Ans: a) In fuel processing and road construction b) In manufacturing of products which are then sold.

6. *Special care should be taken to store kerosene oil. Give a reason.*

   Ans: kerosene oil is a combustible substance and produces heat and light immediately when heated so special care should be taken to store kerosene oil.

7. *When the clothes of a person catch fire, the person is covered with a blanket to extinguish the fire. Can you guess why?*

   Ans: Blanket cut off supply of air or oxygen to extinguish the fire

8. *How does water help to extinguish fire?*

   Ans: When water is poured over a burning substance, it absorbs heat from the substance. As a result the temperature of the substance falls below the ignition temperature, and it stops burning.

Answers to Test Your Competence 1

1. Check whether the student is able to recognise the close association of Biology and Chemistry and their importance in the field of medicine.
2. Mark correct as long as the learner is able to mention an area in Geography and Agriculture where Chemistry knowledge is required.
3. a. The learner should explain how vaccines are important especially in reducing infant mortality and helping in cutting expenditure on health.
   b. The increase in harvest due to application of fertilizers in farming should be brought out clearly.
   c. Efficient transport and communication system allows faster delivery of goods and services to the consumer. hence faster trade.
4. Knowledge obtained from Chemistry enables us to understand the effects of pH changes to the crops. Farmers are thus able to take care of their soils.
5. Ensure all the parts of the report are tackled. Award marks accordingly.
6. D
7. To decant or filter drinking water to remove all impurities. Treat the water to kill diseasse causing microorganisms. Boil water before drinking.
8. Learner C.

Unit 2 Laboratory safety and Apparatus

(Number of Periods - 15)

Refer to learner's book

Key unit Competence

After studying this unit, the learners should be able to use effectively laboratory equipment and materials to carry out experiments.

Unit outline

- Definitions of Laboratory
- Laboratory Safety
- Laboratory apparatus (Names, diagrams and uses)

Learning objective

Chemistry as a subject is learnt in a special room called the Laboratory. The equipment tools used in learning chemistry are called apparatus. To use these apparatus in the laboratory safely there are safety rules, which must be observed. The teacher should let learners understand that other science subjects such as Biology and Physics are also learnt in Laboratory and use similar apparatus. Emphasize that the safety rules used in Chemistry is also applicable in Biology and Physics.

As you teach this unit, you should ensure that learners acquire the following knowledge, skills, values and attitudes.

Table 2.1 Knowledge, skills and values to be attained

Knowledge and Understanding	Skills	Attitudes and values
By the end of this unit the learner should be able to: - State the safety rules and precautions usually followed in a chemistry laboratory. - Explain the uses of common laboratory apparatus.	By the end of this unit the learner should be able to: - Appropriately interpret warning signs about danger and hazards. - Effectively use and handle common laboratory apparatus/ equipment (e.g. fire extinguisher measuring cylinders, separating funnel, thermometer, Bunsen Burner and beam balance. - Draw common laboratory apparatus.	By the end of this unit the learner should: - Respect laboratory rules and regulations. - Show vigilance and caution when handling chemicals and apparatus. - Take care of oneself, colleagues, individuals and public materials. - Develop confidence in the use of laboratory apparatus.

Links to other subjects

This unit is linked to Biology and Physics both of which use almost similar apparatus.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the test your competence 2 at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting high achievers and remedial exercises.
- To assess skills acquisition – you may ask learners to interprete warning signs about dangers and hazards. You can also give a learners some apparatus to carry out a particular exercise and assess how they go about it or ask them to draw some apparatus. Particular questions have been suggested in the 'test your competence 2' that target assessing skills acquisition.
- To assess attitude change - you may use role play to see how they respond for example in case of a fire outbreak. Their attitude can then be gauged by finding out if they care about others and public property. Ask them to carry out a simple experiment to gauge the confidence with which they handle the apparatus. Also, specific questions have been provided in the 'test your competence 2' which target attitude change and societal values.

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered.

The general criteria to use to gauge the various generic competences are given in the table below.

Table 2.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking

Blue – AverageRS – Research Skills
LL – Life long skills, C & I – Creativity & Innovation
PS – Problems solving skills

Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives.

Background information

Like other science subjects, Chemistry is taught mainly by use of experiments. Experiments are mainly carried out in the laboratory. Some experiments produce flames while others lead to production of poisonous gases. Therefore emphasize the need to be careful and cautious while carrying out experiments.

This unit is about laboratory safety apparatus. It involves laboratory rules and regulations that must be adhered to while handling chemicals and apparatus. These rules are meant to reduce cases of accidents and also increase the accuracy of experimental results.

Additional information for the teacher

- Syringe is sometimes used for accurately measuring values of liquids.
- Other apparatus used to provide heat in the laboratory include spirit burner and stove. The learners should be made aware of these apparatus as some of them are used at home for lighting and cooking for example the spirit lamp.
- Apparatus that can be used for measuring time include stopwatch and stop clock.

2.1: Definition of a laboratory

2.2: Laboratory safety

PERIODS 1, 2, 3 and 4: Definition of a laboratory and laboratory safety

Refer to the learner's book

Specific objective

By the end of this lesson, learners should be able to define the term laboratory and observe laboratory safety.

Materials and learning resources

High cost	Low cost/no cost
First Aid kit	Chalkboard
	Learner's book
	Charts on laboratory rules and regulations

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

The four periods will be taught in two lessons. It will involve mainly activities by the learner. The teacher will engage learners in a discussion regarding the activities and assess learning achievements.

You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching/learning activities/approaches

- Introduce the lesson by emphasizing the fact that Chemistry is majorly studied in the laboratory.
- Let the learners know that most experiments involves flammable and poisonous materials and also some apparatus too need to be handled with care as they are expensive.
- The learners should see the need to be careful while carrying out experiments.
- Let the learners work in pairs and do questions in the dicussion corners. As they work in pairs, they improve their co-operation and interpersonal skills.
- Guide the learners to answer the questions in the discussion corners. This will enhance their critical thinking and problem solving skills. They should appreciate the importance of the different rules of the laboratory.
- Put the First Aid kit and charts for study on the table. Ask the students to observe the rules on the charts after dicussion and remind them of the use of First Aid kit.
- Use role play to emphasize some of the laboratory rules.

Cross cutting issues

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties should be allowed to bsit in convinient positions.
- **Peace, values and gender education** – Let the learners see the need to accommodate other people's views in a discussion.
- **Financial education** – Encourage learners to develop a habit of responsible use of resources. For example electricity.
- **Environment, conservation and sustainability** – Let the learners know the importance of proper disposal of wastes. E.g. dispose separately halogenated waste (such as chlorinated) from non-chlorinated waste.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Research skills** – as learners find out in advance about laboratory.
- **Communicating in English** – as learners discuss the questions in the discussion corners.
- **Critical thinking** – As learners think about their findings in the discussion corners.

Formative assessments

- Assess attitudes and values by finding out if learners appreciate the fact that Chemistry is learnt in "house" laboratory. Use the house analogy.
- Ask oral questions to assess knowledge and understanding. For example:

  a) Name some of the rooms found in the laboratory.

  b) What will you do in case a reagent spills on your hands?
- Listen and gauge learners language competence during class discussion and correct them accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussions.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted using visual aids such as charts. This will enable them internalize the requisite knowledge. • Slow learners to be guided on how to search information from the internet.	• The teacher should ensure that groups formed are balanced in terms of learners physical and academic ability. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 2.1

1. Assess learners answer based on whether they have some care towards others.
2. The answer here should show that the learner is now vigilant and is ready to act incase of an emergency.
3. The learners should bring out the importance of First Aid and reporting to the technician any accident that occurs in the laboratory.
4. Learners should remember the need to inform the laboratory technician before attempting any experiment in the laboratory.

PERIODS 5,6,7 and 8: Laboratory safety precautions and warning labels

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to interpret safety precautions and warning labels.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Leaner's book
	Chart/manilla paper on laboratory safety symbols
High cost	**Low cost/no cost**
	No smoking and corruption free symbols,laboratory symbols and labels.

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

These lessons will be taught in two periods. It will involve an activity by the learners as the teacher is engaging them in a discussion and assessing their learning achievements.You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by reminding the learners the need to observe laboratory rules so as to avoid dangers and risks associated with laboratory reagents and apparatus.
- Remind the learners that laboratory precautions and labels are meant to improve safety in the laboratory.
- Let the learners work in pairs and do Activity 2.1 in the learner's. As they work in pairs they improve their co-operation and interpersonal.
- Guide the learners to answer in the discussion corner. This will enhance their critical thinking and problem solving skills.
- Allow them to link the importance of road signs and rules with those ones in the laboratory.
- Put the materials you brought for study on the table, ask the learners say what the symbols imply.
- In the third and fourth period, let the learners carry out activity 2.1 as you provide proper guidance.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with visual or hearing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Research skills** – as learners find out in advance the various signs on laboratory reagents.

- **Communicating in English** – as learners discuss the questions in the discussion corner.
- **Critical thinking** – As learners think about their findings in the dicussion corner.
- **Problem solving skills**-As learners make the safety symbols.

Formative assessments

- You may ask learners some diagnostic assessment questions in the course of the lesson to gauge their knowledge and understanding of the laboratory safety precautions and warning labels.
- Learners acquisition of skills can be assessed by asking them to make laboratory safety symbols and labels. Also find out if they can interpret other warning signs about dangers and hazards by asking them diagnostic questions.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion.
- Use some of the questions in the self evaluation test 2.1 to assess attitude towards laboratory safety precautions.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and waring signs. This will enable them internalize the requisite knowledge. • Slow learners to be guided on how to search information from the internet.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

PERIOD 9: Measures to take in case of accidents

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to develop interest in taking care of oneself, colleagues, individual and public materials.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Pictures of a bandaged leg, a patient being resuscitated.

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

The lessons will be taught in one period. It will involve mainly activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to list some laboratory rules which are precautionary.
- Use role play to let learners know what they should do in case of an accident.
- Let the learners work in pairs and answer questions in the discussion corner.
- As they work in groups they improve their co-operation and interpersonal skills.
- Guide the learners to answer questions in the discussion corner. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the need to give First Aid before a patient is taken to the hospital.
- Put the materials you brought for study on the table, ask the learners to explain what they mean.
- Both slow and fast learners to try and give their thoughts on the pictures as you correct them where necessary.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.

- **Communicating in English** – as learners discuss the questions in the discussion corner.
- **Critical thinking** – As learners think about their findings in the discussion corner.

Formative assessments

- You may ask learners some diagnostic assessment questions in the course of the lesson to gauge their knowledge and understanding of the measures to take in case of accidents.
- Learners acquisition of skills can be assessed by use of role play,during which you observe the actions taken by each learner.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion.
- Use some of the questions in the self evaluation test 2.2 to assess their attitude towards accident victims.Allow learners to exchange and mark each other's books.This should be a fair exercise. Let them voice any disagreeable answer.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted using visual aids such as photographs of bandaged cuts and burns This will enable them internalize the requisite knowledge. • Slow learners to be guided on how to search information from the internet.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 2.2

1. The answer should portray an attitude change to the better towards the visually impaired. Observing road signs that indicate that 'it is' safe to cross.
2. Answers can include describing features of an object to them, explaining observations among others.
3. Responses to this question should correspond to the appropriate laboratory rules and regulations. Refer to learners book.
4. To avoid confusion that might lead to accidents.

2.3 Laboratory apparatus

PERIOD 10: Laboratory apparatus

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to handle common laboratory apparatus effectively.

Materials and learning resources

High cost	Low cost/no cost
Thermometer	Chalkboard
Electronic weighing balance	Learner's book
	Charts on laboratory apparatus

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in one period. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by mentioning that the equipment used to carry out experiments are known as apparatus.
- The learners should appreciate the relevance of studying apparatus in their daily lives through subsequent activities.
- Let the learners work in pairs and do Activity 2.2 and answer questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions in the activities. This will enhance their **critical thinking** and **problem solving** skills.
- Let them appreciate the fact that many of the apparatus used in the laboratory are also useful in daily life.
- Put the materials you brought for study on the table, ask the learners to mention what they are and what they are used.
- Put more emphasis of the apparatus to avoid expenses incurred in replacing new sets some of which are expensive. Let the learners name such apparatus.
- Use the chart to emphasize uses of some laboratory apparatus.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.

- **Peace, values and gender education** – Let the learners see the need to accommodate other people's views in a discussion.
- **Financial education** – Learners should develop ahabit of handling the apparatus with care to reduce damages.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in the discussion corner.
- **Critical thinking** – As learners think about their findings in activity 2.2.
- **Problem solving skills**-As learners try to solve some of the problems presented in activity 2.2.

Formative assessments

- You may ask learners some diagnostic assessment questions in the course of the lesson to gauge their knowledge and understanding of the laboratory apparatus and their uses.
- Learners acquisition of skills can be assessed by taking the learners to the laboratory and observing how they manipulate the apparatus.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Use certain diagnostic questions to assess their attitude towards taking care of oneself,colleagues and public materials.Also take the learners to the laboratory and assess how vigilant and cautionary they are while handling apparatus.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be given homework to go and draw certain laboratory apparatus. • Fast learners may be given an assignment of describing the functions of certain apparatus. • Slow learners to be guided on how to search information from the internet.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with vision problems can be placed in front of class. • Physically challenged learners to be given priority when observing apparatus • The fact that disability is not inability should be driven home well.

PERIOD 11: Sources of heat in the laboratory

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to name sources of heat in the laboratory.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
Stove	Learner's book
	Candle
	Spirit lamp

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in one period. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by mentioning the importance of heat in changing the properties of substances hence its necessary while carrying out many experiments.
- Mention the Bunsen burner, its brief history and why it is the most prefferred source of heat in the laboratory.
- Let the learners work in pairs and answer questions in the discussion corners.
- As they work in pairs they improve their **co-operation** and **interpersonal** skills.
- Guide the learners to answer the questions in the discussion corner. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that costs and environmental impact are factors to consider when describing on the kind of heat source we use at home and in school.
- Put the materials you brought for study on the table, ask the learners to name them.
- Let learners suggest the most suitable source of heat to use in the laboratory.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education** – Let the learners see the need to accommodate other people's views in a discussion.

- **Financial education**- Emphasis on the economical use of energy.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in the discussion corners.
- **Critical thinking** – As learners think about their findings from the discussion corner.

Formative assessments

- You may ask learners some diagnostic assessment questions in the course of the lesson to gauge their knowledge and understanding of other sources of heat that can be used in the laboratory.
- Learners acquisition of skills can be assessed by asking the learners to assemble different parts of the Bunsen burner.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Use certain diagnostic questions to assess their attitude towards the criteria of choosing the appropriate fuel to use while at school and at home.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can assist in holding parts of the Bunsen burner as the teacher explains their functions this enables them internalize the requisite knowledge. • Slow learners can be asked to give examples of sources of heat used at home while fast learners may give reasons why certain sources are preferred over others.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

PERIOD 12: How to light a Bunsen burner

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to light the Bunsen burner.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book
High cost	**Low cost/no cost**
	Candle,matchbox
	Spirit lamp

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in two periods. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements. The teacher will then demonstrate to the learners on how to light the Bunsen burner. Because it will be a practical period, you are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Let learners know that the Bunsen burner is lit following a particular set of instructions just as other sources of heat we use at home.
- Remind them by use of questions the different parts of the Bunsen burner.
- Let the learners work in pairs and do Activity 2.3 and the questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the questions in the discussion corner. This will enhance their **critical thinking** and **problem solving skills**.
- Let them appreciate the fact that the different sources of heat used at home must be lit in a particular way to avoid occurrence of accidents.
- Put the materials you brought for study on the table, ask the learners to describe how they are lit.
- In the second period, demonstrate activity 2.3. Let them appreciate that extra care is important when lighting a Bunsen burner to prevent any injuries.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with visual and hearing difficulties can be put in front of the class.

- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in discussion corner.
- **Critical thinking** – As learners think about their findings from the discussion corner.

Formative assessment

- You may ask learners some oral questions in the course of the lesson to gauge their knowledge and understanding of how different sources of heat are lit.
- Learners acquisition of skills can be assessed by asking the learners to demonstrate how to light the Bunsen burner. Provide guidance and correct where necessary.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Use certain self evaluation test 2.3 questions to assess their confidence in the lighting the Bunsen burner. You could ask them to exchange their books and mark them. Let it be a fair exercise.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.8 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may explain how a stove is lit as a prelude to the lighting Bunsen burner.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 2.3

1. Mark and award accordingly.
2. a. Regulate the size of the air hole.
   b. Enable the Bunsen burner to sit on a bench and be stable.
   c. To raise the flame to a suitable height for heating or lighting.

PERIOD 13 and 14: Flames of the Bunsen burner

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to differentiate the two different kinds of flames of the Bunsen burner.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book
	matchbox

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in two periods. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements. The teacher will guide the learners on how to light the Bunsen burner in the second period. Because it will be a practical period, you are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to describe the kind of flames produced by the sources of heat used at home.
- Let the leaners know that there are two kinds of flame produced by the Bunsen burner.
- Let the learners work in pairs and do Activity 2.4 in learner's book
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions in the activities. This will enhance their **critical thinking** and **problem solving skills**.
- Let them appreciate the fact that the kind of flame produced depends on whether the airhole is open or closed.
- In the second lesson, lead the learners in discussing the different parts of the Bunsen burner flames. Let them understand why the luminous flame produces soot.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 2.4
- **Critical thinking** – As learners think about their findings in the activity 2.4
- **Problem solving skills**-As the learners try to light the Bunsen burner on their own.

Formative assessments

- You may ask learners some oral questions in the course of the lesson to gauge their knowledge and understanding of the different flames of the Bunsen burner.
- Learners acquisition of skills can be assessed by asking the learners to demonstrate how to light the Bunsen burner. Provide guidance and correct where necessary.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Keenly observe as the learner lits the Bunsen burner to assess his/her attitude towards taking care of others.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.9 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may be allowed to draw sketches of the flames as the lesson continues. • Slow learners may just participate and make sketches later.	• The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

PERIOD 15: Heating effects of luminous and non-luminous flames

Refer to learner's Book

Specific objective

By the end of this lesson, the learners should be able to differentiate the heating effects of the two kinds of flame.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book
	matchbox
	Measuring cylinder, ruler, tripod stand, wire gauze and beakers.

Teaching methodologies

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

The teacher will first demonstrate the experiment to the learners. Because it will be a practical lesson, you are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasizing need to use the suitable flame when heating substances to be able to get the desired results in an experiment.
- Lead the learners in discovering the fact that the non-luminous flame is the most preferred flame used for heating in the laboratory.
- Let the learners work in pairs and do Activity 2.5 in learner's book. As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions in the activity. This will enhance their **critical thinking** and **problem solving skills**.
- Let them appreciate the fact that the two kinds of flames produced by the Bunsen burner have different heating effects.
- After the activity, guide them in discussing different parts of the flames and lead them to discovering the hottest part of the non-luminous flame.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 2.5.

- **Critical thinking** – As learners think about their findings in the activity 2.5.
- **Problem solving skills**-As the learners try to light the Bunsen burner on their own.

Formative assessments

- Ask questions to test understanding and knowledge for example 'Which of the two kinds of the Bunsen burner flames can be used when heating substances in the laboratory?"
- Learners acquisition of skills can be assessed as the learners light the Bunsen burner. Provide guidance and correct where necessary.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Keenly observe as the learner lits the Bunsen burner to assess his/her attitude towards taking care of others.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 2.10 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners may take short notes as they discuss while the slow learners may write notes later. • Slow learners can be assisted using visual aids such as charts with the two kinds of flame. This will enable them internalize the requisite knowledge.	• The teacher should ensure learners with special needs are spread across the groups so that they participate fully with other learners. • Learners with sight problems can be placed in front of class. • The fact that disability is not inability should be driven home well.

Table 2.11 Additional excercises

Remedial exercises for slow learners	Extended exercises for fast learners
1. Name two apparatus that can be used in the Chemistry laboratory for measuring volume. 2. State one use of a Burette 3. State one laboratory rule.	1. What is safety? 2. Explain why laboratory rules are important when working in the laboratory? 3. Explain what you will do if a fellow learner is cut by broken glass in the laboratory? 4. Name the most suitable piece of apparatus that can be used for preventing a compound from absorbing atmospheric moisture.

Table 2.12 Answers to additional exercises

Remedial exercises for slow learners	Extended exercises for fast learners
1. Measuring cylinder, pipette	1. State of being free from danger or harm.
2. For accurate measurement of volumes.	2. To prevent occurences of accidents
3. Do not eat anything in the laboratory.	3. The learner must display first aid skills. 4. Dessicator.

Consolidation Activities

1. *Chose the substances which will produce flame on burning from this list: Charcoal, molten wax, paper, coal, mustard oil.*

   Ans: molten wax and mustard oil.

2. *Draw a well-labelled diagram for the flame of a candle and answer the following:*

   Questions:

   (a) Which zone is luminous and why?

   (b) Why is the innermost zone grey in colour and the coldest zone?

   (c) Which zone is called the zone of complete combustion and why?

   Ans: Figure – Luminous flame

   (a) Innermost zone is luminous due to partial combustion. The unburnt carbon particles impart a pale-yellow colour to the flame.

   (b) The innermost zone is grey in colour and the coldest zone because it contains unburnt gas particles. No combustion takes place here as no oxygen is available.

   (c) Outer most zone is called the zone of complete combustion. Here, carbon and hydrogen are completely oxidized to carbon dioxide and water vapour.

3. *Why is it dangerous to burn coal in a closed room?*

   Ans: When coal burns in a closed room toxic fumes or smoke or other harmful products are produced.

4. *Write any four characteristics of good fuel.*

   Ans: The main characteristics of a good fuel are:

   i) Is readily available and cheap.

   ii) Does not leave behind any undesirable substances.

   iii) Is easy to store and transport.

   iv) Burns at a moderate rate.

   v) Produces a large amount of heat.

   vi) Does not cause pollution.

5. *Name the gases, which lead to formation of acid rain.*

   Ans: Oxides of sulphur and nitrogen dissolve in rainwater forming acids. Such rain is called Acid Rain. It is very harmful for crops, buildings and soil.

6. *How does CO_2 help in firefighting?*

   Ans: Carbon dioxide is the best fire extinguisher to put out fire caused by inflammable materials

like oil and petrol and electrical equipment. Carbon dioxide is heavier than air and it covers the fire and cuts off the supply of oxygen and puts out the fire.

7. *What are the drawbacks of using solid fuel?*

   Ans: The drawbacks of solid fuels are as follows:

   – They have a high ignition temperature.
   – They produce a large amount of residue (soot, ash) after combustion.
   – Their calorific value is low.

8. *What are the harmful effects on the environment due to burning of fuels?*

   Ans:

   i) Fuels like wood, coal, petroleum release unburnt carbon particles, which cause respiratory diseases like asthma.

   ii) Incomplete combustion of fuels release carbon monoxide gas, which is a very poisonous gas, which can cause death.

   iii) Burning of most fuels release carbon dioxide gas which causes rise in the temperature of the atmosphere. This is called global warming. It causes melting of polar ice, rise in sea level and flooding of coastal areas.

9. *Define fuel. Give examples of solid, liquid and gaseous fuels.*

   Ans: A substance that undergoes combustion and produces a lot of heat without producing undesirable by-products.

   i) Solid fuels: - wood, coal, charcoal etc.
   ii) Liquid fuels: - kerosene, petrol, diesel etc.
   iii) Gaseous fuels: - CNG, LPG, biogas, hydrogen etc.

10. *Differentiate between combustible and non-combustible substances giving two examples of each kind?*

    Ans: Combustible substances: Substances which burn in air to produce heat and light. Examples are wood, coal, charcoal, kerosene, petrol, diesel, liquefied petroleum gas (LPG), compressed natural gas (CNG) among others. Substances like stone, glass, iron nails, etc. do not burn on being exposed to flame. Such substances are called non-combustible substances.

11. *What is combustion?*

    Ans: The chemical process in which a substance reacts with oxygen to produce heat. OR Combustion is the burning of substances in air or oxygen to release heat and light.

12. *Why does a candle stop burning when covered with a glass tumbler?*

    Ans: A candle stop burning when covered with a glass tumbler due to absence of oxygen that support burning. Air is necessary for combustion.

13. *How is spontaneous combustion different from explosion?*

    Ans: Spontaneous combustion: - is combustion in which a substance burns spontaneously and produces heat and light without the help of external heat. E.g.: - phosphorus

burns spontaneously at room temperature

Explosion: - is a combustion in which a substance burns suddenly and produces heat, light and sound with the help of heat or pressure. Example :- explosion of crackers on applying heat or pressure.

14. *Why is L.P.G labelled as inflammable substance?*

    Ans: L.P.G has low ignition temperature and catches fire easily so L.P.G l abeled as inflammable substance.

15. *Which substance added to LPG to detect any leakage?*

    Ans: A small amount of ethyl mercaptan, an inert gas with a characteristic odour, is added to LPG to detect any leak.

Answers to Self-evaluation Test 2.4

1. Learners should name at least two apparatus that can be used for heating in the laboratory.
2. Non-luminous flame.
3. Incomplete combustion of carbon particles due to insufficient air. The carbon particles glow producing light.
4. • Pipette
   • Preparing accurate volumes of liquids.
   • Holding small quantities of substances while heating.
   • Separating funnel.

Answers to Test Your Competence 2

1. a. (i) Luminous
      (ii) Non-luminous
   b. X – Thin outter region
      Y – Green-blue region
      Z – Yellow region
      W – Almost colourless region
2. a. A pair of tongs
   b. It is made of material that cannot conduct heat.
3. a. Drawing of a pipette (refer to the learners book)
   b. To allow easy observation
4. The learner must provide the precise apparatus used in each case.
5. Mark and award marks accordingly
6. Learners should display their understanding of laboratory rules.

Unit 3 States and changes of States of Matter

(Number of Periods - 8)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to relate properties of matter to daily life physical and chemical phenomena.

Unit outline

- Definition of matter
- States of matter and examples
- Change of the states of matter
- Differences between physical and chemical changes
- Kinetic Theory of matter

Learning objectives

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is; knowledge and understanding, skills acquisition, attitude and values. At the end of the lesson, the learner should have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 3.1 Knowledge, skills and values to be attained

Learning Objectives		
Knowledge and Understanding	**Skills**	**Attitudes and values**
• Explain the states of matter using kinetic theory of matter. • State differences between physical and chemical changes of matter and give examples of each. • Explain the factors that affect the rate of diffusion.	• Interpret a graph of temperature against time for a substance changing state. • Perform experiments to show the change of state of matter. • Carry out experiments to distinguish between physical and chemical changes. • Draw and describe the arrangement of particles in solids, liquids and gases. • Demonstrate Brownian motion through a simple experiment.	• Develop a teamwork approach during group activities and experiments. • Show curiosity and inquiry in exploring physical phenomena in daily life. • Take care of oneself, colleagues, individuals and public materials • Develop self-confidence through experiments and presentation of findings.

Links to other subjects

The contents in this unit can be applied in Physics when explaining changes in states of matter and in Biology when explaining diffusion of ions.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the test your competence 3 at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition – you may ask learners to interpret a graph of temperature against time for a substance changing state. They can also draw and describe the arrangement of particles in different states. Also, particular questions have been suggested in the test your competence 3 that target assessing skills acquisition.
- To assess attitude change – you may ask probing questions aimed at finding out if they appreciate the importance of following procedures during experiments. Also, specific questions have been provided in the test your competence 3 which target attitude change and societal values.

The teacher should continously assess learners to gauge the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competences are given in the table below.

Table 3.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – AverageRS – Research Skills

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

Background information

Matter is anything that occupies space and has mass. Many things in the environment are said to have matter. These substances change from one form to another under different conditions. Let the learners appreciate changes of matter in nature. This should also motivate the learners and help them change their attitude towards experiments and presentation of findings.

This unit is about matter and changes of states of matter. Matter consists of tiny particles which are always in constant motion. This is explained by kinetic theory of matter. Change of the states of matter involve processes such as me lting,boiling,condensing,solidifying and subliming.

Additional information for the teacher

Sometimes it is not easy for learners to differentiate between chemical and physical changes. The table below will guide learners in telling whether a change is chemical or physical.

Table 3.3 Comparison between physical and chemical changes

Physical change	***Chemical change***
1. There is no new substance formed.	1. A new substance is formed.
2. Generally, physical changes do not involve the production of energy.	2. Energy is usually given out or absorbed Source: https://byjus.com/chemistry/difference-between-physical-and-chemical-change/
3. The change can be reversed to get the initial substances.	3. The change is usually irreversible

However, there are some chemical reactions that can be reversed. They are called reversible chemical changes. Examples include:

a) *Calcium carbonate* $\xrightarrow{\text{Heat}}$ *Calcium oxide + Carbon dioxide.*

This is a chemical reaction as it involves absorption of heat. However, it can be reversed as follows:

Calcium oxide + Carbon dioxide $\longrightarrow$ *Calcium carbonate*

(b) Ammonium chloride $\xrightarrow{\text{Heat}}$ *Ammonia + Hydrogen chloride.*

Just as in (a) above this is chemical change. However, it can be reversed as below:

Ammonia + hydrogen chloride $\longrightarrow$ *Ammonium chloride*

3.1 Definition of matter and states of matter

PERIOD 1: Definition of matter and states of matter

Refer to learners book

Specific objective

By the end of this lesson, the learners should be able to define matter and list different states of matter

Materials and learning resources

High cost	Low cost/no cost
Gas cylinder	Chalkboard
	Learner's book
	Pens,water
	A piece of rock

Teaching methodologies

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasising the fact that most of the things around us occupy volume and have got weight.
- Tell the learners to name some of the things that do not have such properties.
- Let the learners work in pairs and do discussion corner. As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activity. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that many substances around us can be referred to as matter.
- Let learners classify learning resources based on their physical appearances.
- Now you can define the meaning of matter to the whole class.
- Fast learners can take short notes as the discussion continues. Slow learners can write notes later. All learners should try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.

- **Communicating in English** – as learners discuss the questions in Discussion Corner
- **Critical thinking** – As learners think about their findings in the Discussion Corner
- **Research skills**-As the learners discover the objects around them and give a description of what they are like.

Formative assessments

- To test understanding and knowledge ask questions on content covered
- Learners acquisition of skills can be assessed as the learners classify the items in the Discussion Corner.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Keenly listen to the way the learners answer the questions in activity 3.1 to assess their attitude towards the fact that almost everything around us is made up of matter.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners to be given more time to classify the items provided as matter and do the experiment of filling water in a glass. They can then be helped to explain why the glass does not take any more water. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 3.1

1. Solid, liquid and air
2. The learners must show that they understand what the three states of matter imply.
3. The learner to mention things like light and electricity. They do not have weight.

3.2 Changes of states of matter

PERIODS 2 and 3: Changes of states of matter

Refer to learner's book

Specific objective

By the end of this lesson, the learners should be able to perform experiments to show the change of state.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
Cooking fat	Learner's book
Ice	Candle,
	Beakers, match box

Teaching methodologies

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This periods will be taught in 2 lessons. It will involve an activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking the learners to name the different states of matter. This will act as a precursor to the change of states of matter.
- Let learners name some of the things that they know can changes their form.
- Let the learners work in pairs and answer questions in the discussion corner. As they work in pairs they improve their co-operation and interpersonal skills
- Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that substances undergo changes if subjected to certain conditions.
- In the second lesson, let the learners carry out activity 3.1 as you guide them on how to answer the questions. Emphasize the importance of putting off the Bunsen burner when not in use to save energy.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 3.1 and in the discussion corners.
- **Critical thinking** – As learners think about their findings in the activity 3.1 and from the discussion corners.

- **Research skills**-As the learners discover the objects around them and give a description of what they are like.

Formative assessments

- Ask learners to carry out an experiment to show the change of state of matter so as to gauge skills acquisition.
- From the answers learners give to the questions in the discussion corner, assess whether learners have acquired curiousity and inquiry in exploring physical phenomena in daily life.
- Ask them oral questions such the importance of keeping cooking fat properly. This way you will be able to assess their attitude towards change of states of matter in relation to financial management.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Keenly listen to the way the learners answer the questions in the discussion corner to assess their communication skills.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be challenged to explain where hailstones go to after rainfall accompanied by hailstones The process of washing and hanging wet clothes on a wire can be used to help slow learners understand the process of evaporation.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

3.3 Physical and chemical changes

PERIODS 4 and 5: Demonstration of physical changes

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to perform experiment to show physical changes.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
Thermometer	Learner's book
Ice,iodine	Tripod stand, spatula
Naphthalene	Beakers, wire gauze, water, pair of tongs

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve practical activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by stating that matter undergoes two types of change.
- Tell the leaners that when matter undergoes a change, a new product can be formed or not.
- Let the learners work in pairs and do Activity 3.2, 3.3 and 3.4 in learner's book...
- As they work in pairs they improve their co-operation and interpersonal skills
- Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that physical changes do not lead to formation of new substances.
- In the second period, let the learners carry out activity 3.2, 3.3 and 3.4 as you guide them on how to answer the study questions. Emphasis on the need to take care while heating substances. The learners should display mastery of laboratory rules as the experiment proceeds.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion. Emphasis on the need to be honest while recording values from an experiment. It leads to accurate results.
- **Standardisation culture**- Bring to the attention of learners the importance of using quality things. Let them develop a habit of using products approved by Rwanda Bureau of Standards.
- **Financial education** – Let the learners appreciate the importance of keeping safely some of the products we use at home to prevent them from expiring fast due to changes they are likely to go.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in Activity 3.2, 3.3 and 3.4.
- Critical thinking – As learners think about their findings in the activity 3.2, 3.3 and 3.4

Formative assessments

- Ask learners to carry out an experiments to demonstrate physical changes so as to assess skills acquisition.
- Be keen to find out if the learners appreciate the importance of following procedures during experiments.
- Ask them oral questions such as characteristics of a physical change to assess their knowledge and understanding.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be challenged to give more examples of substances which undergo physical changes in daily life. Slow learners should be taken through basics of drawing graphs and how to interpret the graphs. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIOD 6: Chemical changes

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to perform experiment to show chemical changes.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book, test tubes, magnesium ribbon, iron nails,, yeast
	Unripe banana, a piece of paper
High cost	Low cost/no cost
	Wooden splint, glucose, water,pair of tongs

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by stating the fact that unlike the physical, chemical changes leads to the formation of new products.
- Let the learners appreciate the application of this sub unit in real life.
- Let the learners pairs up and discuss Activity 3.5 and discussion corner.
- As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the questions in the discussion corners. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that some substances undergo change to form new products.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.
- **Financial education**-Let the learners link chemical changes to the reason why iron sheets are painted to prevent rusting.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 3.5.
- **Critical thinking** – As learners think about their findings in the activity 3.5.

Formative assessments

- Learners may be asked to perform an experiment to demonstrate chemical change. This way you will be assessing skills acquisition.
- Some questions in self evaluation test 3.2 can be used to assess acquisition of knowledge and understanding. The learners may exchange their books, mark them as they discuss.

- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Provide daily life examples of chemical changes such as ripening of bananas rusting of iron nails to slow learners.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evalution Test 3.2

1. To prevent it from melting.
2. i. Chemical
   ii. Physical
   iii. Chemical
3. i. Yellow, white, Physical change
   ii. Purple gas, solid iodine, physical
4. a. True
   b. False
   c. True
   d. True

3.4 Kinetic theory of matter

PERIOD 7: Kinetic Theory of matter

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to describe Kinetic theory of matter.

Material s and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodologies

- Guided discovery
- Questions and answers
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve majorly discussion amongst the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by explaining that matter consist of particles arranged in a particular way.

- Mention that the arrangement of particles in different states of matter is due to inter-particle forces between them. The forces determines the movement of the particles.
- Use the chalkboard for illustrate this explanation.
- Fast learners to be challenged to state some of the properties determined by the arrangement of particles.
- Let the learners work in pairs and do Activity 3.6 in the learner's book. As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activity. This will enhance their critical thinking and problem solving skills.
- Both slow and fast learners to try and give their thoughts on the diagnostic questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether disabled or normal should participate actively in the lesson. Learners with hearing difficulties can be made to sit in front of the class.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss in class.

Formative assessments

- Assess skills by asking learners to draw and describe the arrangement of particles in solids, liquids and water. Let them present their findings.
- Ask learners to answer questions in self evaluation test 3.3 so as to gauge their knowledge and understanding.
- From the answers learners give to the oral questions you ask them on the kinetic theory, assess whether they developed confidence in the kinetic theory.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.8 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and waring signs. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 3.3

1. Melting, freezing.
2. Check that learners draw diagrams as those in the learner's book.
3. **PQ** – Temperature increases. Heat energy supplied increases the kinetic energy of solid particles making them to vibrate faster.

   QR – Temperature remains constant. Heat energy supplied is used to break the inter-particle forces of attraction holding the solid particles together. the solid thus melts.

   RS – Temperature increases. Heat energy supplied increases the kinetic energy of the liquid particles. They thus vibrate faster.

   ST – Temperature remains constant. Heat energy is used to break the interparticle forces of attraction holding the liquid particles together. The liquid thus evaporate changing to gas.
4. All are chemical changes; Irreversible

PERIOD 8: Diffusion

Refer to learner's book

Specific objective

By the end of this lesson, the learner should be able to define diffusion and apply it.

Materials and learning resources

High cost	Low cost/no cost
Perfume	Chalkboard
	Learner's book
	Ink, water

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by giving the learners a case study of how a poisonous gas caused adverse health effects to people in the environment.
- Lead learners to linking movement of particles in a gas to diffusion.
- Let the learners work in pairs and do Activity 3.7 and 3.8, in learner's book. As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that diffusion is due to movement of particles from a region of high concentration to a region of low concentration.
- Fast learners can be challenged to give more examples of real life examples where diffusion of gases is applied.
- Both slow and fast learners to try and give their thoughts on the questions of the activities.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson. Learners with health problems such as allergies, asthmatic conditions can made to stay away fro the perfume smell.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 3.7 and 3.8.
- **Critical thinking** – As learners think about their findings in the activity 3.7 and 3.8.

Formative assessments

- Use some of the questions in self evaluation test 3.4 to test skills, knowledge and understanding.
- From the answers learners give to the questions in the activities you can assess their understanding on the factors that affect the rate of diffusion.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 3.9 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and waring signs. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class.
Slow learners to be taught Brownian motion by use of audio visual materials.	The fact that disability is not inability should be driven home well.

Consolidation Activities

1. *What is a matter?*

   Ans: Anything that occupies space and has mass is called a matter. For example: chalk, milk, sugar etc.

2. *Sodium chloride and sugar have same appearance. Are they same or different?*

   Ans: They have different physical and chemical properties. So, they are different.

3. *All substances around us are alike. How come?*

   Ans: All substances can occupy space and have weight.

4. *How can we say that air is a type of matter?*

   Ans: Air occupies space and have weight. Hence air is matter.

5. *State the characteristics of matter?*

   Ans: Matter has mass, weight and occupies space.

6. *What are the intensive properties of matter?*

   Ans: Density, colour, melting point, boiling point, refractive index etc. are the intensive properties of matter as they do not depend upon the amount of matter contained in it

7. *What are the extensive properties of matter?*

   Ans: The properties which depend upon the amount of matter contained in a substance. For example mass, weight, volume, energy, etc.

8. *State the characteristics of particles of matter.*

   Ans:

   (i) There is enough space between the particles of matter.

   (ii) The particles of matter are continuously moving about their mean position.

   (iii) The particles of matter attract each other.

9. *What is the effect of temperature on matter?*

   Ans: Particles of matter possess kinetic energy. As the temperature rises, kinetic energy increases.

10. *The smell of hot sizzling food reaches us several metres away. Why?*

    Ans: as the rate of diffusion increases with the increase in temperature.

11. *What is diffusion?*

Ans: When two gases are mixed, their molecules mix with each other due to their speed and random motion. This phenomenon is known as diffusion.

12. *If a bottle of perfume is opened in one corner of a room, its smell immediately spreads throughout the room. Why?*

Ans: The molecules of a gas are free to move in a chaotic motion at a greater speed throughout the vessel in which it is contained. When the bottle of perfume is opened in one corner of the room, the molecules of perfume move at random motion in all directions and mix with the molecules of air and reaches us.

13. *What are fluids?*

Ans: Substances having tendency to flow are called fluids. Liquids and gases are fluids.

14. *What are 'intermolecular forces'? How are these related to the three states of matter?*

Ans: The forces operating between the atoms or molecules of a matter. The intermolecular forces in solid are strong. This keeps the constituent particles very close to each other. Due to this, solids are rigid and incompressible. This also gives ordered arrangement of the particles giving regular geometrical shape to the solid. In liquid, inter molecular force is weak to give definite shape.in gas, intermolecular force is negligible and so its constituent's particles are free to move and occupy the available space.

15. *Why are gases compressible but liquids not?*

Ans: The molecules of a gas are separated very far and there is a lot of empty space between them. Hence gases can be compressed easily. In liquids molecules are closer to each other and can be brought further closer only under very high pressure.

16. *Compare the process of boiling and vaporization.*

Table 3.10 Comparison between boiling and vaporisation

Boiling	Vaporization
(i) It is a process of changing liquids into vapour.	(i) It is a process of changing liquids into vapour.
(ii) Molecules of liquids escape from all parts of the liquid into atmosphere.	(ii) Molecules of liquids escape from upper surface of the liquid into atmosphere.
(iii) It is a fast process.	(iii) It is a slow process.
(iv) It takes place only at a fixed temperature called boiling point.	(iv) It takes place at all temperatures, even at melting point.
(v) In boiling, the vapour pressure of liquids is equal to the atmospheric pressure	(v) In evaporation the vapour pressure of liquid is less than the atmospheric pressure.

Answers to Self-evaluation Test 3.4

1. The learners should draw well labelled setups They should also explain how Potassium permanganate get every distributed in the water with time. Water change to purple colour.
2. Let application of diffusion be brought out clearly (absorption of water from the soil not ions)
3. Learners must be able to compare movement of particles in air and liquid. Hint: particles in air are very far apart as compared to liquid.
4. Learner to link the explanation to Brownian motion.
5. If chalk dust can dissolve in water.

Answers to test your competence 3

1. a. False
   b. False
   c. False
   d. True
2. B
3. On heating particles making the ball moves for apart. The ball expands and increases in size.
4. A
5. D
6. Particles in solid become farther apart on hot days leading to increase in size.

Table 3.11 Additional exercises

Remedial exercises for slow learners	Extended exercises for high achievers
1. Explain what makes a burning candle to be termed as physical change. 2. Group the following substances into matter and non matter: soccer ball, air, water, force, electricity and books 3. Why is ripening of bananas considered a chemical change?	1. When iron materials are left outside the house, they tend to change their appearance after some time. Explain. 2. Name the process by which iodine vapour turns to solid.

Table 3.12 Answers to additional exercises

Answers to remedial exercises for slow learners	Answers to extended exercises for high achievers
1. No change occurs 2. Electricity and force are not matter 3. It is irreversible	1. Rusting occurs 2. Deposition

Unit 4 Pure substances and mixtures

(Number of Periods - 8)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to separate mixtures and determine their composition.

Unit outline

- Pure substances
- Mixtures
- Separation of mixtures (Include the criteria for the choice of a certain method and its application

Learning objective

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is, knowledge and understanding, skills acquisition and attitude and values. At the end of the lesson, the learner should have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 4.1 Knowledge, Skills and values to be attained

	Learning Objectives	
Knowledge and Understanding	**Skills**	**Attitudes and values**
- Differentiate between pure substances and mixtures. - Identify different types of mixtures. - Describe different methods of separating mixtures.	- Apply a suitable separation technique for a given mixture. -Interpret a simple chromatogram. - Calculate percentage composition by mass and by volume. - Write a standard report of the findings and present it in a convincing way.	- Develop a responsible attitude to team work in group activities. - Appreciate the importance of pure substances in daily life

Links to other subjects

The contents in this unit can be applied in Mathematics when calculating percentage composition. In Biology, ultrafiltration is a process that enables the kidney to separate components of urine.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the test your competence 4 at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition – you may present to the learners a problem and ask them to suggest the appropriate method they can apply to separate the components. They can also draw and interpret a simple chromatogram. Also, particular questions have been suggested in the test your competence 4 that target assessing skills acquisition.
- To assess attitude change – you may ask probing questions aimed at finding out if they appreciate the importance of having pure substances and mixtures in daily life. Also, specific questions have been provided in the test your competence 4 which target attitude change and societal values.

The teacher continously assess learners to gauge the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competences are given in the table below.

Table 4.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Life long skills
PS – Problems solving skills
C & I – Creativity & Innovation

- Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

Background information

A pure substance is one, whose components cannot be separated by physical means. Unlike pure substances, the components of mixtures can be separated by physical means. Remind the learners that our life is full of separated products from butter on your toast and the juice glass next to it, to the petrol used in a car. All these products are useful in their separated form. Let the learners appreciate the importance of having pure substances and mixtures in nature.

This unit is about pure substances, mixtures and their separation techniques. Separation technique applied in separating components of a mixture is determined by the properties of the components. Some of the separation techniques include centrifugation, winnowing, sublimation and magnetic separation. The learners should appreciate the application of these techniques in real life.

Additional information for the teacher

Magnetism

Magnetism is ideal for separating mixtures of two solids with one part having magnetic properties. Some metals like iron, nickel and cobalt have magnetic properties while gold, silver and aluminum do not. Metals with magnetic properties are attracted to a magnet.

It works like this:

Let us take a mixture of sand and iron filings for example. To separate this, spread out the mixture on a flat surface. Run a magnet bar over the surface. You will notice that the magnetic element (iron filings) will be attracted to the magnet over it. After a number of runs, all the sand will be free from any iron filings.

Separating funnel

In this technique, two liquids that do not dissolve very well in each other (immiscible liquids) can be separated using the concept of unequal density. A mixture of oil and water, for example, can be separated by this technique.

It works like this:

The two liquids in the mixture have different densities, making the heavier liquid settle at the base of the container. In this setup, a funnel with a tap at the spout is placed inside a beaker. The mixture is poured into the funnel and allowed to settle. Soon, the water, which is heavier, settles at the base, with the oil on top of it. The tap is opened to allow the water to pass, and closed as soon as the oil reaches the spout.

Simple distillation

This method is best for separating a liquid from a solution. In a way, the concept is similar to evaporation, but in this case, the vapour is collected by condensation. For example, if you want to separate water from a salt solution, simple distillation would be great for this.

It works like this:

To separate pure water from a salt solution, a beaker of the salt solution is heated to the boiling point of the liquid. As it boils, the liquid turns into vapour (gas). The vapour is directed through tubes (condenser) connected to another beaker.

As the vapor goes through the tube, it is cooled down by running cold water round the tubes. This forces the temperature of the vapour to fall, causing the gas to turn into liquid again (condensation). The liquid is pure at this point, as it is free from salt. The process continues until all the liquid in the solution turns into vapor, leaving the salt residue. The distilled liquid is called a 'distillate'

Fractional distillation

Similar to simple distillation, fractional distillation is best for separating a solution of two miscible liquids. (Miscible liquids are liquids that dissolve in each other).

Fractional method takes advantage of the different boiling points of the two liquids. These however should be close otherwise simple distillation is used.

It works like this: To separate ethanol from a solution of water and ethanol

In a similar set-up like in simple distillation, the heat is applied to the solution to raise its temperature to the boiling point of the ethanol. This will turn the ethanol in the mixture into gas. Unlike in the simple distillation set-up, there is a fraction column between the boiling beaker and the condensing unit. This column is made up of layers of glass or beads. The column helps the rising gas to slowly condense and re-evaporate several times, before it is collected into the beaker. In the end, the water is separated from the ethanol. Fractional distillation takes a bit more time than the simple distillation.

Separation of mixtures by paper chromatography

This method is often used in the food industry. It is used to identify chemicals (coloring agents) in foods or in inks in printing industry. For example, if a scientist wants to know how many substances are in a particular blob of ink, paper chromatography can be used.

Chromatography: experiment

a) Laboratory Procedure:

1. Take a Whatman filter paper strip and draw a line with a pencil above 4cm from one end. Now, draw another line lengthwise from the centre of the paper. Then name the point at which the two lines intersect as P.
2. With the help of a fine capillary tube, put a drop of the mixture of red and blue inks at the point P. Let it dry in air.
3. Put another drop on the same spot and dry again, so that the spot is rich in mixture.
4. Pour equal amounts of isopropyl alcohol and distilled water into a chromatographic chamber and mix it well using a glass rod. It is used as the solvent.
5. Suspend the filter paper vertically in the chromatographic chamber containing solvent in such a way

that the pencil line remains about 2cm above the solvent level.

6. Close the jar with its lid and keep it undisturbed.
7. Notice the rising solvent along with the red and blue inks. After the solvent has risen about 15 cm, you will notice two different spots of blue and red colors on the filter paper.
8. Take the filter paper out of the jar and mark the distance that the solvent has risen on the paper with a pencil. This is called the solvent front.
9. Dry the filter paper and put pencil marks on the centre of red and blue ink spots.
10. Measure the distance of the two spots from the original line and the distance of the solvent from the original line.
11. Calculate the retention factor, or Rf values of red and blue inks by using the formula:

$$Rf = \frac{\text{ditance traveled by a component}}{\text{distance traveled by the solvent}}$$

Centrifugation

Sometimes the solid particles in a liquid are very small and can pass through a filter paper. For such particles, the filtration technique cannot be used for separation. Such mixtures are separated by centrifugation. So, centrifugation is the process of separation of insoluble materials from a liquid where normal filtration does not work well.

The centrifugation is based on the size, shape, and density of the particles, viscosity of the medium, and the speed of rotation. The principle is that the denser particles are forced to the bottom and the lighter particles stay at the top when spun rapidly.

The apparatus used for centrifugation is called centrifuge. The centrifuge consists of a centrifuge tube holder called rotor. The rotor holds balanced centrifugal tubes of equal amounts of the solid-liquid mixture. On rapid rotation of the rotor, the centrifuge tubes rotate horizontally and due to the centrifugal force, the denser insoluble particles separate from the liquid. When the rotation stops, the solid particles end up at the bottom of the centrifuge tube with liquid at the top.

Applications

- Used in diagnostic laboratories for blood and urine tests.
- Used in dairies and home to separate butter from cream.
- Used in washing machines to squeeze water from wet clothes.

4.1 Pure substances

PERIOD 1: Pure substances

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to define apure substance and state its physical properties.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Clear water, muddy water
	Table salt, milk

Teaching methodologies

- Case studies
- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by stating that many substances that we use in our daily life are mixtures. This is probably because mixtures are more useful to us than as pure substances.
- Let the learners work in pairs and do Activity 4.1 in learner's book. As they work in pairs they improve their co-operation and interpersonal skills. Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills.
- Let them appreciate the fact that pure substances consists of only one kind of components.
- Put the materials you brought for study on the table, ask the learners to identify those that are pure substances.
- Now you can define a pure substance.
- Let them appreciate the importance of having pure substances.
- Both slow and fast learners to try and give their thoughts on the questions in the activity.

Cross cutting issues covered

- Inclusive learning – All learners whether disabled or normal should participate actively in the lesson.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in activity 4.1.
- Critical thinking – As learners think about their findings in the activity 4.1.

Formative assessments

- The teacher may use diagnostic questions such as difference between pure substances and mixtures to assess knowledge and understanding.
- From the answers learners give to the oral questions you ask them on the pure substances, assess their attitude towards importance of pure substances.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.

- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and warning signs. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

4.2 Mixtures

PERIODS 2 and 3: Mixtures

Refer to learner's book

Specific objective

By the end this lesson, the learners should be able to define mixtures and state types of mixtures.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Salt solution
	Muddy water

Teaching methodologies

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Let the learners know that many things that we use in daily life are mixtures.
- Give a few examples of mixtures and ask fast learners to give other examples.

- Let learners name some things that they know . Let them brainstorm on their uses and whether it is important to have them.
- Let the learners work in pairs and carry out the activity 4.2 in the learner's book.
- As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activity. This will enhance their critical thinking and problem solving skills.
- Display the learning materials you came with on the table and ask learners to describe them.
- Now you can define a mixture to the whole class.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners participate in the discussion corner.
- Critical thinking – As learners think about their findings in the activity 4.2.
- Research skills – As the learners discover the taste of unstirred and stirred tea.

Formative assessments

- Use questions in self evaluation test 4.1 to test acquisition of knowledge and understanding.
- Ask learners questions such as uses of mixtures in daily life to assess if they appreciate the importance of mixtures.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.4 Special needs and multi ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and warning signs. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 4.1

1. a. The learners should display their understanding of mixtures.
   b. Difference between a homogeneous and heterogeneous mixtures must be addressed.
   c. It is a mixture of sodium chloride and iodine.

4.3 Methods of separating mixtures

PERIODS 4,5 and 6: Methods of separating mixtures (Filtration)

Refer to the learner's book

Specific objective

By the end of this lesson, learners should be able to describe filtration.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
High cost	**Low cost/no cost**
	Beakers, Conical flask, filter paper, funnel
	Soil and water mixture

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by mentioning the fact that some materials are only useful in uncombined states hence the need for separation.
- Fast learners can be asked to state some of the properties of components that can determine separation technique.

- Let the learners work in pairs and the discussion corner. As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills. Let them appreciate the fact that filtration is a technique applied in everyday life in processes such as when treating drinking water.
- Now you can lead the class in listing the different methods of separating mixtures.
- Both slow and fast learners to try and give their thoughts on the questions after the activities.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in the activities and discussion corner.
- Critical thinking – As learners think about their findings in the activities and discussion corners

Formative assessments

- Assess skills by asking learners to suggest a suitable separation technique for a given mixture.
- Ask learners questions such as:

  a. What is Filtration?

  b. Where do we apply filtration?
- From their answers, assess knowledge and understanding.
- From the answers learners give to the oral questions you ask them on the filtration, assess their attitude towards application of the method.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and waring signs. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIOD 7 and 8: Decantation and use of separating funnel

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to describe decantation.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Beakers, paraffin and water mixture
	Sand and water mixture

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by presenting the learners with a challenging case study to trigger their critical and problem solving skills.
- Let them appreciate that decantation can be used as a cost cutting method of separating substances while at home.
- Let the learners work in pairs and do Activity 4.4 in learner's book. As they work in pairs they improve their co-operation and interpersonal skills.
- As learners probing questions like; why did we stir? Why did we allow the mixture to settle before transferring water to another beaker? This will enhance their critical thinking and problem solving skills. Let them appreciate the fact that decantation is a technique that is applied in our daily life.

- Emphasize that decantation can also be used to separate liquids that are immiscible.
- Challenge learners to give cases in which they apply decantation at home.
- Wind up the subtopic by discussing how to use a separating funnel to separate immiscible liquids. Demonstrate as shown in Activity 4.5 learners book.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.
- Financial education – As learners appreciate the importance of applying decantation while at home to cut costs.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners answer probing questions in the various activities.
- Critical thinking – As learners think about their findings the various activities.

Formative assessments

- After activity 4.4, ask learners to mention where decantation is applied in daily life. This way you will be testing their knowledge on decantation.
- Keenly observe learners as they carry out experiment 4.4, to find out if they have developed a responsible attitude to teamwork in group activities.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be assisted using visual aids such as charts containing some of the laboratory precautions and warning signs. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 4.2

Learners to mention applications such as treatment of water.

PERIOD 9: Simple distillation

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to describe simple distillation.

Materials and learning resources

High cost	Low cost/no cost
Thermometer	Chalkboard
	Learner's book
	Beaker, stand, condenser, wire gauze, clamp, pieces of porous pot
	Round bottomed flask, salt and water mixture

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by allowing learners to brainstorm on how alcohol is manufactured to trigger their critical thinking.
- Let the learners appreciate that alcoholic drinks are manufactured through distillation.
- Let the learners work in pairs and do Activity 4.6 in the learner's book.
- As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the discussion

corner. This will enhance their critical thinking and problem solving skills. Let them appreciate the fact that simple distillation can be used as way of making salty water fresh

- Briefly explain the process and let the learners understand what simple distillation is.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- **Inclusive learning** – All learners whether with special educational needs or not should participate actively in the lesson.
- **Peace, values and gender education** – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners discuss the questions in Activity 4.6.
- **Critical thinking** – As learners think about their findings in the activity 4.8.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding.
- After activity 4.6, ask learners to mention where simple distillation is applied in daily life. This way you will be testing their knowledge on simple distillation.
- Keenly observe learners as they carry out experiment 4.6, to find out if they have developed a responsible attitude to teamwork in group activities.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be assisted using visual aids such as charts containing illustration on simple distillation. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIOD 10: Fractional distillation

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to apply fractional distillation.

Materials and learning resources

High cost	Low cost/no cost
Thermometer	Chalkboard
	Learner's book
	Beaker, stand, condenser, fractionating column, Burnsen burner, wire gauze, clamp, pieces of porous pot
	Round bottomed flask, ethanol and water mixture

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by way of flashback on simple distillation to trigger the learners critical thinking.
- Bring to the attention of the learners that unlike simple distillation,fractional distillation is used to separate miscible liquids which have close but different boiling points.
- Let the learners work in pairs and do Activity 4.7 in the learner's book.
- As they work in pairs, they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activities. This will enhance their critical thinking and problem solving skills. Let them appreciate the fact that

fractional distillation can be used to manufacture spirits. Challenge them to suggest more places where this separation technique is applied.

- Briefly explain the process and let the learners understand what fractional distillation is.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.
- Financial education-Remind the learners on the importance of handling the apparatus with care to avoid damages on expensive apparatus.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in Activity 4.7.
- Critical thinking – As learners think about their findings in the activity 4.7.

Formative assessments

- Ask diagnostic questions such as:
  a. Define fractional distillation
  b. Mention areas where fractional distillation is applied.
- This way you will be assessing acquisition of knowledge and understanding.
- Ask learners to carry out activity 4.7 so as to assess skills acquisition.
- Keenly observe learners as they carry out experiment 4.7, to find out if they have developed a responsible attitude to teamwork in group activities.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.8 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can observe keenly as the apparatus are arranged and ask questions where necessary. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIODS 11 and 12: Paper chromatography

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to separate certain mixtures by paper chromatography.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Beaker, filter paper, black ink,dropper,distilled water and pipette

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Research
- Case study

Preparation for the lesson

This lesson will be taught in 1 period. It will involve practical activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by giving a crime related case study to trigger their interest and critical thinking skills.
- Bring to the attention of learners that paper chromatography can be used in identifying suspects in a crime scenario. Encourage learners to think of other areas where this technique can be applied.
- Let the learners work in pairs and do Activity 4.8 in the learner's book.
- As they work in pairs they improve their co-operation and interpersonal skills.
- Engage learners through questions like;
  (i) Why have we used propane and not water as the solvent.
  (ii) Why did the dyes travel different distances?
- Briefly explain the process and let the learners understand what paper chromatography is.

- Both slow and fast learners should be seen to actively participate during the lesson.

Cross cutting issues covered

- **Inclusive learning** – All learners whether dwith special educational needs or not should participate actively in the lesson.
- **Peace, values and gender education**-Let the learners see the need to accommodate other people's views in a discussion.
- **Comprehensive sexual education**-To use this opportunity to emphasize the need to always report any case of rape as first as possible o the relevant authorities in case they occur.

Generic competencies covered

- **Co-operation and interpersonal skills** – as learners interact in pairs and engage in class discussion.
- **Communicating in English** – as learners attempt to answer questions in class.
- **Critical thinking** – As learners think about their findings in the activity 4.8

Formative assessments

- Ask diagnostic questions such as:
  a. Define chromatography
  b. State two factors that determine formation of chromatogram.

This way you will be assessing acquisition of knowledge and understanding.

- Ask learners to interpret a simple chromatogram to assess skills acquisition.
- Keenly observe learners as they carry out experiment 4.8, to find out if they have developed a responsible attitude to teamwork in group activities.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.9 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can observe keenly as the apparatus are arranged and ask questions where necessary. This will enable them internalize the requisite knowledge. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIODS 13 and 14:Magnetic separation and centrifugation

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to apply magnetic separation and centrifugation techniques.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Magnet and iron nails

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Research
- Case study

Preparation for the lesson

This lesson will be taught in 1 period. It will involve discussion by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by giving a case study to trigger the interest and critical thinking of the learners.
- Bring to the attention of the learners that magnetic separation can be used to remove magnetic materials from non magnetic objects. Encourage learners to think of other areas where this technique can be applied.
- Prepare a mixture of iron fillings and sulphur. Let learners in pairs use a magnet to separate the two.
- As they work in pairs they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the discussion corner. This will enhance their critical thinking and problem solving skills.
- Briefly explain centrifugation and let the learners understand what the process is.

- Both slow and high achievers should be seen to actively participate in the lesson.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational need or not should participate actively in the lesson.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners attempt to answer the questions you asking class.
- Critical thinking – As learners think about their findings in the discussion corner.

Formative assessments

- Ask diagnostic questions such as: define the term centrifugation
- This way you will be assessing acquisition of knowledge and understanding.
- The way learners give answers to the discussion corner questions will help you assess their attitude towards the use of magnetic separation technique.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.10 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learner can be given an opportunity to be secretary during discussion. This will enable them internalize the requisite knowledge. Slow learners to be shown pictures of a centrifuge from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 4.3

1. a. The water contains magnesium, sodium and calcium ions
   b. Carry out fractional distillation
2. a. Evaporation, simple and fractional distillation
   b. Fractional distillation
   c. small stones
3. Solving parental disputes

PERIOD 15: Crystallisation and Evaporation

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to explain crystallisation and evaporation processes.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Beaker, conical flask,filter funnel, glass rod, filter paper, wire gauze, sand salt
	Tripod stand, evaporating dish

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson explaining what a crystal is let them know that crystals are formed from saturated solutions.
- Let learners do activity 4.9 in the learner's book. They should then leave it in a safe place for observations to be done later.
- Bring to the attention of learners that evaporation is accompanied by other techniques such as filtration. Encourage learners to think of areas where this technique can be applied.
- Let the learners work in pairs and do Activity 4.10 in the learner's book.
- As they work in pairs, they improve their co-operation and interpersonal skills.
- Guide the learners to answer the study questions in the activity 4.10. This will enhance their critical thinking and problem solving skills.
- Briefly explain evaporation and let the learners understand what the process is.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.

- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in Activity 4.10.
- Critical thinking – As learners think about their findings in the activity 4.10.

Formative assessments

- Ask diagnostic questions such as: define the term evaporation.
- This way you will be assessing acquisition of knowledge and understanding.
- Ask learners to write a report on the findings of an experiment they have done and present to the class. During presentation, listen and mark language used and confidence
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 4.11 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learner can be given an opportunity to be secretary during discussion. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 4.4

1. 22.22% 2. 60% 3. 66.03%

Consolidation activities

1. *What would happen if you were to take a saturated solution at a certain temperature and cool it slowly?*

Ans: Different substances in a given solvent have different solubilities at the same temperature. So on cooling substances start to precipitate out.

2. *What is suspension? Write its properties?*

   Ans: A non-homogeneous systems in which solids are dispersed in liquids. They are called suspensions because it is a heterogeneous mixture.

   Properties of a suspension

   Suspension is a heterogeneous mixture. The particles of a suspension can be seen by the naked eye. The particles of a suspension scatter a beam of light passing through it and make its path visible. The solute particles settle down when a suspension is left undisturbed, that is, a suspension is unstable. They can be separated from the mixture by the process of filtration.

4. *How can we separate cream (fat) from milk ?*

   Ans: The denser particles of water are forced to the bottom and the lighter particles of cream/fats stay at the top when milk is spun rapidly in a centrifuge machine.

5. *How can we separate kerosene oil from water?*

   Ans: By using a separating funnel.

6. *How can we separate a mixture of salt and ammonium chloride?*

   Ans: By sublimation method since ammonium chloride is a sublimating substance

7. *How can we separate dyes in black ink?*

   Ans: By chromatography method.

8. *What according to you, can be the reason for the rise of the coloured spot on the paper strip?*

   Ans: The ink that we use has water as the solvent and the dye is soluble in it. As the water rises on the filter paper it takes along with it the dye particles. Usually, a dye is a mixture of two or more colours. The coloured component that is more soluble in water, rises faster and in this way the colours get separated

Answers to Test Your Competence 4

1. Table salt and drinking water
2. Copper is a pure substance while common salt and tap water are mixtures.
3. a. Fractional distillation

   b. Simple distillation
4. Learners to explain application centrifugation is applied in this context
5. By crushing off the maize grains from the husks.
6. Use evaporation technique
7. C
8. It is a false statement. Milk contains a number of components such as dissolved vitamins, mineral salts and water.
9. a) Solvent front

   b) Mixture, several bands were formed on separation.

   c) Propane, ethanol

d) C was moore soluble in the solvent and less sticky on the paper. A was less soluble in the solvent but more sticky on the paper.

10. Learner should use the following methods in the procedure
    - picking stones
    - filtration or decantation
    - Evaporation

11. a) Fractional distillation

    b) (i) Fractionating column

    (ii) To increase the surface area for condensation

    c) A – Hot water out

    B – Cold water in

    d) Ethanol. It has a lower boiling point than water.

12. Through sublimation and then deposition ammonium chloride will be separated from the other two. Filtration and evaporation will separate sand and salt.

Table 4.12 Additional exercises

Remedial exercises for slow learners	Extended exercises for first learners
1. State two industrial areas where fractional distillation is applied. 2. State two methods that can be used to separate a mixture of salt and water. **Write true/false for question 3 and 4** 3. Mixtures have fixed melting and boiling points. 4. In filtration, the filtrate is always a pure liquid.	1. Suppose you do have glass beads to use during fractional distillation, what will you do? 2. Fractional distillation is a more accurate method of separating miscible liquids with close boiling points. 3. Is milk a pure substance or mixture? Explain your answer. 4. Name the appropriate techniques for separating leaves from a swimming pool?

Table 4.13 Answers to additional exercises

Answers to remedial exercise for slow learners	Answers to extended exercise for high achivers
1. Fractional distillation of liquid air and industrial separation of crude oil 2. Simple distillation and evaporation 3. False 4. False 5 a. Glass beads b. To ensure that boiling occurs without jumping off. c. Pure water	1. Let learners appreciate the use of locally availlable materials such as small stones. 2. With fractioanl distillation, both liquids do not distill over at the same time. 3. Milk is a mixture of fat droplets,water and proteins. 4. Learners may suggest hand picking as a way of removing leaves from the pool.

Unit 5 Atoms, elements and compounds

(Number of Periods - 18)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to comprehend the structure of an atom and relate the valency to the chemical formulae of compounds.

Unit outline

- Definition of element, atom and molecule
- Symbols of the first 20 chemical elements
- Main components of an atom
- Atomic characteristics
- Instability of atoms
- Elements and compounds
- Chemical formulae and nomenclature

Learning objectives

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is; knowledge and understanding, skills acquisition, attitude and values. At the end of the lesson, the learner should be able to have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 5.1 Knowledge, skills and values to be attained

Learning Objectives		
Knowledge and Understanding	**Skills**	**Attitudes and values**
- Name the different sub-particles of an atom and their properties.	- Write the symbols of different chemical elements.	- Appreciate the uniqueness of atoms of elements.
- Explain the concepts of isotopes.	- Write the electronic configuration of the first 20 elements in terms of energy levels.	- Appreciate the role of an atom as a building block or unit of matter.
- Explain how simple molecules are formed.	- Determine the number of protons, neutrons and electrons from atomic numbers and mass numbers.	- Appreciate that atoms of elements combine to form compounds.

- Distinguish between an elements and acompound.	- Represent atoms of an element by using the symbol,atomic number and mass number.	
	- Use the valence of different elements and radicals to write the formulae and names of chemical substances.	

Links to other subjects

The contents in this unit is applicable in Physics when studying the components of an atom under the atomic structure. Geometry enables us to understand the shape and size of particles.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts, use the self evaluation tests and specific questions in the test your competence 5 at the end of the unit. You can also formulate your own questions or use the diagnostic assessment exercises or exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition, ask learners to write the symbols of different chemical elements.They can also write the electronic configuration of the first 20 elements in terms of energy levels. Certain questions have been suggested within the unit asking them to determine the number of protons,neutrons and electrons. In test your competence 5, questions that target assessing skills acquisition on writing formulae has been provided at the end of the unit.
- To assess attitude change, you may ask probing questions aimed at finding out if they appreciate the uniqueness of an atom and its role as the building block of matter. Specific questions have been provided in the test your competence 5 which targets attitude change and societal values.
- The teacher should continuously assess learners to gauge the extent of knowledge and skills acquisition.
- The general criteria to use to gauge the various generic competencies are given in the table below.

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green

Table 5.2 Assessment criteria

E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – AverageRS – Research Skills
COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

Background information

An atom is the smallest particle into which an element can be divided without losing the properties of the element. An atom is made up of sub-atomic particles namely; electrons and nucleons i.e protons and neutrons. A particular atom will have the same number of protons and electrons and most have atleast as many neutrons as protons. An element is a pure substance that cannot be split into simpler substance by chemical process. An element is a substance that is made entirely from one type of atom. If a sample of hydrogen atoms are observed, you would notice that most of the atoms have no neutrons, some of them have one neutron and a few of them have two neutrons. These different versions of hydrogen are called isotopes. So if you change the number of protons in an atom,you change the type of an element. If you change the number of neutrons an atom has, you make an isotope of an that element. Let the learners appreciate the uniqueness of atoms of elements.

This unit is about atoms, elements and compounds. Atoms of the same element combine to form a molecule while atoms of different elements combine to form compounds. Examples of compounds include; water, table salt and chalk.

Additional information for the teacher

The search for an atom began long time ago with the greek philosophers. This was as early as 400 B.C. Some greek philosophers proposed that matter is made up of indivisible building blocks known as 'atoms'. Later several scientists came up with theories to describe the atom. These include:

(i) J. J. Thomson
(ii) Rutherford
(iii) Neil Bohr
(iv) Chadwick and Erwin Schrodinger

Learners will learn different theories proposed by these scientists in higher levels. However, mentioning them will

enable learners appreciate the work of these early scientists.

5.1 Definition of element, atom and molecule

PERIODS 1, 2 and 3: Definition of element, atom and molecule

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to define element, atom and molecule.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Inflated balloons
	Small pieces of paper

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involves an activity by the learners. The teacher engages learners on the activity and assesses learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking the learners to remember what matter is.
- Using guided discovery, let the learners appreciate the fact that the atom is the smallest particle into which an element can be divided without losing its properties.
- Let the learners work in pairs to answer questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Briefly explain the meaning of atom, element and a molecule and let the learners understand what they mean.
- Suggest to the learners an activity in which each one of them rubs a balloon on their hair and clothes. Let them bring the balloons slowly towards small pieces of paper and note the observations.
- When balloons are rubbed on hair, they become negatively charged, when brought near pieces of paper, electrons are repelled and move away from the balloon, leaving a positive area in papers leading to attraction.
- After the activity' bring to the attention of learners that protons are positively charged and electrons are negatively charged hence, the two attract each other.
- Learners should be able to explain that balloons and small pieces of papers attract each other due to presence of charged particles.
- Both slow and fast learners to try and give their thoughts on the questions.

- Wind up the lesson by asking learners to research on what compounds are.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education-Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in Activity 5.1
- Critical thinking – As learners think about their findings in the activity 5.1

Formative assessments

- Assess attitudes and values by finding out if they appreciate the role of an atom as the building unit of matter. Also be keen to assess their interest to find out if they appreciate the uniqueness of an atom.
- Ask diagnostic questions such as; define an atom, element and a molecule. This way you will be assessing acquisition of knowledge and understanding.
- Listen and gauge learners language, competence during class discussion of activity 5.1 and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be given remedial excercises. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

5.2 Symbols of chemical elements

PERIOD 2 and 3: Symbols of chemical elements

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to write the symbols of the first 20 elements.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson through guided discovery to enable learners create linkage between specific names of people and symbols of elements.
- Bring to the attention of learner's that just like names are specific to people, symbols too are specific to elements.
- Let the learners work in pairs. Participate in answering questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions you ask on the content covered. This will enhance their critical thinking and problem solving skills.
- Briefly guide the learners in writing symbols of some chemical elements.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills is seen as learners interact in pairs and engage in class discussion.

- Communicating in English as learners discuss the questions in the discussion corners.
- Critical thinking as learners think about their findings in the discussion corner.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding. Such questions may include:
  a. Write the symbol of copper and cobalt
  b. Name the element represented by symbol Fe.
- Assess skills acquisition by asking learners to write symbols of different chemical elements
- Assess attitudes and values by finding out if they appreciate the use of symbols in representing elements.
- Listen and gauge learners language competence when they answer the discussion questions and correct them accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be given an assignment on writing chemical symbols. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class.
	The fact that disability is not inability should be driven home well.

5.3 Main components of an atom

PERIOD 4: Main components of an atom

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to describe the components of an atom.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Oranges
	First Aid kit

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by guiding the learners towards understanding the components of an atom and how the components are arranged.
- Use blackboard illustrations to explain to the learners the positions of neutrons, protons and electrons in an atom. Allow them to discuss what they have understood in pairs.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Briefly highlight the components an atom, the relative masses and charges.
- Ask the learners to point out the differences and similarities among the sub-atomic particles.
- Wind up the lesson by asking learners to research on what compounds are.

Cross cutting issues covered

- Inclusive learning – All learners whether with special education needs or not should participate actively in the lesson.
- Peace, values and gender education – Learners should see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact in pairs and engage in class discussion.
- Communicating in English as learners attempt to answer questions in class.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding. For example; Name the sub-atomic particles and state where they are found in an atom.
- Assess skills acquisition by asking learners to write the charges of the sub-atomic particles
- Assess attitudes and values by use of open minded questions such as; An atom is the smallest particle that takes part in a reaction, explain.

- Listen and gauge learners language competence during class discussion when answering questions you ask on the content covered and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be asked to name the sub atomic particles during discussion as away of emphasis. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

5.4 Atomic characteristics

PERIODS 5 and 6: Atomic characteristics

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to define atomic number, mass number and isotope.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods.

It will involve an activity by the learners. The teacher will engage leaners on the activity and assess learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by reminding learners of the components of an atom.
- Let the learners create a link between the proton number and the atomic number. Then introduce the concept of mass number and isotope.

- Let the learners work in pairs and attempt to answer questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions. In the discussion corner. This will enhance their **critical thinking** and **problem solving skills**.
- Briefly explain the meaning of proton number, atomic number and mass number.
- Let the learners internalize the symbols of the atomic number and mass number.
- Let the learners find the number of neutrons and protons in given examples.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact in pairs and engage in class discussion.
- Communication should be in English as learners discuss the questions in the discussion corner.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding.
- Assess skills acquisition by asking learners to :
  a. Determine the mass and atomic numbers.
  b. Determine the number of protons, neutrons and electrons from the mass and atomic numbers.
- Assess attitudes and values by finding out if they appreciate the existance of isotopes. Use analogy of a family sharing a common name.
- Listen and gauge learners language competence during class discussions and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be given simple questions on finding number of neutrons and protons in an atom during discussion. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

5.5 Electronic configuration in an atom

PERIODS 7 and 8: Electronic configuration in an atom

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to write the electronic configuration of the first 20 elements in terms of energy levels.

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Questions and answers
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve an activity by the learners. The teacher will engage learners on the activity and assess learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by simulation i.e guided discovery to enable learners understand how the electrons are arranged in the energy levels.
- Let the learners understand that there are unique energy levels that carry more than the expected number of electrons .
- Draw an energy level diagram of sodium on the board. Let learners in pairs discuss the diagram.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Explain to the learners how electrons are distributed in the energy levels.
- Ask the learners to write electronic configuration of some of the elements.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need

to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact in pairs and engage in class discussion.
- Communication should be in English as learners discuss in pairs.
- Critical thinking as learners think about the distribution of electrons in energy levels.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding. For example; Write the electronic configuration of the following elements.
  a. Silicon
  b. Helium
- Assess skills acquisition by asking learners to write electronic configuration of the first 20 elements in terms of energy levels.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.8 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be given remedial exercise to be marked later. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

5.6 Elements and compounds

PERIOD 9: Elements and compounds

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to establish the relationship between elements and compounds.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners. The teacher will be engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Let the learners recall the meaning of atom and molecule as you introduce the lesson.
- Bring to the attention of learners that the atoms of an element make up a molecule and different atoms may combine to form compounds.
- Let the learners work in pairs and discuss the questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions in the discussion corner. This will enhance their **critical thinking** and **problem solving skills**.
- Briefly explain the meaning of elements and compounds.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in the discussion corner.
- Critical thinking – As learners think about their answers on the discussion corner.

Formative assessments

- Assess knowledge and understanding by use of self evaluation test 5.1.
- Assess skills acquisition by asking learners to classify molecules and compounds given a list of substances.

- Assess if they appreciate the fact that molecules can be compounds but compounds cannot be molecules. Do this by asking diagnostic questions.
- Listen and gauge learners language competence during class discussion of activity 5.6 and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.9 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be given a list of substances from which they classify them into elements and compounds. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-assessment Test 5.1

1. Understanding the meaning of elements and compounds will enable the learner to classify the substances.
2. Mastery of chemical elements is required for the learner to answer this question corectly.
3. a. Pb is the chemical symbol of Lead
   b. Lead is poisonous
   c. Recycling

5.7 Instability of atoms and tendency to gain or lose electrons

PERIODS 10,11,12 and 13: Instability of atoms

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to describe formation of ions.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 3 periods. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasising the fact that atoms react in order to attain stability.
- Introduce the concept of noble gas electronic configuration.
- Let the learners work in pairs and discuss the questions in the discussion corner.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the study questions in the discussion corner. This will enhance their critical thinking and problem solving skills.
- Briefly explain the meaning of the terms ionization energy, electron affinity, cations and anions.
- Let the learners internalize the concept of noble gas electron configuration by doing more examples.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in the discussion corner.
- Critical thinking – As learners think about their findings in the discussion corner.

  The teacher should emphasize the purpose of sharing within our communities since it fosters national unity.

Formative assessments

- Ask diagnostic questions and self evaluation test 5.2 to assess knowledge and understanding.
- Assess skills acquisition by asking learners to illustrate ion formation in given examples.
- Assess attitudes and values by finding out if they appreciate the need for sharing in our everyday life.
- Listen and gauge learners language competence during class discussions and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.

- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.10 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learner can be given an opportunity to be secretary while others can ask questions during discussion. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to self assessment test 5.2

1. Duplet implies the state of an atom having 2 electrons in the outermost energy level while octet is when an atom has 8 electrons in the outermost energy level.
2. Losing 2 electrons enables magnesium to gain stability easily.
3. Aluminium is unstable, it needs to lose 3 electrons to acquire stability.
4. Learners need to remember that nonmetals react by losing valence electrons.

5.8 Radicals and valence of elements

PERIODS 14 and 15: Radicals and valence of elements

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to define radicals and valence of elements.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve discussion activity by the learners while the teacher is engaging learners on the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by reminding the learners on the formation of ions.
- Let the learners appreciate that atoms can occur in groups and each group has its charge. In this state, they are called radicals.

- Guide the learners in discussing radicals and giving more examples. This way, their **co-operation** and **interpersonal skills** are improved.
- Let the learners state the valencies of some radicals.
- In the second period guide the learners in finding the valencies of elements.
- Ask learners to find the valencies by giving out questions.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English as learners discuss in class.
- Critical thinking – as learners state the valencies of radicals from their formulae.

Formative assessments

- Ask diagnostic questions and questions from self evaluation test 5.3 to assess knowledge and understanding.
- Assess skills acquisition by asking learners to represent atoms of certain elements using the symbols, atomic numbers and mass numbers.
- Assess attitudes and values by finding out if they appreciate the fact that it is the valence electrons that actually takes part in a reaction.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.11 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be given an opportunity to be secretary during discussion. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

5.9 Chemical formulae

PERIOD 16: Chemical formulae

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to use the valence of different elements and radicals to write the formulae and names of chemical substances.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve discussion activity by the learners while the teacher is engaging learners on the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking the learners to explain why atoms lose or gain electrons as previously learnt.
- Emphasize the fact that although atoms attain stability after losing or gaining electrons, they become electrically charged and can bond with atom of the opposite charge hence forming chemical formulae.
- Guide the learners in discussing how chemical formulae of different compounds are formed. Use chalkboard for llustrations.
- As they discuss they improve their co-operation and interpersonal skills.
- Give learners more questions and ask them to write their chemical formulae.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills is seen as learners interact and engage in class discussion.
- Communication in English as learners discuss in class.

Formative assessments

- Ask diagnostic questions such as the difference between a molecule and a compound. This is to assess knowledge and understanding.
- Assess skills acquisition by asking learners to write chemical formulae of certain elements.
- Assess attitudes and values by finding out if they appreciate the fact that sharing brings forth or

improves peace and stability in our community.

- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 5.12 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later. Slow learners can be given an opportunity to ask questions during discussion. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Consolidation activities

1. *Why is it important to use symbols in naming elements other than just use words?*

   Ans: Symbols are known and acceptable internationally. They also provide an easy way of writing chemical equations.

2. *Electrons are always freely moving around in the energy levels. What makes them not detach from the atom and disappear?*

   Ans: Electrons are negatively charged. They are therefore attracted to the protons that are found in the nucleus and are positively charged.

3. *Why are atoms referred to as neutral?*

   Ans: The number of electrons and protons in an atom are equal. Since protons are positively charged and electrons negatively charged, the charges cancel out making the atom neutral.

4. *Why does an atom become negatively charged after gaining an electron and becomes positively charged after losing an electron.*

   Ans: When an atom loses an electron, the number of protons (positively charged particles) becomes more than that of electrons (negatively charged particles). On the other hand, when an atom gains an electron, the number of electrons exceeds that of the protons.

5. *Chlorine has an electron configuration of 2.8.7.*

   a) Does it gain stability by gaining or losing electrons?

b) Explain your answer in (a) above.

c) How do you expect aluminium with an electron configuration of 2.8.3 to gain stability?

Ans: Chlorine gains stability by gaining one electron to fill its outermost energy level. This is because it requires less energy to gain one electron than to lose seven of them. Aluminium on the other hand, gains stability by losing the three electrons in the outermost energy level.

Answers to Test Your Competence 5

1. Mark correct formulae only
2. i. Let learners give names and not symbols
   ii. Mark correct formula only
3. True
4. Isotopes
5. Oxygen exists as a molecule consisting of the same atoms.
6. Protons,electrons and neutrons
7. c
8. c
9. Learner's should show all the steps.
10. a) Number of protons =19
    b) Number of neutrons, N= A- Z = 39-19 =20
    c) Configuration of X= 2,8,8,1
    d) X becomes stable by losing one electron of its outermost shell because it requires less energy to lose one electron than to gain 7 electrons.

Table 5.13 Extended excercises

Remedial exercise for slow learners	Additional exercise for first learners
1. An element with different atoms can have a different number of? 2. What is the relationship between atomic number, number of protons and electrons in an atom. 3. Name an element with the following numbers of particles. (a) 0 neutrons (b) 11 electrons 4. In the Periodic table, no **two** different elements will have the _____ atomic number.	1. Given the chemical symbol of an element, what kind of information will you obtain? 2. Group VIII elements are inert. Explain. 3. Give the symbol and the number of electrons in an atom of: a. Oxygen b. Carbon 4. The atomic number tells you the number of _____ in an atom of an element. It also tells you the number of _____ in a neutral atom of that element. The atomic number gives the "identity" of an element as well as its location on the Periodic Table. 5. What is special about valence electrons?

Table 5.14 Answers to extended exercises

Answers to remedial exercise for slow learners	Answers to additional exercise for first learners
1. Neutrons. 2. Atomic number, number of protons and number of electrons are equal. 3. a. Hydrogen b. Sodium 4. Same	1. Mass number and atomic number. 2. Let learners appreciate that group VII atoms does lose or gain electrons. 3. a. O-8 b. C-6 4. Protons, electrons 5. Used in bonding.

Unit 6 Arrangement of Elements in the Periodic Table

(Number of Periods- 6)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to use the atomic number, valence electrons and number of shells to classify the first 20 elements in the Periodic Table.

Unit outline

- Early classification of elements.
- Dobereiner's Triads and Newlands
- Historical development of the modern Periodic Table
- Metallic and non-metallic trend in the Periodic Table

Learning objective

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is; knowledge and understanding, skills acquisition, attitude and values. At the end of the lesson, the learner should be have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 6.1 Knowledge, Skills and values to be attained

Learning Objectives		
Knowledge and Understanding	**Skills**	**Attitudes and values**
- Describe the historical evolution of the modern Periodic Table. - State the trends in metallic and non metallic character of elements across a period and down a group on the Periodic Table.	- Deduce the position of an element in the Periodic Table from its electronic configuration. - Relate metallic and non-metallic properties of elements from their position on the Periodic Table.	- Appreciate the importance of classifying elements in the Periodic Table. - Appreciate the contribution of scientists such as Mendeleev and Mosley in the development of the modern Periodic Table.

Links to other subjects

The content in this unit is related to Mathematics whereby a set is a collection of distinct objects considered as an object on its own.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts, use the self evaluation tests and specific questions in the test your competence 6 at the end of the unit. You can also formulate your own questions or use the diagnostic assessment exercises and exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition, you may present learners with electronic configuration of certain elements and ask them deduce their positions in the Periodic Table. Also, Let them relate metallic and non-metallic properties of elements to their position on the Periodic Table. Particular questions have been suggested in the test your competence 6 that target assessing skills acquisition.
- To assess attitude changes you may ask probing questions aimed at finding out if they appreciate the importance of classifying elements in the Periodic Table. Also, specific questions have been provided in the test your competence 6 which target attitude change and societal values.

The teacher should continuously assess learners to gauge the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competencies are given in the table below.

Table 6.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

- Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

Background information

Periodic Table is the tabular arrangement of elements in order of atomic number, usually in rows, so that elements with similar atomic structure appear in vertical columns.

This unit is about arrangement of elements in the Periodic Table. Attempts by early Chemists to classify elements that is Dobereiner's triads and Newlands octaves as part of development of the Periodic Table, metallic and non-metallic trend in the Periodic Table. The learners should appreciate the contribution of scientists such as Mendeleev and Moseley in the development of the modern Periodic Table.

Additional information for the teacher

Transition elements are elements that make up groups III through XII of the periodic table. These elements are all metals. They include some of the best known names on the periodic table like iron, gold, silver, copper, mercury, zinc, nickel, chromium and platinum amont others. Other transition elements might be unfamiliar. They however find application in industry. They include titanium, vanadium, manganese, zirconion, molebdenum, palladium and tungsten.

Mercury is unique as it is the only liquid metal. All others have high melting and boiling points. They also have shiny, lustrous, metallic appearance. Chemical properties for transition elements include;

(i) Ability to form complexes.

(ii) Tendency to form coloured compounds.

(iii) Having catalytic properties.

6.1 Dobereiner's triads and Newlands octave

PERIODS 1 and 2: Dobereiner's triads and Newlands octaves

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to describe Dobereiner's triads and Newland's octaves.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve discussion activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking the learners to define the Periodic Table as previously learnt.
- Emphasize the contribution of J. W Dobereiner and John A. R Newlands towards classification of elements.
- Guide the learners in discussing the triads and the octaves. Use chalkboard for illustrations.
- As they discuss, they improve their **co-operation** and **interpersonal skills**.
- Use diagnostic questions to enhance **critical thinking** and **problem solving skills**.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills is seen as learners interact and engage in class discussion.
- Communicating in English as learners discuss in the class.

Formative assessments

- Ask diagnostic questions for example:
  a. What is a triad?
  b. Why was triads discarded as a a way of arranging and classifying elements?

This way you will be assessing knowledge and understanding.

- Assess attitudes and values by listening to their answers to the discussion corner questions. This will help you to find out if they appreciate the importance of classifying elements in the Periodic Table
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 6.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may explain how the law of Triads was used to classify elements. Slow learners may be asked diagnostic questions to reinforce their learning. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

6.2 Historical development of the modern Periodic Table

PERIOD 3: Historical development of the modern Periodic Table

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to describe development of the modern Periodic Table.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Periodic Table

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Research

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by creating a connection between the early attempts to classify elements and the work of Mendeleev Dmitri.
- Emphasize the periodic law i.e the properties of the elements and the function of their atomic weight as stated by Mendeleev.
- Guide the learners in discussing how Mendeleev came up with periods. Ensure **co-operation** and **interpersonal skills** are enhanced among the learners during discussion.
- Bring to the attention of the learners the discovery of the atomic number by Henry G Moseley.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.

- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.
- Environment, conservation and sustainability – Ask learners to name some of the newly created elements that poses danger to the environment.

Generic competencies covered

- Co-operation and interpersonal skills is seen as learners interact in pairs and engage in class discussion.
- Communicating in English as learners discuss in the class.

Formative assessments

- Ask diagnostic questions and use self evaluation test 6.1 to assess knowledge and understanding.
- Assess skills acquisition by asking learners to mention how one discovery in the development of the Periodic Table led to another.
- Assess attitudes and values by stating the major contributions of Henry Moseley and Mendeleev in the development of Periodic Table.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussions and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 6.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to state and explain the periodic law. Slow learner can asked to state the contribution of Mendeelev Dmitri and Henry G. Moseley towards development of the Periodic Table. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 6.1

1. Both Lothar Meyer and Mendleev's suggested separately periodic table where elements were arrange by increasing mass.
2. He left blank spaces for elements that had not yet been discovered by then; for example noble gases. Mendeleev's work became limited when no one was able to measure atomic number.
3. By discovering the position of elements in the table, it became easy to predict the position of the missing elements.
4. Let the learners show appreciation for arrangement of things in a shop i.e easy access to certain products.

6.3 The modern Periodic Table

PERIOD 4: The Periodic Table

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to describe the Periodic Table based on Mendeleev's original idea.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Periodic Table

Teaching methodologies

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by revisiting Mendeleev's idea on the development of Periodic Table.
- Guide the learners in discussing the principal characteristics of the modern Periodic Table. As they work in pairs, their **co-operation** and **interpersonal skills** are enhanced.
- Emphasize the importance of Periodic classification of elements i.e there is always consistency of properties in a group. This will make them appreciate the work of the modern periodic function.

Cross cutting issues covered

- Inclusive learning where all learners whether with special education needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact and engage in class discussion.

- Communicating in English as learners discuss in the class
- Critical thinking as learners think about the answers to the diagnostic questions.

Formative assessments

- The teacher may use diagnostic questions and self evaluation test 6.2 to assess knowledge and understanding. Reinforce where necessary.
- From the answers learners give to the oral questions you ask them on the pure substances, assess their attitude towards the importance of classifying elements in the Periodic Table.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 6.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to state the atomic number and symbol of an element from the Periodic Table.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be assisted using visual aids such as Periodic Table. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class.
Slow learners to be guided on how to search information from the internet.	The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 6.2

1. a. Let the learner appreciate Mendeleev's periodic law and table consisting of groups and periods.
   b. Elements in a group have similar properties. They form a family.
   c. 7 periods and 18 groups.
2. a. As one move from left to right the elements become less metallic.
   b. Alkali metals, Alkaline earth metals, Halogens and noble gases.
3. Having completely filled outermost energy level makes it stable hence, member of the noble gases.

6.4 Relationship between electronic structure of elements and their position on the Periodic Table

PERIOD 5: Electronic structure of elements and their position on the Periodic Table

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to locate the position of an element from its electronic structure.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Periodic Table

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by creating linkage with the previous lesson of the Periodic Table.
- Emphasize the fact that from the electronic configuration we can locate the position of elements in the Periodic Table.
- Let the learners work in pairs and do Further activity in the learner's book.
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the diagnostic questions. This will enhance their **critical thinking** and **problem solving skills**.
- Learners should state elements with the same number of electrons in the outermost energy level and those with the same number of energy levels.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact in pairs and engage in class discussion.
- Communicating in English as learners discuss in the class.
- Critical thinking as learners think about the answers to the diagnostic questions.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding.
- Assess skills acquisition by asking learners to :
  a. determine the position of an element from its electronic configuration.
  b. classify elements which belong to the same group from a list.
- Listen and gauge learners language competence during class discussion in the Further activity and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 6.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be given a Periodic Table containing some elements and asked to state their atomic number and their configuration. Slow learners can be given simple questions such as selecting elements which belong to the same group, given a list. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 6.3

1. (a) Assess the skill of writing electronic configuration.
   The learners should show how they arrived at the answers.
   (b) Atomic number enables one to locate the position of the element in the Periodic Table.
2. The answers provided should show appreciation for the uniqueness of the hydrogen element.
3. The learners should know that elements in a group display similar properties.
4. Sometimes materials can be arranged for convenience purposes.

PERIOD 6: Metallic and non-metallic trend

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to describe the metallic and non-metallic trend in the Periodic Table.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodologies

- Role playing
- Guided discovery
- Brainstroming
- Discussions

Preparation for the lesson

This lesson will be taught in two periods. It will involve discussion activity by the learners as the teacher is assessing learning achievements. You are therefore required to get the various materials in advance and organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Bring to the attention of learners that across the Period, from left to right, metallic character decreases.
- Also emphasize that down the group, there is increase in metallic character.
- Let the learners work in pairs and answer the study questions.
- As they work in pairs, they improve their **co-operation** and **interpersonal skills**.
- Guide the learners in discussing the fact that, down a metallic group it becomes easier to lose valence electrons while across the Period from left hand side to the right hand side it becomes difficult to lose valence electrons hence decrease in metallic properties.

Cross cutting issues covered

- Inclusive learning where all learners whether with special educational needs or not should participate actively in the lesson. Learners with seeing difficulties can be put in front of the class.
- Peace, values and gender education allows the learners to see the need to accommodate other people's views in a discussion.
- Financial education should put emphasis on the economical use of energy.

Generic competencies covered

- Co-operation and interpersonal skills should be seen as learners interact in pairs and engage in class discussion.
- Communicating in English as learners discuss study questions.
- Critical thinking as learners think about the answers of the diagnostic questions.

Formative assessments

- You may ask learners some diagnostic assessment questions in the course of the lesson to gauge their knowledge and understanding of the arrangement of elements in the Periodic Table.
- Learners acquisition of skills can be assessed by asking the learners oral questions to find out if they can relate metallic and non-metallic properties of elements to their position on the periodic table.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.

- Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Use certain diagnostic questions to assess their attitude towards the criteria of choosing the appropriate fuel to use while at school and at home.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 6.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to explain why metallic properties increases from right to left across the period and down a group. Slow learners can be asked to name the metallic and non-metallic groups. This enables them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 6.4

1. a. It tells us the group and period of an element.
   b i. Increases (check the explanation given),
   ii. Decreases from left to right hand side. (check the explanation given).
2. It enables electricians to choose the best conductor to use as cables.

Consolidation activity

1. Why is silicon classified as metalloid?

Ans: Silicon is a grey solid at room temperature with very high melting point and boiling point. It loses or gains 4 electrons hence have both metallic and non-metallic properties so it is classified as metalloid.

2. Why do inert gases have zero valence?

Ans: It is because inert gases have 2 or 8 electrons in outermost energy level.

3. How is valency of an element determined?

Ans: The valency of an element measures its ability to combine with other elements. The valency is determined by knowing its place in periodic table. All the elements in group VIII have eight electrons in their outer shells, and thus have a valency of zero (highly stable). Elements in group I just have one

valence electron in their outer shells and thus have a valency of one.

4. *Why could no fixed position be given to hydrogen in Mendeleev's Periodic Table?*

   Ans: Hydrogen is placed in the first column above alkali metals. It is because hydrogen and alkali metals have similar properties. However, hydrogen also resembles halogens. Like halogens, hydrogen is a gas, and exists as a diatomic molecule (H_2). It forms covalent compounds like halogens unlike alkali metals. Hence, it can also be placed above the halogen group. Therefore, Mendeleev was not able to explain the position of hydrogen.

5. *In modern Periodic Table, the isotopes of chlorine Cl-35 and Cl-37 have different atomic masses hence will be kept in different slots or they would be assigned same position on the basis of their chemical properties? Give reasons in support of your answer*

   Ans: It is because periodic table is based on the atomic numbers of the element and both the isotopes of chlorine have the same atomic number (z = 17).

6. *Why was dobereiner's system of classification of elements into triads not found to be useful?*

   Ans: it is because he could not arrange all elements in triads.

7. *Oxygen (O, 8) and sulphur (S, 16) belong to group 16 of the Periodic Table.*

   (i) Write the electronic configuration and valency of these two elements?

   Ans (i) Oxygen (O, 8) = 2,6 ; valency =2 ; Sulphur (S, 16) = 2,8,6 ; valency =2

8. *How does electronic configuration of atoms change in a period with increase in atomic number?*

   Ans: On moving across a period from left to right, the atomic number of the elements increases, therefore, the number of electrons in the valence shell increases from 1 to 8, i.e, the first element in the given period will have one electron in its valence shell and the last element in the same period will have eight electrons.

9. *Why is chlorine (atomic number 17) more electronegative than sulphur (atomic number 16) ?*

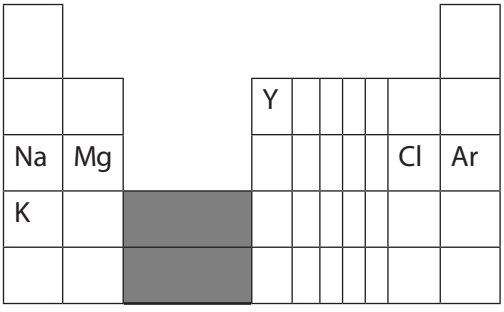
   Ans: The nucleus of chlorine has more tendency to attract an extra electron than the nucleus of sulphur because chlorine needs only one 1 electron to complete its shell. Hence, chlorine is more electronegative than sulphur.

10. *An element has electronic configuration 2, 8, 3. What is the atomic number of this element? To which (i) group and (ii) period does this element belong?*

    Ans: Atomic Number = 13, Group 3 Period 3

Answers to Test Your Competence 6

1. a. The learners must know the real names of the scientists.
   b. Atomic number
   c. All elements with same number of energy levels.
2. a. P, S belong to group 1
   b. P, Q, R are all in period 2 and S, T are both in period 3
3. a. B b. E
   c. P, S have one electron in the outermost energy level. All elements with the same number of energy levels are in the same period.
   d. C and F
4. a. Transition metals.
   b.



   b. Halogens
5. a. (i) No one
   (ii) F
   (iii) H
   (iv) H
   b. 3
6. a. 2.8.7
7. a. The learner can name another element from the same group
   b. Let the learner mention its adverse effect to the environment.
8. d

Table 6.8 Extended excercises

Remedial excercises for slow learners	Additional exercises for high achievers
1. Element V has an atomic number 14. Write its electronic configuration. 2. When carbon reacts, does it lose or gain electrons? Explain.	1. Account for the contribution of Henry Moseley's towards development of the Periodic Table. 2. What makes two elements to belong to the same group?

Table 6.9 Answers to extended exercises

Answers to extended exercises	Answers to additional exercises
1. 2.8.4 2. Carbon atoms reacts by gaining electrons. Carbon is a non-metal.	1. He proposed that atoms be arranged based on their numbers. 2. Possession of the same number of valence electrons in the outermost energy level.

Unit 7 Water and its composition

(Number of Periods - 8)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to state standard requirements for different categories of water and explain steps involved in water treatment.

Unit outline

- Sources of water.
- Physical properties of pure water.
- Testing for the presence of water using anhydrous copper(II)sulphate and cobalt(II) chloride
- Characteristics of different categories of water.
- Treatment and purification of water.
- Uses of water
- Water cycle

Learning objective

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is, knowledge and understanding, skills acquisition and attitude and values. At the end of the lesson, the learner should be have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 7.1 Knowledge, Skills and values to be attained

Learning Objectives		
Knowledge and Understanding	**Skills**	**Attitudes and values**
- State the physical properties of pure water.	- Perform experiments to show the properties of water.	- Develop the sense for importance of managing natural resources correctly.
- Outline the steps involved in the treatment and purification of water.	- Test for the presence of water in any given substance in the laboratory.	- Appreciate the value of clean water for our health.
- Explain the water cycle and its importance in daily life.	- Illustrate the water cycle through a labelled diagram.	

- Differentiate between pure water and clean water.	- Relate the characteristics of water to its uses. - Write a standard report of field visits and research. Present findings in a convincing way.	

Links to other subjects

The content in this unit is related to Mathematics whereby a set is a collection of distinct objects considered as an object on its own.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the test your competence 7 at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition – learners can perform experiments to show properties of water. Also, Let them test for the presence of water in agiven substance. They can also be asked to illustrate water cycle through a labelled diagram. Furthermore, particular questions have been suggested in the test your competence 7 that target assessing skills acquisition.
- To assess attitude change - you may ask probing questions aimed at finding out if they have developed a sence of managing resources correctly. Also, specific questions have been provided in the test your competence 7 which target attitude change and societal values.

The teacher should continuously assess learners to guage the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competencies are given in the table below.

Table 7.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – AverageRS – Research Skills
COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

- Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

This unit is about sources of water, it's physical properties, chemical test of water in the laboratory, treatment and purification of water, uses of water and the water cycle.

Background information

Water is an odourless, tasteless and transparent liquid. It is colourless in small amounts but exhibits a bluish tinge in large quantities. It is the most familiar and abundant liquid on earth. It covers about 70% of the earth's surface. Water is also a major component of tissues of living organisms.

Water has interesting thermal properties. When heated from 0°C to 4°C it contracts and becomes denser unlike other substances which expand and become less dense. Conversely, when water is cooled within this temperature range, it expands, as a result, ice is less dense than water and floats on it.

Because of hydrogen bonding between water molecules, the latent heats of fusion, evaporation and the heat capacity of water are usually high. Due to these reasons, water serves both as a heat transfer medium(ice for cooling and steam for heating) and as a temperature regulator(the water in lakes and oceans help regulate atmospheric temperature).

Additional information for the teacher

Water conservation

Water conservation involves the policies, strategies and activities made to manage fresh water as a sustainable resource, to protect the water environment and to meet current and future human demand. Increase in population has increased demand for water. Climate change brought about by some human activities have increased pressure in water demand for manufacturing and irrigation.

The following are the goals of water conservation:

(a) To ensure availability of water for future generations.

(b) To protect habitat for acquatic animals like fish.

(c) To preserve water for energy generation.

The strategies to conserve water can be summarised as below:

1. Avoiding water loss – This can be done by harvesting rain water,

closing taps after use, use of modern irrigation methods that save water like drip and use of swimming pool covers.

2. Avoiding any damage to water quality – Avoid activities that pollute water for example dumping wastes in water bodies.
3. Improving water management practices that will reduce or enhance the beneficial use of water.

7.1 Sources of water

PERIOD 1 Sources of water

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to state and briefly explain sources of water.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Charts

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve discussion activity by the learners as the teacher is engaging learners in assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to mention places where they get water for domestic purposes.
- Emphasize the need to drink treated water to avoid contracting waterborne diseases.
- Guide the learners in discussing the sources of water. Remind them of the importance of conserving water resouces.
- As they discuss they improve their co-operation and interpersonal skills.
- Use diagnostic questions to enhance critical thinking and problem solving skills.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English – as learners discuss in the class.

Formative assessments

- Ask diagnostic questions for example; state and briefly explain three sources of water. This way

you will be assessing knowledge and understanding.

- Assess attitudes on conservation of resources by listening to the answers they provide to the oral questions you ask them.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may explain why it is important to treat water before drinking. Slow learners may be asked diagnostic questions to reinforce their learning. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

7.2 Physical properties of pure water

PERIOD 2: Physical properties of pure water

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to state the physical properties of pure water.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book
	Boiling tube, tripod stand, wire gauze, thermometer, matchbox, sample of water

Teaching methodology

- Guided discovery
- Demonstration
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve practical activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to describe the water they use at home.
- Provide the learners with the apparatus and let them determine the boiling point of water.
- Guide the learners in discussing the questions in the discussion corner. As they discuss they improve their **co-operation** and **interpersonal skills**.
- Use diagnostic questions to enhance **critical thinking** and **problem solving skills**.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.
- Financial education – Let the learners display caution while using thermometer to avoid breakage.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English – as learners discuss in the class.

Formative assessments

- Ask diagnostic questions for example:
  a. What is the colour of water?
  b. Describe the test of water?
- This way you will be assessing knowledge and understanding.
- Assess skills acquisition by asking learners to perform experiments to show properties of water.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to state the physical properties of pure water. Slow learners may be asked diagnostic questions i.e State the colour, smell and taste of pure water.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

7.3 Testing the presence of water in a given substance

PERIOD 3: Testing the presence of water in a given substance

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to test for the presence of water in any given substance.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Colourless liquid, test tubes
	Anhydrous copper(II) sulphate, cobalt (II) chloride

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Demonstration

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by way of flashback. Let learners mention the physical properties of water.
- Tell the learners that there are certain reagents that can be used to test for the presence of water in a substance.
- Let the learners work in pairs and do activity 7.3 in the learner's book,
- As they work in pairs they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer discussion corner questions. This will enhance their critical thinking and problem solving skills.
- Emphasize the effect of water on anhydrous copper (II) sulphate and cobalt (II) chloride.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss in the class.
- Critical thinking – As learners think about the answers to the diagnostic questions.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding for example; When cobalt(II) chloride is dipped in a certain clear liquid in a beaker, it changes to pink. What can you conclude about the liquid?
- Assess skills acquisition by asking learners to test for the presence of water in a given substance.
- Listen and gauge learners language competence during class discussion of the Further activity and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be given an opportunity to test for presence of water in a given substance. Slow learners can be asked to state the colour changes when water is added to anhydrous copper(II) sulphate. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

7.4 Characteristics of different categories of water

PERIOD 4: Characteristics of different categories of water

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to state characteristics of different categories of water.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner	Chalkboard
	Learner's book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Research

Preparation for the lesson

This lesson will be taught in 1 period. It will involve research and discussion activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasizing the fact that water from different sources have different characteristics.
- Encourage learners to appreciate the need for boiling tap water if its portability is in doubt.
- Guide the learners in discussing the findings of their research. As they discuss, they improve their co-operation and interpersonal skills.
- Use diagnostic questions to enhance critical thinking and problem solving skills.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English – as learners discuss in the class.

Formative assessments

- Ask diagnostic questions for example:
  a. State the characteristics of distilled water?
  b. What is the main difference between distilled water and mineral water.
- This way you will be assessing knowledge and understanding.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.

- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to differentiate between mineral water and distilled water. Slow learners may be asked diagnostic questions.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

7.5 Treatment and purification of water

Refer to learner's book

PERIOD 5: Treatment and purification of water

Specific objective

By the end this lesson, learners should be able to outline the steps involved in the treatment and purification of water.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Any relevant Chemistry book

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasizing the fact that contaminated water spreads disease causing microorganisms.
- Organize a field trip to an industry that purify and pack water. After the visit, let them write a report and present it to the class.
- Guide the learners in discussing the steps involved in the treatment of water.
- As they discuss they improve their **co-operation** and **interpersonal skills**.
- Guide the learners in answering diagnostic questions. This will enhance their **critical thinking** and **problem solving skills**.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.

- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss in the class.
- Critical thinking – As learners think about the answers to the diagnostic questions.
- Problem solving skills – As the learners discuss the steps involved in water treatment, their skills are sharpened.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding for example;
  a. What happens at the coagulation stage in the treatment and purification of water?
  b. What is the function of chlorine in the treatment of water?
- Through diagnostic questions find out if they appreciate the value of clean water for our health.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may explain the reason why chemicals such as sulphur dioxide and lime may be added to water during treatment. Slow learners can be asked to state the importance of these steps in the treatment of water. a. Sedimentation b. Filtration This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIOD 6: Differences between pure water and clean water

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to differentiate between pure water and clean water.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Charts

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve discussion activity by the learners as the teacher is engaging learners in assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by giving learners samples of water and asking them to pick the clean and pure samples. Ask them to state how they would differentiate pure water from clean water.
- Emphasize the need to drink treated water to avoid contracting waterborne diseases.
- Guide the learners in discussing the characteristics of pure and clean water. Remind them of the importance of conserving water resources.
- As they discuss the questions in the discussion corner, they improve their co-operation and interpersonal skills.
- Use diagnostic questions to enhance critical thinking and problem solving skills.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English – as learners discuss in the class.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.

- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.8 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may explain the difference between pure water and clean water.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners may be asked diagnostic questions to reinforce their learning. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class.
	The fact that disability is not inability should be driven home well.

7.6 Water Cycle

PERIOD 7 Water cycle

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to explain the water cycle and its importance in daily life.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Chart

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Research

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve discussion activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to reflect upon certain occurences to trigger their interest and critical thinking skills.
- Bring to the attention of learners the importance of conserving the environment.
- Lead the learners in discussing the water cycle.

- Let them work in pairs and answer the discussion corner questions. This way, they improve their co-operation and interpersonal skills.
- Guide the learners to answer the discussion corner questions. This will enhance their critical thinking and problem solving skills.
- Both slow and fast learners to try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.
- Environmental conservation and sustainibility – Let the learners appreciate the need to conserve environment.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in class.

Formative assessments

- Ask diagnostic questions such as definition of transpiration and precipitation. This way you will be assessing acquisition of knowledge and understanding.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.9 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to explain how precipitation occurs. Slow learners can be asked to state the three phases water undergo during the water cycle. This will enable them internalize the requisite knowledge. Slow learners should be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

PERIOD 8: Uses of water

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to state the importance of water.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve activities by the learners as the teacher is engaging learners in a discussion regarding the activities and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking the learners to state some of the uses of water they know.
- Let them appreciate the importance of water in everyday life.
- Let the learners work in pairs and answer the questions in the discussion corner. As they work in pairs they improve their co-operation and interpersonal skills
- Guide the learners in discussing uses of water. This should be accompanied by diagnostic questions aimed at reinforcing critical thinking skills.
- Both slow and fast learners should try and give their thoughts on the questions.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.
- Environmental conservation and sustainibilty – As learners see the essence of conserving water sources..

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss in class
- Critical thinking – As learners think about diagnostic questions asked in class.

Formative assessments

- Some of the questions in the test your competence 7 can be used to test their knowledge on decantation.
- Keenly listen to learners as they discuss uses of water to find out if they have developed a responsible attitude towards sustainable use of resources.

- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 7.10 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to explain how water molecules move through the water cycle and why water is considered a universal solvent.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners can be assisted using visual aids such as charts containing an illustration of the water cycle. This will enable them internalize the requisite knowledge.	Learners with sight problems can be placed in front of class.
Slow learners should be guided on how to search information from the internet.	The fact that disability is not inability should be driven home well.

Table 7.11 Additional excercises

Remedial excercises for slow learners	Extended exercises for fast learners
1. Water exists in three states. Name these states. 2. Name the term used to describe movement of water throughout the environment.	1. Why is water considered a "strange" chemical substance? 2. How does temperature affect water? 3. Explain how pollution and water are related. 4. Ice does not sink in water. Explain.

Table 7.12 Answers to additional exercises

Answers to remedial exercises	Answers to extended exercises
1. Solid, liquid, gas 2. Water cycle.	1. Answer should be towards this effect i.e It defies gravity and constantly changes form. 2. At low temperatures i.e below 0°C, water molecules move slowly. As temperature rises, they start to move faster and at 100°C, it boils and evaporates. 3. As a universal solvent, many chemicals can dissolve in it and carried to water sources. 4. Water expands as it freezes i.e air spaces in between the crystals makes ice less dense.

Consolidation activities

1. State various uses of water.

Ans: Water is used for: drinking, cooking, washing clothes & utensils, generating electricity, bathing, habitat for various organisms, etc.

2. *What are the various causes of water pollution?*

Ans: Water is polluted by various factors like:

- Bathing of cattle in river bodies.

- Washing of clothes & utensils by people in rivers.

- Discharging wastes from factories, industries in nearby river bodies & ponds.

3. *When is world water day celebrated?*

Ans: World water day is celebrated on 22nd March every year.

4. *Name any two chemicals that are used to disinfect water.*

Ans: Chlorine & ozone.

5. *Discuss the various steps involved in water treatment.*

Ans: The processes involved in water treatment are grouped into physical, chemical & biological processes.

- Wastewater is passed through bar screens to remove big objects like cans, sticks, rags, etc.

- The liquid material is then passed through sedimentation tank where solid waste like faecal matter, sand and grit settles down.

- This solid matter is then removed with the help of a scrapper. This is the sludge. A skimmer removes the floatable solids like oil, grease etc. The clear water so obtained is called clarified water. Air is pumped into clarified water to help aerobic bacteria to grow. The bacteria then consume the unwanted matter still present in clarified water. The suspended microbes settle at the bottom & the water is removed from the top.

6. *Why should chemicals not be released in the drains?*

Ans: Chemicals like paints, solvents, insecticides among others should not be thrown down the drain as it may kill the useful microbes

that help to decompose the water present in the sewage & purify water.

7. *Why should used tea leaves, solid food remains, etc. not be released in the drains?*

   Ans: Used tea leaves, solid food remains etc. should not be thrown down the drain as they may choke the drain.

8. *What do you understand by the term "sewerage"?*

   Ans: Sewerage is like a transport system that carries sewage from the point where it is being generated to the point of disposal i.e. treatment plant.

9. *List five ways to control sewage generation.*

   Ans: Ways to control sewage generation are:

   • Leakage in sewer lines should be checked & repaired regularly.

   • Do not defecate, spit or scatter litter in public places.

   • Used tea leaves, solid food remains, toys, towels etc should not be thrown in water pipe because these materials may choke the pipe.

Answers to Test Your Competence 7

1. a. Let the learners display procedural use of copper(II) sulphate or cobalt(II) chloride in testing for the presence of water.
   b. Water has definite boiling and freezing points.
2. Drinking helps us to quench thirst
   Dissolved mineral salts are necessary for our bodies.
3. Let the learners clearly explain the steps in the treatment of water.
4. Checking its expiry date and a tag from Rwanda Standards Board.
5. By periodically replacing water and adding chlorine for disinfection.
6. Determine the micro-climate of an area (learners should explain).
7. Ensure treatment of water before drinking.
8. To close the tap always. Water is an important resource.
9. D
10. Learner's should give all the benefits of water to living organisms (plants and animals).

Unit 8 Air Composition and Pollution

(Number of Periods - 9)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to assess the components of air and analyse the causes of air pollution and its prevention.

Unit outline

- Components of air
- Oxygen as the active part of air
- Importance of air
- Definition of pollution
- Major pollutants of air and their sources
- Ways of preventing air pollution

Learning objective

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is; knowledge and understanding, skills acquisition, attitude and values. At the end of the lesson, the learner should have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society where they live. Therefore, emphasize attainment of these three objective areas during the learning process.

Table 8.1 Knowledge, Skills and values to be attained

Learning Objectives		
Knowledge and Understanding	**Skills**	**Attitudes and values**
- State the main components of air and their percentages. - Define air pollution. - State the major air pollutants and their sources. - Discuss the different ways of preventing air pollution.	- Perform experiments to determine the percentage of oxygen in the atmosphere. - Write a standard report and present it in a convincing way.	- Develop a culture of managing natural resources. - Develop confidence in the presentation of reseach work.

Links to other subjects

The content in this unit is related to Physics whereby radioactive pollutants are considered hazardous when in contact with the human body i.e they can cause cancer and genetic disorders.

Biologically, many chemical processes take place in the presence of oxygen. In Geography, we learn that some human activities such as burning of charcoal causes air pollution.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the test your competence 8 at the end of the unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting bright students and remedial exercises.
- To assess skills acquisition – learners can perform experiments to determine the prcentage of oxygen in the atmosphere. Also, Let them write a report and present it in a convincing way. Furthermore, particular questions have been suggested in the test your competence 8 that target assessing skills acquisition.
- To assess attitude change – you may ask probing questions aimed at finding out if they have developed a sense of managing resources. Also, specific questions have been provided in the test your competence 8 which target attitude change and societal values.

The teacher should continuously assess learners to guage the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competencies are given in the table below.

Table 8.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – AverageRS – Research Skills

COMM – Communication in English
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
LL – Life long skills
PS – Problems solving skills
C &I – Creativity & Innovation

- Grade the learners based on how they have scored on the various competencies and the tests given to assess the various learning objectives

Background information

The atmosphere contains air. Air is a mixture of several components with varying percentage composition. Air is important since it is responsible for life processes such as respiration of living organisms. The constituent of air which supports such activities is called oxygen. Air is a raw material for chemical industries and also determines climate of an area.

Examples of air pollutants include sulphur dioxide, exhaust gases from vehicles, gaseous release from idustries, dust particles and CFCs

This unit is about sources of air composition and pollution. We need to prevent air pollution so as to make environment safe and habitable.

Additional information for the teacher

Health risks associated with air pollution

Air pollution is a major environmental risk to health. Reducing air pollution can reduce the burden of diseases like stroke, heart disease, lung cancer and both chronic and acute respiratory diseases including asthma. The lower the level of air pollutin, the better the cardiovascular and respiratory health of a population.

The following policies can help reduce air pollution and associated health risks:

1. Employing clean technology that will reduce smoke emissions, improved management of urban and agricultural waste etc.
2. Shifting to clean modes of power generation, cleaner heavy duty diesel vehicles and low emission vehicles and fuels. This includes fuels with reduced suplhur content.
3. Improving the energy efficiency of buildings in urban areas and making cities more compact hence energy efficiency.
4. Increased use of low-emissions fuels and renewable combustion free power sources (like solar, wind and hydro-power).
5. Coming up with strategies for waste reduction, waste separation, recycling and re-use of waste. Also using anaerobic waste digestion to produce biogas.

8.1 Components of air

PERIOD 1: Components of air

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to state the main components of air and their percentages.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Air

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve an activity by the learners as the teacher is engaging learners regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasizing the fact that air is a mixture and not a pure substance.
- Using guided discovery, let the learners appreciate the existance of other components of air.
- Guide the learners in discussing the percentage composition of air.
- As they discuss, they improve their co-operation and interpersonal skills.
- Ask them oral questions that will enhance their critical thinking and problem solving skills.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss in class.

Formative assessments

- Ask diagnostic questions aimed at assessing acquisition of knowledge and understanding.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their Co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 8.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may asked to differentiate between a mixture and a compound. Slow learners can be asked to: a. State the component of air that sustains life. d. State component of air used during combustion. This will enable them internalize the requisite knowledge.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

8.2 Oxygen as the active part of air

PERIOD 2 and 3: Oxygen as an active part of air

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to determine the percentage of the most active part of air.

Materials and learning resources

High cost	Low cost/no cost
Bunsen burner, syringes	Chalkboard
	Learner's book, Chart
	Combustion tube
	Copper turnings,glass wool, air

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Demonstration

Preparation for the lesson

This lesson will be taught in 1 period. It will involve demonstration activity by the learners as the teacher is engaging learners and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by emphasizing the fact that oxygen is the active part of air.
- Encourage learners to appreciate the need for following procedure in an experiment.
- Guide the learners in discussing the findings of the activity 8.2. As they discuss, they improve their co-operation and interpersonal skills.
- Use diagnostic questions to enhance **critical thinking** and **problem solving skills**.
- Display the chart on the percentage composition. This way, you will be reinforcing understanding of slow learners.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson. Disabled learners to be intergrated in all groups so that they learn with others.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.
- Financial education – Let learners use delicate apparatus such as the combustion tube carefully to avoid unnecessary costs.
- Standardization culture- The apparatus and chemicals used must be those approved by Rwanda Bureau of Standards.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact and engage in class discussion.
- Communicating in English – as learners discuss in the class.

Formative assessments

- Ask diagnostic questions to assess knowledge and understanding.
- The teacher can assess skill acquisition by providing certain apparatus to the learners and asking them to determine the active part of air.
- Assess attitude change towards managing natural resources by asking questions such as; explain the importance of reafforestation.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Assess their critical thinking and problem solving skills from the way they answer questions in the discussion corner.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 8.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to research on an alternative way of how the percentage of oxygen in the atmosphere can be determined.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners may be asked to name the main components of air.	Learners with sight problems can be placed in front of class.
	The fact that disability is not inability should be driven home well.

8.3 Importance of air

PERIOD 4: Importance of air

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to explain the importance of air

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Air

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions

Preparation for the lesson

This lesson will be taught in 1 period. It will involve discussion activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by bringing to attention of learners the fact that life would not be possible without air.
- Let the learners carry out a research and then do a presentation on the importance and application of air in daily life and in industries.
- Lead the learners in discussing various areas where air is applied.
- As they discuss, they improve their **co-operation** and **interpersonal skills**.
- Ask learners certain probing questions during the lesson. This will enhance their **critical thinking** and **problem solving skills**.
- Let them appreciate that we can tap wind and use it to generate wind power, a non pollutant and renewable source of energy.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion.
- Environmental conservation and sustainibility- Wind can be tapped and used to generate electricity.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss in class
- Research skills- As learners gather information from various materials on the importance of air, their reseach skills are sharpened.

Formative assessments

- Ask diagnostic questions such as: Why do you think air transport is faster than land or water transport.

This way you will be assessing acquisition of knowledge and understanding.

- Assess skills acquisition by keenly looking at the format of the report if it is of standard. Also find out if they have developed confidence during their presentation.
- Keenly observe and listen to learners as they discuss to find out if they have developed a responsible attitude towards teamwork in group activities.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 8.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may take short notes as they discuss while the slow learners may write notes later.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners.
Slow learners should be guided on how to search information from the internet.	Learners with sight problems can be placed in front of class.
	The fact that disability is not inability should be driven home well.

8.4 Air pollution

PERIOD 5: Air pollution

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to define air pollution and state the sources of major air pollutants.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Chart on air pollution

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Demonstration

Preparation for the lesson

This lesson will be taught in 1 period. It will involve a practical activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to brainstorm on the meaning of pollution.
- Bring to the attention of learners the importance of conserving the environment.
- Let them work in pairs and answer the discussion corner questions. This way, they improve their co-operation and interpersonal skills.
- Guide the learners to answer the discussion corner questions. This will enhance their critical thinking and problem solving skills.
- Both slow and fast learners should try and give their thoughts on the questions.
- Lead the learners in an interactive discussion on air pollutants as you try to gauge their language competence.
- Remind learners of the risks involved in smoking cigarettes.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education- Let the learners see the need to accommodate other people's views in a discussion. Let the learners work harmoniously and with mutual respect during the discussion. Also remind them of the fact that equitable distribution of resources leads to peaceful coexistance among communities.
- Environmental conservation and sustainability- Let the learners appreciate the need to conserve environment. Let them suggest how this can be done.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners discuss the questions in class.
- Critical thinking – As learners think of the responses of the questions in the discussion corner.

Formative assessments

- Ask diagnostic questions such definition of air pollution and sources of air pollutants. This way you will be assessing acquisition of knowledge and understanding.
- Assess attitude change through questions such as; Which natural resources do you think is being mismanaged in Rwanda? Explain how you expect the resources to be managed.
- Listen and gauge learners language competence during class discussion and correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 8.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked to explain the terms greenhouse effect and photochemical smog. Slow learners can be asked to name other forms of environmental pollution apart from air pollution. Let them also state the common air pollutants around their school and homes.This will enable them internalize the requisite knowledge. Slow learners to should guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

8.5 Ways of preventing air pollution

PERIODS 6 and 7: Ways of preventing air pollution

Refer to learner's book

Specific objective

By the end this lesson, learners should be able to discuss different ways of preventing air pollution.

Materials and learning resources

High cost	Low cost/no cost
	Chalkboard
	Learner's book
	Charts on air pollutants, their effects and prevention measures.

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Demonstration

Preparation for the lesson

This lesson will be taught in 2 periods. It will involve an activity by the learners as the teacher is engaging learners in a discussion regarding the activity and assessing learning achievements.

You are required to organize the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to research on various ways of preventing air pollution. Let them do a presentation on their findings.
- Let them work in pairs and answer the discussion corner questions. This way, they improve their **co-operation** and **interpersonal skills**.
- Guide the learners to answer the discussion corner questions. This will enhance their **critical thinking** and **problem solving skills**.
- Both slow and fast learners to try and give their thoughts on the questions.
- Display the chart and let the learners compare their findings with the information on the chart.

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion. Let the learners work harmoniously and with mutual respect during the discussion. Also remind them of the fact that prevention of air pollution can help foster peace among individuals and nations.
- Environmental conservation and sustainibility – Let the learners appreciate the need to prevent air pollution. Let them suggest how this can be done.
- Financial education – As learners understand the effects of air pollution on property such as buildings, they appreciate the need to prevent air pollution.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners answer discussion corner questions in class, during presentation
- Critical thinking – As learners think of the responses of the questions in the discussion corner.
- Lifelong skills – As learners respond to some questions in test your competence 8, for example importance of planting trees, they acquire a lifelong skill.

Formative assessments

- Ask diagnostic questions such the effects of excess release of carbon dioxide to the atmosphere. This way you will be assessing acquisition of knowledge and understanding.
- Assess attitude change by listening and observing the learners present, gauge their confidence.
- Assess skill acquisition by finding out if the learners have written a standard report. Also keenly follow their presentations to gauge their confidence and if their findings are convincing.
- Listen and gauge learners language competence during class discussion and during presentation of their findings. Correct accordingly as you encourage them to improve.
- Their co-operation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.
- Allocate marks for each colour and calculate the marks that the learner has attained in various tests. Grade learners based on the table for assessment criteria.

Table 8.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Fast learners may be asked the following questions: a. How is acid rain formed? b. What are the effects of acid rain on the environment? c. Explain how recycling helps control pollution. d. Recycling helps control pollution. Explain. Slow learners can be asked state how dust causes air pollution. Slow learners to be guided on how to search information from the internet.	The teacher should ensure learners with special needs are spread across the pairs so that they participate fully with other learners. Learners with sight problems can be placed in front of class. The fact that disability is not inability should be driven home well.

Answers to Self-evaluation Test 8.0

1. The teacher to check on accuracy of facts and confidence during presentation.
2. Inform them of the adverse effects of smoking.

Consolidation activities

1. *Nitrogen constitutes about 78% of air. What is the importance of the high percentage?*

   Ans: Due to its inert nature, nitrogen keeps away explosions from different reactions.

2. *What role does carbon dioxide play in living organisms?*

   Ans: Carbon dioxide is a raw material in photosynthesis which is a process by which green plants make their own food. When animals consume plants, they benefit from the stored food in plant tissues.

3. *What is the role of ozone to living organisms?*

   Ans: Ozone (O_3) is a gas in the atmosphere that filters ultraviolet rays from the sun preventing most of them from reaching the surface of the earth. Ultraviolet radiations are harmful to living organisms and can lead to diseases like cancer.

4. *What are the main compounds that destroy the ozone layer?*

   Ans: The main substances that destroy the ozone are chlorofluorocarbons (CFCs). These react with ozone releasing molecular oxygen hence reducing the amount of ozone in the atmosphere.

5. *What is global warming and what causes it?*

   Ans: Global warming is the increase in the temperature of the earth due to the accumulation of certain gases in the atmosphere, especially gases that retain the solar energy reflected by the earth's surface. The main gas that causes global warming is carbon dioxide, CO_2. Other gases include methane, CH_4, and nitrous oxide, N_2O. The exaggerated increase of

carbon dioxide in the atmosphere has been caused by the burning of fossil fuels (mainly oil and coal) in industrial and urban societies and by forest fires

Answers to Test Your Competence 8

1. The learner should display understanding of ways of preventing air pollution.
2. Knowledge of all components of air is required.
3. The learner should be able to explain the effects of acid rain to the crops, soil and roofs.
4. The role of trees in the water cycle should be brought out clearly.
5. a. The learner should be able to explain the importance of gaseous exchange in trees
   b. Recycling reduces pollutants
6. Let the learners appreciate the fact that the 3Rs does not add any pollutant to the environment.
7. Learners can suggest solutions such as installation of biogas plant

Table 8.3 Additional exercises

Remedial exercises for slow learners	Extended exercises for fast learners
1. Why is oxygen referred to as active part of air? 2. Name other components of air apart from the main components.	1. A candle was burnt in a trough of sodium hydroxide and covered with a measuring cylinder of capacity 80cm3. After some time the candle went off and the final volume was found to be 64cm3. a. State any other observation in this experiment b. Caculate the percentage of the active part of air used in combustion.

Table 8.4 Answers to additional exercises

Answers to remedial exercises	Answers to extended exercises
1. It supports combustion 2. Water vapour, dust .	1a. The level of sodium hydroxide rises up the measuring cylinder. b. The learners to display manipulative skill as they calculate the percentage of air that supports combustion

Unit 9 Waste Materials

(Number of Period - 4)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to minimise and properly manage waste materials.

Unit outline

- Definition of waste
- Types of waste materials
- Sources of wastes
- Sources of waste materials at school level and their management
- Hazards of wastes to environment

Table 9.1 Knowledge, skills and values to be attained

Knowledge and understanding	Skills	Attitudes and values
By the end of the unit, learners should be able to: • Define a waste material. • Identify different types of wastes. • Identify the hazards of wastes to people and the environment. • Identify different sources of waste materials.	By the end of the unit, learners should be able to: • Categorise waste materials according to their nature and sources. • Identify the solid, liquid and gaseous wastes in the school environment. • Identify different sources of waste materials in the school environment. • Manage waste materials around homesteads and the school environment.	By the end of the unit, learners should develop a sense of responsibility to maintaining a clean environment.

Links to other subjects

The contents in this unit can be applied in Biology, Ecology and Geography. In Biology, the processes of decomposition and the components of various materials are considered.

Formative assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the knowledge checks and specific questions in the Test your Competence at the end of each unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting fast learners and remedial exercises.
- To assess skills acquisition – you may present to the learners a problem and ask them to suggest the methods of writing balanced chemical equations. Also, particular questions have been suggested in the Test your Competence that target assessing skills acquisition.
- To assess attitude change - you may ask probing questions aimed at finding out if they have developed confidence in writing and interpreting chemical formula and equations. Also, specific questions have been provided at the end of unit in the competence test which targets attitude change and societal values.

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered.

You can also continuously assess learners to gauge the extent of knowledge and skills acquisition.

The general criteria to use to gauge the various generic competencies are given in the table below.

Table 9.2 Assessment criteria

Name of learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English,
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Lifelong skills
PS – Problems solving skills
C & I – Creativity & Innovation

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Background information

Waste has been a major environmental issue everywhere since the industrial revolution. Besides the waste we create at home, school and other public places, there are also those from hospitals, industries, farms and other sources. Humans rely so much on material things and they all (almost) end up as waste.

Waste are items we (individuals, offices, schools, industries, hospitals) don't need and discard. Sometimes there are things we have that the law requires us to discard because they can be harmful. Waste comes in infinite sizes, some can be as small as an old toothbrush, or as large as the body of a school bus.

Everyone creates waste, although some people are environmentally conscious and create very little. Likewise, some countries do a very good job creating less waste and managing the rest. Others are pretty horrible and have created huge environmental problems for the people and animals living there.

All over the world, communities handle their waste or trash differently. Some common methods of managing their waste include landfilling, recycling and composting. Other communities strongly embark on waste reduction and litter prevention/control aimed at reducing the production of waste in the first place. Some communities also engage in waste-to-energy plants and hazardous waste disposal programs. Under this unit we will specifically tackle types of waste materials, Sources of waste materials at school level, their management and hazards of waste to the environment.

Additional information for the teacher

What exactly is a landfill?

A landfill is a specially designed facility for the burial of municipal solid waste. In the past, landfills were poorly designed, poorly managed garbage dumps that created ongoing environmental problems as chemicals leached into the soil and air. Today's landfills are designed in such a way that leachates cannot leak down through the soil into the water table. This is accomplished by a layer of clay-like soil at the bottom of the landfill. The next layer up is a synthetic lining, usually made of plastic. All remaining layers alternate between soil and garbage.

How does the trash in a landfill decompose?

There are three classes of bacteria and fungi that work to degrade garbage. Cellulolytic microbes initiate the process by breaking down the cellulose in paper, wood, and other plant wastes. Then acidogens ferment these sugars into acids, which methanogens then convert into methane gas and carbon dioxide.

What types of materials are put in landfills?

Municipal solid waste landfills are filled with everything we throw away, from glass bottles to grass clippings and other yard wastes. The latter constitutes nearly 20% of all garbage landfilled. Disposable and non-durable products are major culprits in the growth of waste. In just one day, Americans throw away 150,000 tons of packaging material. This would fill 10,000 tractor trailer trucks, which would stretch 120 miles end to end. (Source: Garbage magazine)

What are the three main problems or environmental concerns associated with landfills?

Methane Gas, leachate, and loose waste are the three main challenges for landfills today. Methane gas is produced in a landfill by anaerobic decomposition. It can be collected using current technology and then used to generate electricity, or it can be purified and used as a power generating fuel.

Leachate is a thick liquid that forms when garbage decomposes. At its best, it is similar to very strong sewage water; at its worst, it carries hazardous materials with it that were dissolved from the waste. Newer landfills have synthetic liners above a clay-like soil that help to prevent the leachate from leaking into the groundwater, causing contamination. Older landfills do not utilize this type of liner, and are therefore a threat to our groundwater especially to nearby places.

Loose waste is another problem. It attracts disease carrying vermin of all types, and it can fly away in the breeze. At the end of every working day, a "daily cover" must be applied to minimize these problems. Once the landfill stops accepting waste, a final multi-layer cover must be applied to keep liquids away from the waste. Vegetation is then planted to reduce the effects of erosion.

Are there products in my house that should not be sent to a landfill?

Many of the products we use in our homes are considered hazardous materials. A hazardous material is one that is toxic or will corrode metal, burn, or explode. Materials like oven cleaner, batteries, motor oil, paints, varnishes, thinners, fluorescent bulbs, mercury switches, etc., should not be sent to landfills because they are considered hazardous.

These materials should be taken to a hazardous waste drop-off site. If every citizen convinces him or herself that "my hazardous materials are so small they won't matter," the total problem remains enormous.

- Compost yard and organic wastes. Use them as nutrients for other plants.
- Mulch leaves and grass clippings.
- Buy recycled paper products and products with less packaging.
- Buy durable products rather than disposable ones.
- Reuse jars and containers.
- Recycle oil and old tires.

9.1 Definition of waste & 9.2 Types of waste materials

Refer to learner's book

PERIODS 1 & 2: Definition and types of waste materials

Specific objective

By the end of these lessons, learners should be able to:

- Define a waste material
- Identify different types of wastes

Suggested materials and learning resources

High cost	Low cost/no cost
Learner's book	The surrounding Various types of waste materials

Suggested teaching methodology

- Case studies
- Guided discovery
- Brainstorming
- Discussions
- Role play

Suggested preparation for the lesson

- These are practical and discussion lessons that will involve many activities by the learners. They include practicals, field visits and class debates.
- You will engage learners in discussions regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials, equipment and chemicals in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

Period 1

- Introduce the unit by asking learners to name various wastes they know. Ask them to do Activity 9.1. They can do it in groups of 4.
- Begin a class discussion on wastes. Allow learners to participate actively.

Period 2

- Start the lesson by asking learners to do Activity 9.1 followed by 9.2.
- Allow a few learners to present their findings to the whole class. Build on their findings to explain the various types of waste materials.
- Let the session be open such that learners can freely interact and participate fully in the learning process.

Table 9.2 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Slow learners should be closely monitored during the activities	• All learners whether disabled or able should participate actively in the lesson.

• Fast learners can be given additional task of classifying all the waste from school and from home.	• Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should be given a chance to participate actively in the lesson.
- Gender education – Let all learners participate in the activities. Girls should not shy away from the practical.
- Environment, climate change and sustainability – Emphasise to learners that conservation of natural resources is important for sustainable development. They should also avoid throwing away rubbish carelessly but rather deposit it in designated places.
- Financial education – Advise learners to always buy things that are long-lasting. These items should also be environment friendly.

Generic competencies covered

- Co-operation and interpersonal skills – As learners interact in pairs and engage in class discussions.
- Communicating in English – As learners interact during group work.
- Critical thinking – As learners think about their findings in the activity.
- Problem solving skills – As the learners discuss and solve given tasks.
- Lifelong skills - As learners perform experiments as directed.

Formative assessment

1. Find out if learners are able to:
   - Define a waste material
   - Identify different types of wastes
2. Test learner's attitude towards waste management as they work in groups.
3. Check learner's skills as they relate what they already know with what they have learnt in class.
4. Gauge learners based on their competence and grade them accordingly.
5. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competences and the tests given to assess skills acquisition and attitude change.

9.3 Sources of wastes

Period 3: Sources of wastes

Refer to learner's book

By the end this lesson, the learners should be able to identify different sources of waste materials.

Suggested materials and learning resources

High cost
Learner's Book

Suggested teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Suggested preparation for the lesson

- You will engage learners in a discussion regarding sources of wastes.
- You are therefore required to get the various reference materials and computers with internet connection can also be helpful.

Suggested teaching and learning activities/approaches

- Begin the lesson by asking learners to state the various sources of wastes they know. Build on the answers the learners will have given in order to begin a class discussion.
- The class discussion should be as interactive as possible, allowing learners to ask questions and contribute as much as they can.
- End the lesson by asking learners to attempt Self-evaluation Test 9.1.

Table 9.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Give slow learners an assignment of finding out all sources of wastes at home. • Fast learners can be given additional task of finding out ways of reducing kitchen and classroom wastes.	• All learners whether disabled or able should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Lifelong skills – As learners carry out an experiments and interact.
- Cooperation and interpersonal skills – As learners interact in pairs and engage in class discussion.
- Communicating – as learners interact during a discussion.
- Research skills – As the learners observe record and interpret their findings.

Formative assessment

1. Find out if learners are able to identify different sources of waste materials.
2. Check learner's attitude and interest during the class discussion. Assess the questions they ask and the answers they give to the questions you ask.

The following are some sample questions you can ask learners:

- What happens after you throw something away in the trash? Where does it go?
- What is a landfill?
- What is the name of the landfills used by the Kigali city or any other place in Rwanda?

3. Gauge learners based on their competence and grade them accordingly.
4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self-evaluation Test 9.1

1. Allow learners to be creative at this point and base their categories in any form they want.
2. Biodegradable waste – can be decomposed by micro-organisms like bacteria. In most cases it enriches the soil.
   Non-biodegrable waste – cannot be broken down by micro-organisms. Pollutes the soil.

9.4 Hazards of wastes to the environment and waste management

PERIOD 4: Hazards of wastes and waste management

Refer to learner's book

Specific objective

By the end of this lesson, learners should be able to identify the hazards of wastes to people and the environment.

Suggested materials and learning resources

High cost
Learner's book

Suggested teaching methodology

- Case studies
- Guided discovery
- Brainstorming
- Discussions
- Role play

Suggested preparation for the lesson

- This is a discussion lesson that will involve an activity by the learners.
- You will engage learners in a discussion regarding the activity and assess their learning achievements.
- You are therefore required to get the various reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Begin the lesson by asking learners about the hazards of wastes.
- Engage them in a class discussion and make it as interactive as possible.
- Put learners into groups of 4 and ask them to do Activity 9.3. Give them time to present their answers.
- Summarise by giving details on how to manage wastes.
- Use examples in the learner's book to show learners how to manage wastes.
- End the unit by instructing learners to attempt Test your competence 9.

Table 9.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Fast learners can be given an extra task of finding out all diseases that can be caused by poor waste disposal. • Let slow learners give reasons as to why we should keep the school compound free of litter. • Fast learners can be given additional exercises.	• All learners whether disabled or able should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Cooperation and interpersonal skills – As learners interact in pairs and engage in class discussion.
- Communicating – As learners interact during group work.
- Critical thinking – As learners think about their findings in the activity.
- Problem solving skills – As the learners discuss and solve given tasks.

Formative assessment

1. Find out if learners are able to identify the hazards of wastes to people and the environment. Use structured questions and the examples in the learner's book.
2. Test learner's confidence in their knowledge about waste management.
3. Gauge learners based on their competence and grade them accordingly.
4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Consolidation activities

1. *What is wastewater?*

   Ans: The dirty water which contains various impurities like dust, polythene bags, vegetable peels, kitchen waste, oil & water that goes down the drains from sinks, showers, toilets, laundries, etc. Wastewater cannot be used further.

2. *What is sewage?*

   Ans: The wastewater that is being generated at homes, industries, agricultural activities, human activities etc are called sewage.

3. *What do we mean by "sewage treatment"?*

   Ans: Sewage treatment is a process of removing pollutants before it enters a water body or is refused.

4. *Explain why it is harmful to discharge untreated sewage into water bodies?*

   Ans: It is harmful to discharge the untreated sewage into the water bodies as it contains harmful substances. Most of it is water, which has dissolved & suspended impurities, which may pollute the water bodies and also harm the aquatic plants & animals.

5. *What is sludge? How is it treated?*

   Ans: Solid faecal matter which is generated after the water is treated. The sludge is transferred to a separate tank where it is decomposed by anaerobic bacteria. The biogas produced can be used as a fuel and the dried sludge is used as manure for replenishing the nutrients of the soil.

6. *Untreated human excreta are a health hazard. Justify the statement.*

   Ans: Untreated human excreta is a health hazard as it may cause water pollution. It pollutes both surface water as well as ground water. Since ground water is a source of water for wells, tube wells, etc. Therefore, it leads to waterborne diseases like cholera, jaundice, typhoid etc.

7. *What are the harmful effects of sewerage?*

   Ans: Accumulation of sewerage leads to:

   - Spread of various diseases.
   - Water pollution.
   - Discharge of sewerage in water bodies leads to excessive growth of algae.

8. *What is the function of bar screens in wastewater treatment plant?*

   Ans: The bar screen removes the large objects like rags, sticks, cans, plastics packets etc. from the sewage.

9. *What is a manhole? Why are manholes made?*

Ans: A manhole is a covered vertical hole in the ground, pavement or road above the underground sewer pipeline. If there is any leakage or blockage in the underground sewer pipeline, the sanitary worker can go down, up to these sewer pipelines for cleaning or any repair work.

10. Suggest alternative arrangement for sewage disposal.

    Ans: To improve sanitation, low cost onsite sanitation sewage disposals are being made. For example: septic tanks, composting pits, etc.

Additional exercises and their answers

Table 9.4 Additional exercises and activities

Remedial exercises for weak learners	Extended exercises for bright learners
1. Waste has to go somewhere. a) True b) False 2. What harm can come from uncontrolled dumping of garbage? 3. How can we help reduce wastes?	1. What are the components or features of integrated waste management? 2. Governments alone can win the war against waste. 3. How has technology contributed to integrated waste management? 4. Why is a country's economy related to its ability to limit the impact of waste on the environment?

Table 9.5 Answers to Extended exercises and activities

Remedial exercises for weak learners	Extended exercises for bright learners
1. a) True 2. Water pollution, air pollution and disease infections 3. Recycling, reusing and reducing	1. Recycling, use of landfills and converting waste to energy. 2. Allow learners to engage in a debate about the statement. 3. Integrated waste management consists of evaluating the options of reuse, recycling, composting, landfilling, and waste-to-energy and then selecting those that fit into the community's needs and budget. Technological changes have allowed facilities that manage waste to be more environmentally protective than their predecessors. 4. A country must have a strong economy in order to place a high priority on the protection of the environment and the proper management of waste.

Answers to Test your Competence 9

1. Discuss answers with learners.
2. Discuss and listen to the creative views of learners.
3. (a) Industries
   (b) Houses and offices
4. Engage learners in a debate and let them give their views.
5. There has to be special areas for all these to be deposited.
6. They are non-biodegrable hence pollutes the soil.
7. Most of the waste is biodegrable hence enriches the soil. Soil is home to many organisms. Plants grow on the soil. We use soil for agriculture.
8. (a) Can provide clean farmyard manure.
   (b) With fertile soils enough food is provided.
   (c) Diseases caused by poor waste disposal are kept away.

Unit 10 Chemical equations

(Number of Periods - 18)

Refer to learner's book

Key unit competence

After studying this unit, learners should be able to write and use balanced chemical equations.

Unit outlines

- Chemical equations
- Balancing chemical equations
- Interpreting and translating word equation into chemical equations

Table 10.1 Knowledge, Skills and values to be attained

Knowledge and Understanding	Skills	Attitudes and values
By the end of the unit learners should be able to: • State the law of conservation of mater. • Explain how a chemical equation relates to the law of conservation of matter. • State the rules of balancing equations.	By the end of the unit learners should be able to: • Relate a chemical equation to a chemical reaction. • Write balanced chemical reactions with state symbols. • Translate a word equation into a chemical equation and vice-versa. • Experimentally verify the law of conservation of matter.	By the end of the unit learners should be able to: • Develop a team approach when performing experiments in a group. • Develop confidence in writing and interpreting chemical formula and equations.

Links to other subjects

The contents in this unit can be applied in Mathematics when calculating algebraic equations using symbols. In Biology, respiration involves oxygen and carbon dioxide while chemicals of life: carbohydrates, proteins and vitamins are formed from elements.

Assessment criteria

Assessment method used should help the teacher to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the knowledge checks and specific questions in the 'Test your Competence' at the end of each unit. You can also formulate your own questions and/or use the diagnostic assessment exercises or exercises suggested in this unit targeting fast learners and remedial exercises.
- To assess skills acquisition – you may present to the learners a problem and ask them to suggest

the methods of writing balanced chemical equations. Also, particular questions have been suggested in the Test your Competence that target assessing skills acquisition.

- To assess attitude change - you may ask probing questions aimed at finding out if learners have developed confidence in writing and interpreting chemical formula and equations. Also, specific questions have been provided in the 'unit competence test' targeting attitude change and societal values.

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered.

You can also continuously assess learners to gauge the extent of knowledge and skills acquisition.

Table 10.2 Assessment criteria

The general criteria to use to gauge the various generic competences are given in the table below.

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average
LL – Lifelong skills
PS – Problems solving skills
C & I – Creativity & Innovation
COMM – Communication in English,
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Background information

A chemical equation should convey the following information.

- Reactants and products involved in the reaction.
- Symbols and formulae of all substances involved in the reaction.

- Relative number of reactants and product participating in the reaction.
- Relative masses of reactants and products.
- Physical states of reactants and products.

Additional information for the teacher

A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formulae, wherein the reactant entities are given on the left-hand side and the product entities on the right-hand side.

Chemical equations give information in two major areas. First, they tell us what substances are reacting (those being used up) and what substances are products (those being made).Second, the coefficients of a balanced equation tell us in what ratio the substances react or are produced.

Chemical equations usually do not come already balanced. Making sure they are balanced must be done before the equation can be used in any chemically meaningful way.It is an unbalanced equation (sometimes also called a skeleton equation). This means that there are unequal numbers at least one atom on each side of the arrow. By the way, a skeleton equation is not wrong; it just hasn't been balanced yet. Presenting it as being balanced would be wrong.

10.1. Chemical reactions

Refer to learner's book

PERIODS 1-6: Chemical reactions

Specific objective

By the end of this lesson, learners should be able to

- Define a chemical reaction.
- Write word equations
- Write chemical equations
- Write chemical equations with state symbols.

Materials and learning resources

High cost	Low cost/no cost
Reference materials and textbooks	Chalkboard
Laboratory equipment and chemicals	Learner's book
	Clear water, muddy water
	Table salt, milk

Teaching methodology

- Case studies
- Guided discovery
- Brainstorming
- Discussions
- Role play

Preparation for the lesson

- These are practical and discussion lessons that will involve many activities by the learners.

  They include practical experiments in the laboratory, demonstrations, observations and recording among others.

- You will engage learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials and laboratory equipment and chemicals in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Introduce the unit by asking learners to name some processes going on in their surroundings for example rusting, weathering among others. Tell them that the processes involve chemical reactions. Also inform them that there are chemical reactions that take place in our bodies.
- Let learners form groups of 2 to 6. Let them carry out Activity 10.1 as directed in the learner's book.
- Guide them through the activity as they find out how chemical reactions take place and their effect on substances.
- Allow learners to present their findings to the whole class. Build on their findings to explain the nature of chemical reactions and the observations made.
- Explain what reactants and products are and how they can be represented in a chemical equation.
- Show how chemical equations obey the law of conservation of matter.
- Introduce Activity 10.2. Let it be a class demonstration. Move on to activity 10.3
- Caution them to be careful during experiments like this that produce heat.
- Emphasise the differences between the product and reactants. Learner's should appreciate this.
- Use this activity to explain to the learner the different changes that occur when reactants are converted to products in a chemical reaction.
- Thereafter let learners attempt Self – evaluation Test 10.1. check their knowledge and understanding on writing word equations.
- Organise learners in pairs and let them research on other common types of reactions. From their findings explain how to write word equations.
- Introduce task (b) of writing chemical equations using symbols. Let learners perform Activity 10.4 as they discuss and compare in groups.
- Thereafter explain to them how to write chemical equation using symbols. Use the examples in the learner's book.
- Introduce task (c) of writing chemical equations using state symbols. Remind learners of the states of matter and how they are used in chemical equations.
- Let learners in pairs carry out Activity 10.5. it will enable them understand the necessity of states of matter in chemical equations.

- Show them how to write chemical equations while indicating state symbols. Use examples in the learner's book.
- Instruct learners to carry out Self-evaluation Test 10.2.

Table 10.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Slow learners can be given easy guiding questions on how to write chemical equations from products to reactants while indicating state symbols. • Give slow learners additional home work on chemical reactions and their symbols. • Fast learners can be given additional task of writing chemical reactions with their state symbol.	• All learners whether disabled or able should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Gender education – Let all learners participate in the activities. Girls should not shy away from the practical.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners interact during group work.
- Critical thinking – As learners think about their findings in the activity.
- Problem solving skills – As the learners discuss and solve given tasks.
- Lifelong skills-as learners perform experiments as directed.

Formative assessment

1. Find out if learners are able to:
   - Define what chemical equations are. Use structured questions to test for this.
   - Write word equations - use examples in the Learners book.
   - Write chemical equations- use self –evaluation Test 10.2 to test for this.
   - Write chemical equations with state symbols-use questions in task 2
2. Test learner's attitude during experiments as they work in groups and interpret chemical formula and equations.
3. Check learner's skills as they relate chemical equations to a chemical reaction.
4. Gauge learners based on their competence and grade them accordingly.

5. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self-evaluation Test 10.1

1. a. hydrogen + oxygen ⟶ water
   b. Iron + Sulphur ⟶ iron sulphide
   c. carbon + oxygen ⟶ carbon monoxide
2. Sodium + chlorine ⟶ sodium chloride
   Calcium + oxygen ⟶ calcium oxide
   Copper + iodine ⟶ copper iodide

Answers to Self-evaluation Test 10.2

1. Chemical reaction is a process while a chemical equations shows how a certain reaction takes place.
2. a) Sulphur + Oxygen ⟶ Sulphur dioxide
   $S(s) + O_2(g) \longrightarrow SO_2(g)$
   b) Methane + Oxygen ⟶ Carbon dioxide + Water
   $CH_4(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(l)$
   c) Zinc + Hydrochloric acid ⟶ Zinc chloride + Hydrogen gas
   $Zn(s) + HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$
   d) Copper oxide + Hydrogen gas ⟶ Copper + Water vapour
   $CuO(s) + H_2(g) \longrightarrow Cu(s) + H_2O(g)$
3. a. False
   b. True
   c. False
5. Never use substandard products they can be hazardous
6. a. $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$
   b. $K_2CO_3(s) + 2HNO_3(aq) \longrightarrow 2KNO_3(aq) + CO_2(g) + H_2O(l)$
   c. $Na(s) + H_2O(l) \longrightarrow NaOH(aq) + H_2(g)$
   d. $Pb(NO_3)_2(aq) + Na_2SO_4(aq) \longrightarrow PbSO_4(aq) + 2NaNO_3(aq)$

10.2. Balancing chemical equations

Refer to learner's book

PERIODS 6-12: Balancing chemical equation

By the end of this lesson, the learners should be able to explain:

- Rules of balancing chemical equation.
- The law of conservation of matter.

Materials and learning resources

High cost	Low cost/no cost
Reference materials and textbooks	Chalkboard
Laboratory apparatus and reagents	Learner's book
	Salt solution
	Muddy water

Teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions

Preparation for the lesson

- These are practical and discussion lessons that will involve many activities by the learners. They include practical experiments in the laboratory, demonstrations, observations and recording among others.
- You will engage learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials, laboratory equipment and chemicals in advance. Also, organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Begin the lesson by Activity 10.6. Let learners form pairs to carry out the activity.
- This activity will enable learners appreciate balancing and be able to relate it to balancing an equation. Use equations in the learner's book to show them how to balance equations.
- Go step by step as enumerated in the learner's book, as you guide them on how to balance equations.
- Let learners attempt Activity 10.7 in pairs. Build up from their findings to come up with a list of rules to follow when balancing chemical equations. Use many examples for them to understand.
- Check learner's knowledge and understanding by instructing them to attempt Self-evaluating Test 10.3.
- Introduce the law of conservation of matter; tell learners a brief history of Antoine Laurent Lavoisier and his discovery.

Table 10.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners in balancing chemical equations. • Give slow learners additional home work on balancing chemical equations. • Fast learners can be given additional task of writing balanced chemical equations.	• All learners whether disabled or able should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.
- Peace, values and gender education – Let the learners see the need to accommodate other people's views in a discussion.

Generic competencies covered

- Lifelong skills – as learners carry out an experiments and interact.
- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating – as learners interact during a discussion.
- Critical thinking – As learners think about their findings in the activity 10.2.
- Research skills-As the learners observe record and interpret their findings.

Formative assessment

1. Find out if learners are able to:
   - Describe the rules of balancing chemical equations. Use examples in the learner's book and Self-evaluation Test 10.3.
   - Explain the law of conservation of energy and how it relates to chemical equations. use structured questions to test for this.
2. Check learner's attitude and interest during experiments as they work in groups and balance chemical equations.
3. Check learner's skills as they experimentally verify the law of conservation of matter. Look for participation during the experiment and their presentation in class.
4. Gauge learners based on their competence and grade them accordingly.
5. Allocate marks for each colour and calculate the marks that the learner has attained.Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to self –evaluation Test 10.3

1. a. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$
   b. $ZnO(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2O(l)$
   c. $NaCl(aq) + AgNO_3(aq) \longrightarrow NaNO_3(aq) + AgCl(s)$
2. a. $Li(s) + H_2O(l) \longrightarrow LiOH(aq) + H_2(g)$
   b. $MgO(s) + 2HNO_3(aq) \longrightarrow Mg(NO_3)_2(aq) + H_2O(l)$
   c. $2KOH(aq) + H_2SO_4\ (aq) \longrightarrow K_2SO_4(aq) + 2H_2O(l)$
   d. $ZnCO_3(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + CO_2(g) + H_2O(l)$

Answers to self–evaluation Test 10.4

1. a. Matter is neither created nor destroyed during a chemical reaction.
   b. Any experiment whereby the states of reactants are different from those of products.
   c. number of kinds of atoms on the reactants side are the same as those on the products side.
2. a. $2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$
   b. $CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_20(g)$
   c. $2PbNO_3(s) \longrightarrow 2PbO(s) + 2NO(g) + O_2(g)$
   d. $BaCl_2\ (aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$
3. a. $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$
   b. $N_2\ (g) + 3H_2(g) \longrightarrow 2NH_3(g)$
   c. $4Cu(s) + 2NO_2\ (g) \longrightarrow 4CuO(s) + N_2(g)$
   d. $3CuO(s) + 2NH_3(g) \longrightarrow 3Cu(s) + 3H_2O(l) + N_2(g)$

10.3. Interpreting and translating word equations into chemical equations

Refer to learner's book

PERIOD 13-18: Interpreting and translating word equations into chemical equations

Specific objective

By the end of this lesson, learners should be able to interpret and translate word equation into chemical equations.

Materials and learning resources

High cost	Low cost/no cost
Reference materials and textbooks	Chalkboard
	Learner's book

Teaching methodology

- Case studies
- Guided discovery
- Brainstorming
- Discussions
- Role play

Preparation for the lesson

- This is a discussion lesson that will involve an activity by the learners.
- You will engage learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching and learning activities/approaches

- Begin the lesson by revisiting the elements of the periodic table already covered. Jog learner's memory as they relate it to chemical equations.
- Introduce Activity 10.8. Organise learners into groups of between 2 to 6.
- Let them discuss as directed in the learners book. They will also write a report on their findings and individually do a presentation in class.
- Build on their presentation as you explain translation of word equations into chemical equations.
- Bring to learners' attention Table 10.1 and 10.2 on charged ions and radicals. This table is crucial during the formation and interpretation of chemical equation. Leaners should study the tables carefully.
- Introduce the steps used in deriving chemical formulae of compounds. Take them through the steps one by one as you explain and engage them. You will use various examples for them to understand the concept clearly.
- Use examples in the learner's book to show learners how to convert word equations into chemical equations and vice versa.
- End the unit by instructing learners to attempt 'Test your competence 10'.

Table 10.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Assist slow learners in deriving chemical formulae of compounds. • Take slow learners stepwise in converting word equations to chemical equations. Also guide them in understanding the tables. • Give slow learners additional home work in converting word equations to chemical equations. • Fast learners can be given additional exercises.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether with special educational needs or not should participate actively in the lesson.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating – As learners interact during group work.
- Critical thinking – As learners think about their findings in the activity.
- Problem solving skills – As learners discuss and solve given tasks.

Formative assessment

1. Find out if learners are able to interpret and translate word equations into chemical equations. Use structured questions and the examples in the learner's book.
2. Test learner's confidence in writing and interpreting chemical formulae and equations.
3. Check learner's skills in translating word equation into a chemical equation and vice-versa.
4. Gauge learners based on their competence and grade them accordingly.
5. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Consolidation activities

Balance the following chemical equations:

1. $C_5H_{12} + O_2 \longrightarrow CO_2 + H_2O$

   Ans: There are five carbons on the left but only one on the right, and on each side the carbon is in a single chemical species. Put a 5 in front of the CO_2 on the right hand side.

   $C_5H_{12} + O_2 \longrightarrow 5CO_2 + H_2O$

   There are twelve hydrogens on the left but only two on the right hand side, and hydrogen is in a single species on each side. Put a 6 in front of the H2O on the right hand side.

$C_5H_{12} + O_2 \longrightarrow 5CO_2 + 6H_2O$

Finally, there are only two oxygens on the left hand side but 16 of them on the right hand side. So put a 8 in front of the O2 on the left hand side.

$C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$

The equation is now a balanced chemical equation.

2. $Zn + HCl \longrightarrow ZnCl_2 + H_2$

There are two chlorines on the right but only one on the left, and the chlorine is in a single chemical species on each side. Put a 2 in front of the HCl on the left hand side.

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

And if you look carefully, you will see that the equation is now balanced, with one Zn on each side, two hydrogens on each side and two chlorines on each side. Some examples can be rather easy!

3. $Ca(OH)_2 + H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + H_2O$

Ans:

$3Ca(OH)_2 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 6H_2O$

4. $FeCl_3 + NH_4OH \longrightarrow Fe(OH)_3 + NH_4Cl$

Ans:

$FeCl_3 + 3NH_4OH \longrightarrow Fe(OH)_3 + 3NH_4Cl$

5. $S_8 + F_2 \longrightarrow SF_6$

Ans:

$S_8 + 24F_2 \longrightarrow 8SF_6$

6. $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

Ans:

$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$

7. $Al_2(CO_3)_3 + H_3PO_4 \longrightarrow AlPO_4 + CO_2 + H_2O$

Ans:

$Al_2(CO_3)_3 + 2H_3PO_4 \longrightarrow 2AlPO_4 + 3CO_2 + 3H_2O$

8. Translate the following chemical equations into word equations:

a) $Co(NO_3)_2(aq) + Na_2CO_3(aq) \longrightarrow CoCO_3 + 2NaNO_3$

b) $KI(aq) + Pb(NO_3)_2(aq) \longrightarrow PbI_2(S) + 2KNO_3$

c) $CuSO_4(aq) + LiNO_3(aq) \longrightarrow Cu(NO_3)_2 + Li_2SO_4$

d) $Na(NO_3)_2(aq) + Na_3PO_4(aq) \longrightarrow Na_3(PO_4)_2 + 3\,NaNO_3$

e) $K_2SO_4(aq) + Ba(NO_3)_2(aq) \longrightarrow BaSO_4 + 2KNO_3$

Answers to Test Your Competence 10

1. i. Carbon + Oxygen ⟶ Carbon dioxide
   ii. Hydrogen + Oxygen ⟶ Water
   iii. Sodium hydroxide + hydrochloric acid ⟶ sodium chloride + water
   iv. Methane + Oxygen ⟶ Carbon dioxide + Water
2. i. $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$
   ii. $S(g) + O_2(g) \longrightarrow SO_2(g)$
   iii. $S(g) + Fe(s) \longrightarrow FeS(s)$
3. i. $4Li(s) + O_2(g) \longrightarrow 2Li_2O(s)$
   ii. – vi. Discuss with the learners
4. i. Sodium + Chlorine ⟶ Sodium Chloride
   ii. – iv. Discuss with the learners
5. Refer to Learner's book.
6. Check that formulae are correct. The two methods should be used.

Unit 11 Acids, Bases and pH

(Number of Periods - 9)

Refer to learner's book

Key unit competency

After studying this unit learners should be able to:

- Extract indicators from flowers.
- Use indicators to test the observable properties of acids and bases in common domestic substances.

Unit outlines

- Properties of acids and alkalis.
- Indicators of acids and alkalis found in nature and in common products.
- Definition of pH
- pH scale and pH meter
- pH of common commodities in our life.
- Application of acids and bases
- Drugs associated with acids and bases.

Table 11.3 Knowledge, Skills and Values to be attained

Knowledge and understanding	Skills	Attitudes and values
By the end of this unit learners should be able to: • Describe the existence of acids and bases in nature. • State applications of acids and bases in daily life. • Understand the difference between a base and an alkali. • Explain the pH scale. • Compare the properties of acids and bases. • State the dangers associated with handling bases and acids.	By the end of this unit learners should be able to: • Test acidity and alkalinity solution using indicators • Extract indicators from flowers • Use common laboratory indicators such as litmus and phenolphthalein and methyl orange. • Use universal indicators and pH paper to measure acidity and alkalinity of solutions. • Use pH water to measure the acidity and alkalinity of solutions. • Relate pH values to the acidity, alkalinity and neutrality of different solutions.	By the end of this unit learners should be able to: • Develop orderliness and carefully approach when handling acids and bases. • Respect the procedures described for carrying out experiments involving acids and bases.

Link to other subjects:

The contents of this unit are linked to:

- Agriculture where soil pH is vital in crop production.
- Biology where body fluids such as: gastric juice, blood, urine and other body fluids require a narrow pH range to be able work efficiently.
- Ecological studies where air pollution leads to acid rain which destroys buildings and harms organisms.
- Pharmacy
- Food industry
- Electrochemical Industry
- Paper and textiles industry
- In medicine.
- etc…

Formative Assessment Criteria

Assessment method used should help you to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the knowledge checks and specific questions in the Test Your Competence at the end of each unit. You can also formulate your own questions and/or exercises suggested in this unit targeting fast learners and remedial exercises.
- To assess skills acquisition – you may present to the learners a problem and ask them to suggest the methods of extracting juices from flowers to form indicators. Also, particular questions have been suggested in the Test your Competence that target assessing skills acquisition.
- To assess attitude change - you may ask probing questions aimed at finding out if they have developed orderliness and a careful approach when handling acids and bases. Also, specific questions have been provided in the end of unit competence test which target attitude change and societal values.

You should continously assess learners to gauge the extent of knowledge and skills acquisition.

You can also decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered.

The general criteria to use to gauge the various generic competencies are given in the table below.

Table 11.2 Assessment criteria

Name of learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue

F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English,
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Lifelong skills
PS – Problems solving skills
C & I – Creativity & Innovation

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Background Information

A solution is said to be acidic when the pH is less than 7 and alkaline when the pH is above 7. A litmus paper is used to determine, qualitatively, acidity or alkalinity of a substance. Typically blue litmus paper turns red under acidic conditions and red litmus paper turns blue under basic or alkaline conditions.. Additionally, acids taste sour and bases taste bitter.

Additional information for the teacher

Svante Arrhenius (Sweden) in 1884 defined an acid as a material that can release a proton or hydrogen ion (H+). Hydrogen chloride in water solution ionizes and becomes hydrogen ions and chloride ions. If that is the case, a base, or alkali, is therefore a material that can donate a hydroxide ion (OH). Sodium hydroxide in water solution becomes sodium ions and hydroxide ions.

Thomas Lowry (England) and J.N. Brønsted (Denmark) working independently in 1923, defined an acid as a material that donates a proton and a base is a material that can accept a proton.

The Arrhenius definition serves well for a limited use. The Lowry- Brønsted definition is broader, including some ideas that might not initially seem to be acid and base types of interaction. Every ion dissociation that involves a hydrogen or hydroxide ion could be considered an acid- base reaction. Just as with the Arrhenius definition, all the familiar materials we call acids are also acids in the Lowry - Brønsted model.

The G.N. Lewis (1923) idea of acids and bases is broader than the Lowry - Brønsted model. The Lewis definitions are: Acids are electron pair acceptors and bases are electron pair donors.

11.1 & 11.2 Acid and bases

Refer to learner's book

PERIODS 1-3: Definition and properties of acids and bases

Specific objective

By the end of the lesson, learners should be able to:

- Define an acid and an alkali in terms of H and OH ions.
- Describe the properties of acids and alkali.

Materials and learning resources

No cost/ Low cost	High cost
Water, Oranges, Lemon, paper, sour milk Wall charts	Reference materials and textbooks Laboratory equipment and chemicals

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a practical lesson that will involve mainly activities by the learners.
- You will engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various materials and equipment and also reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching/learning activities/approach

1. Introduce the unit by asking learners to suggest substances that contain acids and bases.Let the learners come up with substances that contain acids and bases.
2. From the substances they name, discuss with them the use of either the acid or base contained in the named substance.
3. Organise the learners in the classroom into pairs to carry out Activity 11.1. Provide them with the necessary materials and let them carry out the activity as directed in the learner's book. Encourage them to work as a team and share tasks, listen to others opinion and also air their views. This will improve their **communication**, **team work** and **interpersonal skills**.

Caution them not to eat anything in the laboratory.

4. Allow them to present their findings to the class. From their presentation build up on it as you explain what acid and bases are. Use examples to show this and differentiate between an acid and a base.
5. Go ahead and classify the acids as natural or commercial acids citing examples.
6. Discuss with them the nature of bases citing examples too.

7. Introduce properties of acids and alkali by Activities 11.2 and 11.3. These are laboratory practicals. Organise learners into groups of between 2 to 6 and then provide them with the necessary materials. Let them carry out the activity as directed in the Learner's book. They can do the experiments in rotation.
8. Instruct them to record their observations in a table format. Allow them to do a presentation on their findings to the class.
9. Thereafter engage them in a discussion about their finding and come up with a summary of the properties of acids and bases.
10. End the lesson by instructing learners to attempt Self-evaluation Test 11.1.

Table 11.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Assist slow learners when testing for acidity and alkalinity. • Fast learners can be given additional task of finding out the different definition of acid and bases.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in all class activities.
- Peace and values education – Bring to the attention of learners the need to accommodate other people's views. Discipline should be observed at all times in these groups since some cases can distract learners from the main objectives.

Generic competencies covered

- Critical thinking – As learner's use guiding questions to study subject content.
- Problem solving skills – As learners solve the given tasks.
- Cooperation and interpersonal skills – As learners interact through group work.
- Communication – As learners discuss and interact during group work.

Formative Assessment

1. Find out if learners are able to:

- Describe the existence of acids and bases in nature. Use structured questions to test for this
- State applications of acids and bases in daily life. Ask them to name various uses of acids and bases.
- Understand the difference between a base and an alkali. Use a comparison table to test for this.

2. Check learner's ability to test for acidity and alkalinity during Activities 11.2 and 11.3.
3. Assess learners attitudes in how they develop orderliness and a

careful approach when handling acids and bases and their respect for procedures when carrying out experiments.

4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self-evaluation Test 11.1

1. a. An acid is substance that dissolves in water and dissociates to give hydrogen ions while a base gives hydroxyl ions.
   b. Kills germs
2. • Commercial
   • Natural, commercial
   • Commercial
   • Commercial
   • Commercial
3. Base – toothpaste, limewater, baking soda
   Acid – pineapple, lime juice

11.3. Simple acid-base Indicators

Refer to learner's book

PERIODS 4 & 5: Indicators

Specific objective

By the end of the lesson, learners should be able to,

- Extract indicators from flowers.
- Use common laboratory indicators.

Materials and learning resources

No cost /Low cost	High cost
Flowers	Phenolphthalein indicator
Red cabbages	Methyl orange indicator
Wall charts	Ethanol
Water	Motor and pestle, source of heat Laboratory materials and chemicals Reference materials and textbooks

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a practical lesson that will involve activities by the learners. They will carry out laboratory experiments to test for acids and bases.
- You will also engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various materials and reference materials in advance and organise the class in a way that will encourage the teaching methods suggested. Arrange for learners to use the laboratory in advance.

Suggested teaching/learning activities/approach

1. Begin the lesson by Activity 11.5. Let learners discuss in groups using the guiding questions in the activity.
2. Use the analogy in the activity to explain the meaning of indicator. Thereafter tell learners what indicators are, ways of preparing them and their uses.
3. With that, introduce Activity 11.6 on how to prepare acid-base indicators.
4. Organise learners into groups of four and let them carry out the activity as directed in the learner's book. Instruct them to tabulate their observations.
5. Engage learners in a discussion based on their findings from the activity. Discuss the various types of indicators citing examples.
6. Introduce Activity 11.7. Let learners determine colour changes in indicators through this experiment. Allow them to form groups of four and follow the laid down procedures.
7. They should tabulate their findings. Thereafter engage them in a discussion on the colour changes with different solutions tested.
8. End the lesson by instructing them to attempt Self–evaluation Test 11.2.

Table 11.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners through the activity to differentiate colour changes in acids and bases. • Fast learners can be given additional exercises of finding various indicators and their colour changes.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class.
- Financial education – Bring to learners attention the need to make use of laboratory apparatus and chemicals efficiently to prevent damages and misuse.
- Health check – Make learners aware of the dangers of mishandling chemicals especially acids.

Generic competencies covered

- Lifelong skills-As learners test for acidity and alkalinity during the experiment.
- Critical thinking-As learners use guiding questions tocome up with subject content.
- Problem solving skills-As learners solve the given tasks.
- Cooperation and interpersonal skills-As learners interact through group work.

- Communication – As learners interact during the activities.

Formative Assessment

1. Find out if learners can test for acidity and alkalinity using indicators. Observe this during the practical experiments.
2. Check learners' attitude and interests by their level of participation during the activities.
3. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self –evaluation Test 11.2

1. Refer to Learner's Book
2. a. & b Phenolphthalein (colourless-pink), methyl blue (pink-yellow), litmus paper (red-blue)
3. To determine the kind of reactions that might take place.

11.4. pH of a solution

Refer to Learner's Book

PERIODS 6 & 7: pH of a solution

Specific objective

By the end of the lesson, learners should be able to:

- Define pH of a solution.
- Explain the pH scale and pH metre.
- Describe pH of common commodities in daily life.

Materials and learning resources

No cost /Low cost	High cost
Rain water, tap water	Laboratory equipment and chemicals
Wall charts	Indicators.
	Reference materials

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a practical lesson that will involve activities by the learners. They will carry out laboratory experiments to test for acids and bases.
- You will also engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various materials and reference materials in advance and organise the class in a way that will encourage the teaching methods suggested. Arrange for learners to use the laboratory in advance.

Suggested teaching/learning activities/approach

1. Begin the lesson by introducing activity 11.8. Let learners do a research using the guiding questions.

2. They will write a report which they will present in class. Link the presentation to measuring pH of a solution.
3. Organise learners to carry out Activity 11.9. Let them determine pH of various solutions as directed in the learner's book. Instruct them to present their observation sin a table format.
4. Using their observations explain the use of a universal indicator to determine the pH values using a pH chart.
5. Discuss with the learner's the pH values and their categories as strong, weak and neutral citing examples.
6. Explain the pH scale and the colours observed.
7. Show learners how to use pH-metre in Activity 11.10. Organise them into groups and take them through the procedure as directed in the learner's book. Thereafter engage the learners in a discussion involving the pH metre.
8. End the lesson by instructing learners to attempt Self-evaluation Test 11.3

Table 11.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Assist slow learners during the determination of pH of solutions. • Give fast learners additional exercises.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class activities.
- Financial education – learners should use chemicals efficiently to avoid wastage.
- Health check – learners should be careful when handling chemicals and laboratory equipment.

Generic competencies covered

- Critical thinking – As learners use guiding questions to study subject content.
- Problem solving skills-As learners solve the given tasks.
- Cooperation and interpersonal skills-As learners interact through group work.
- Communication – As learners discuss the meaning and importance of a pH meter and a universal indicator.

Formative Assessment

1. Find out if learners can use universal indicators, pH paper to test, qualitatively, the acidity and alkalinity of solutions and pH metre to measure, quantitatively acidity and alkalinity of solutions.

Observe this during the practical experiments.

2. Check learners' attitude and interests by their level of participation during the activities. Observe their orderliness, approach and respect for procedures.
3. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self –evaluation Test 11.3

Discuss the answers with the learners

11.5. & 11.6 Application and dangers of acids and bases

Refer to learner's book

PERIOD 8: Application and dangers of acids and bases

Specific objective

By the end of the lesson, learners should be able to:

- Describe the application of acid and bases.
- Explain the dangers associated with acid and bases.

Materials and learning resources

No cost /Low cost	High cost
Wall charts	Reference materials and textbooks

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorm
- Discussions
- Games

Lesson preparation

- This is a discussion lesson that will involve activities by the learners.
- You will also engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.

Suggested teaching/learning activities/approach

1. Begin the lesson by Activity 11.11. Show them pictures, for example of medicines, preserved food etc., and let them suggest what they are and what they are made of.
2. Let them carry out the activity as directed in the learner's book. They should come up with application of acids and bases in our daily lives.
3. From their presentations, discuss with them the applications of acids and bases as they take notes.
4. Ask learners about the dangers associated with acids and bases. Allow them to brainstorm and come up with ideas on how acid and bases affect our lives.

5. From their suggestions build on it as you explain the dangers acids and bases possess to organisms and the environment.
6. End the lesson by instructing learners to attempt self-evaluation test 11.4 and Test your competence 11.

Table 11.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners during the discussions, make sure they participate actively. • Fast learners can be given additional research work of the dangers associated with abuse of drugs.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class activities.
- Environment and sustainability – Make learners aware of the need to take care of the environment to prevent effects of acidic rain.
- Standardisation culture – Bring to learners attention the need to go for quality products.

Generic competencies covered

- Critical thinking – As learners use guiding questions to study subject content.
- Problem solving skills – As the learners solve given tasks.
- Cooperation and interpersonal skills – As learners interact through group work and sharing a dictionary.
- Communication – As learners interact during class activities.

Formative Assessment

1. Find out if learners are able to explain the applications and dangers associated with acid and bases. Use structured and probing questions to test for this.
2. Assess learner's attitude and interest in the lesson by their level of participation.
3. Check learner's skills during class discussions and presentation.
4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Consolidation activities

1. Which element is common to all acids?
2. What is common name of water soluble bases?
3. What name is gives the reaction between acids and bases

4. Two solutions A and B have pH values 3.0 and 9.5 respectively. Which of these will turn litmus solution from blue to red and which will turn phenolphthalein from colourless to pink.
5. Name the raw material used for the production of caustic soda.
6. a man found that the cake prepared by him is hard and small in size. Which ingredient has he forgotten to add that would have made the cake fluffy? Give reason.
7. a white powder was heated strongly until no further change and formed a yellow powered on heating , when cooled it turned to white again. Name the white powder and yellow solid.
8. a compound x of sodium forms a white powder. it is a constituent of baking powder and is used in some antacid prescriptions. When heated, x gives out a gas and steam. the gas forms a white precipitate with lime water. Write the chemical formula and name of x and the chemical equation for its decomposition on heating. What is its role in baking powder in antacids?
9. What is the role of pH in our daily life?
10. What happens when?
    (a) Solid sodium hydrogen carbonate is heated
    (b) Chlorine gas is passed through dry slaked lime

Answers to Self –evaluation Test 11.4

1. a. The degree of acidity or alkalinity of a solution.
   b. Acid-A, B, C Bases-D, E
   c. i. E
   ii. A
   iii. F
   iv. B,C
2. a. False
   b. True
   c. False
   d. True
   e. False
3. a. Preservative
   b. Fertiliser production
   c. Chemical production industries
   d. Cleaning agent
4. The gas is poisonous; one can wear a fascial mask.

Answers to Test Your Competence 11

1. A substance that gives a visible sign due to colour change in acid or a base.
2. a. Acid rain that leads to destruction of vegetation and buildings.
   b. Use clean source of energy or put smoke scrubbers.
3. Refer to learner's book
4. a. True
   b. True
   c. False
   d. False
5. Apply an alkaline solution to the site of the sting
6. a. H^+
   b. OH^-
7. a. Violet
   b. 6.0
   c. Violet–preferred pH range 5.0-7.5
   d. Addition of lime to raise the pH.

Unit 12 Inorganic Salts and their Properties

(Number of Periods - 15)

Refer to learner's book

Key unit competency

After studying this unit the learner should be able to analyse properties of different types of salts.

Unit outline

- Definition of salts.
- Nomenclature and chemical formula of simple salts ie chlorides, nitrates and sulphates.
- Physical properties of inorganic salts:
  - Physical state
  - Colour
  - Solubility in water
  - Electric conductivity
- Action of heat on carbonates, hydrogen carbonates, sulphates and nitrates.

Learning objectives

Competence based curriculum embraces three categories of learning objectives namely; knowledge and understanding, skills acquisition, attitude and values. This guide has been structured in a way that a teacher will be able to ensure that learners achieve these objectives. The table below summarizes the key objectives of this unit.

Table 12.1: Knowledge skills and values to be attained

Knowledge and understanding	Skills	Attitudes and values
• By the end of this unit the learner should be able to: • Define the term salt. • Distinguish between soluble and insoluble salts. • State the physical properties of salts. • Describe the effect of heat on different salts.	• By the end of this lesson, the learner should be able to: • Classify salts into soluble and insoluble by dissolving them in water. • Perform experiments to show the effect of heat on solid salts. • Demonstrate experimentally the electric conductivity of salt solutions. • Write a standard report of the experimental findings.	• By the end of this unit, the learner should: • Develop a keen eye for detail when observing experiments. • Get into the habit of repeating an experiment incase of any doubts.

Links to other subjects

The content in this unit is related to the study of salts in Geography. This includes the study of soil formation and types of rocks. In Biology, salts are covered under digestion and enzyme activity. In medicine where salt is being progressively more used as support treatment for skin diseases. Chronically inflamed skin is treated with medical bath salt from the Dead Sea or table salt. The salt peels off dandruff, reduces inflammation, itching and pain, and helps regenerate the skin. Etc…

Formative assessment criteria

The Formative assessment method used should helps the teacher confirm that the key competency of the unit has been met. It therefore should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the self evaluation tests and specific questions in the 'Test your Competence' at the end of each unit. You can also formulate other examples to test the understanding of the learners. Extended exercises and remedial activities suggested in this unit targeting bright students and slow learners respectively can also be used to assess the knowledge and understanding of the different categories of learners.
- To assess skills acquisition, observe how learners go about the different activities in this unit. Some questions in the self evaluation tests and the 'test your competence' also test skills acquisition.
- To assess attitude change you can ask probing questions. These are meant to establish if learners understand the importance of keenness when observing experiments.

The general criteria to use to gauge learner's achievement in the various generic competencies are given in the table below.

Table 12.2: Knowledge skills and values to be attained

Name of learner	COMM	I & C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

Key: Red-poor COMM-Communication

Blue-Average I & C - Co-operation and interpersonal skills.

Green-Good CT-Critical thinking

Yellow-Excellent RS-Research skills

Background information

Most people think that the term salt only means table salt (sodium chloride). In chemistry, the term salt is widely used. Salts are formed when the hydrogen ions in an acid are replaced by a metal or ammonium ion. In this unit, different types of salts and how they are formed has been discussed. Also discussed are the physical properties of salts and the action of heat on the different salts.

Additional information for the teacher

Preoaration of salts

The method used to prepare a particular salt depends on the solubility of the salt in water. Some of the methods used to prepare salts include:

1. Reacting an acid with a metal. Examples of salts prepared by this method include:

$Zn + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

$Mg(S) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2(g)$

2. Reacting an acid and a base

$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + H_2O(l)$

$2HNO_3(aq) + CuO(s) \longrightarrow Cu(NO_3)_2(aq) + H_2O(l)$

3. Precipitation - this involves the formation of an insoluble salt when two soluble salts are mixed.

$Pb(NO_3)_2(aq) + ZnCl_2(aq) \longrightarrow PbCl_2(s) + Zn(NO_3)_2(aq)$

4. Synthesis - This involves the direct combination of elements to form salts.

$Mg(s) + Cl_2(g) \longrightarrow MgCl_2(aq)$

5. Reacting metal oxides or hydroxides with non-metal oxides.

$CaO(s) + CO_2(g) \longrightarrow CaCO_3(s)$

$2KOH(aq) + CO_2(g) \longrightarrow K_2CO_3(s) + H_2O(l)$

12.1: Nomenclature and definition of salts

Refer to the learner's book

PERIODS 1, 2 &3 Definition and nomenclature of salts

Specific objectives

By the end of this lesson, learners should be able to:

- Define salts
- Understand the criteria used to name salts

Materials and learning resources

High cost	Low cost/no cost
Reference materials and textbooks	Chalkboard
Different organic acids	Learner's book
Different salts	Handouts and pamphlets
Internet access	

Teaching methodology

- Guided discovery
- Brainstorming
- Discussions
- Role play

Preparation for the lesson

The three periods can be divided into two sessions. This should be an interactive lesson where learners participate fully in discussion activities.

- Ensure that learners have access to internet. You may also provide some of the salts available in your chemistry lab so that learners can physically handle them.
- Ensure that the class arrangement is that which allows learners to involve themselves in discussions.

Suggested teaching and learning activities/approaches

- Introduce the lesson by asking learners to name other types of salts other than table salt. Let learners mention the importance of table salt. Do they know the chemical name of the salt? Inquire from them.
- Now allow learners to do the research activity 12.1 in the learners book. Provide pamphlets and handouts to help them research. This is meant to introduce learners into the world of research and hence boost their research skills.
- Monitor how learners are doing the activity. Assist learners that cannot assess information.
- Let learners try filling the blank spaces. They should first discuss and make a conclusion before filling the gaps. Discussion will boost cooperation and interpersonal skills of the learners.
- After the activity, ask learners to present their group findings and how they have filled the table. This will boost communication skills of the learners.
- After learners presentations guide them through an all inclusive discussion of the facts in the learners' book as you answer questions that learners might ask.

Table 12.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners on how to derive the name of a salt from the name of the acid forming it. • Fast learners should use their understanding of the lesson to differentiate a normal and acid salt by definition.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners to be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Formative assessment

1. Find out if learners are able to:
   - ♦ Define a salt.
   - ♦ Differentiate between acid, normal, dibasic and monobasic acids
2. Give learners different salts and tell them to identify the acids from which they were derived from.

   Also give them different metals and acids and ask them to mention the

name of the salts formed by each combination.

3. Observe as learners search information from the internet or other reference materials. Watch their body langauge.
4. Let learners do self evaluation test 12.1. Mark in class and revise. See the kind of answers that learners are writing.

Answers to Self-evaluation Test 12.1

1. a) This is an acid with three replaceable hydrogen ions.
   b) Nitrates, Chlorides, Carbonates, Sulphates.
2. a) Both normal and acid salts.
   b) Normal salts only.
   c) Both normal and acid salts.
   d) Normal salts.
3. a) Sodium nitrate
   b) Calcium hydrogen carbonate.
   c) Ammonium chloride.
   d) Potassium hydrogen sulphate.

Name of salt	Formulae of salt	Source (acid)
Zinc nitrate	$ZnNO_3$	Nitric acid
Potassium sulphate	K_2SO_4	Sulphuric acid
Ammonium sulphate	NH_4SO_4	Sulphuric acid

12.2. Physical properties of inorganic salts

Refer to learner's book

PERIODS 4 to 9: Physical properties of inorganic salts

By the end this lesson, the learners should be able to:

- Explain the properties of salts; Solubility, colour and electrical conductivity.
- Analyze results to after an experiment.

Materials and learning resources

High cost	Low cost/no cost
Different salts	Distilled water
Means of heating	Learner's book
Graphite electrodes	
Weighing balance	

Teaching methodology

- Laboratory experiments
- Research
- Brainstorming
- Discussions

Preparation for the lesson

These lessons involve experiments. Ensure therefore that the required materials are available in time. The experiments can be done in groups of to learners. Four lessons can be used in performing the experiments and two in discussing the observations.

Suggested teaching and learning activities/approaches

a) Colour, solubility and physical states of salts

- Introduce the lesson by informing learners that different salts have different properties.

- Put learners in groups of four and let them do the activity 12.2 in the learners' book. Monitor how the learners go about the activity and guide them where they find it difficult.
- Let learners discuss their results in groups. This boosts their **cooperation** and **interpersonal skills**.
- Ask learners to present their findings to the rest of the class. This is meant to boost their **communication skills**.

a) Electrical conductivity of salts

- Introduce the lesson by asking learners to name some substances that conduct electricity.
- Ask learners to mention the molecules or particles used to conduct electricity.
- Ask learners to sit in their groups and do the activity 12.3.Monitor learners to see how they go about the experiment.
- Allow learners to discuss their results. The secretaries of the groups should then present their results to the rest of the class.

Table 12.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Ensure that slow learners are mixed with fast learners in groups so that they can assist them in making the electrical conductivity setup. • Guide slow learners on how to write the report.	• All learners whether disabled or normal should participate actively in the lesson. • Physically challenged learners should be given priority during observations. • Learners with sight problems can be allowed to sit at appropriate positions where they won't strain to see. • Remember Disability is not inability!

Formative assessment

1. Check learner's attitude and interest during experiments as they work in groups. Check also how active they are in group work.
2. Check learner's skills as they make the set up to test conductivity of salts. Check if they are able to solve a problem in case the setup doesn't work.
3. Let learners do the self evaluation test 12.2. Mark in class and revise with the learners.
4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to Self –evaluation Test 12.2

1. Calcium reacts with sulphuric acid forming an insoluble layer of calcium sulphate that coats the metal hence preventing further reaction.
2. a) Calcium sulphate is insoluble in water while lead II chloride dissolves in warm water and not cold water.

b (i) Magnesium sulphate
(ii) Sodium hydrogen carbonate

3. a) Graphite rods or any other conductor.
b) The bulb lights.
c) It is a good conductor of electricity.

12.3. Action of heat on salts

Refer to learner's book

PERIODS 10 to 15: Action of heat on salts

Specific objective

By the end of these lessons, learners should be able to describe the action of heat on carbonates, hydrogen carbonates, sulphates and nitrates.

Materials and learning resources

High cost	Low cost/no cost
1. Test tubes, spatulas, wooden splints, Match box, zinc carbonate, lead II carbonate, test tubes, calcium hydroxide solution	Chalkboard
2. Hydrated copper II sulphate, hydrated iron II sulphate, test tubes, Bunsen burner	Learner's book
3. Potassium nitrate, sodium nitrate, copper II nitrate, lead II nitrate, silver nitrate, test tubes, Bunsen burner, moist litmus paper, glowing splint.	

Teaching methodology

- Laboratory experiments
- Guided discovery
- Brainstorm
- Discussion

Preparation for the lesson

This lesson involves several experiments. Ensure therefore that the required materials are available in time .Ensure also that the lab is free to be used during the lesson. Two lessons can be used for each type of salt; carbonates and hydrogen carbonates, sulphates and nitrates

Suggested teaching and learning activities/approaches

a) Action of heat on carbonates and hydrogen carbonates

- Allow learners to sit in groups of 4 to 6 learners. Ensure that each group has all the materials listed in number 1 of the table above.
- Inform learners of the precautions during the experiment.
- Let learners in groups do activity 12.4 of the learners book. Be keen to see how active learners are during the experiment.
- Ensure that learners follow the procedure keenly. Remind learners to be keen in making observations. Remind them that observation is a **lifelong skill** for scientists.
- After the experiment, allow learners to engage in the discussion corner.

  This will boost their **cooperation** and **interpersonal skills**.

- Allow group leaders to present their results and then lead them through a discussion of the facts in the learners' book.

b) Action of heat on sulphates

- Inform learners of the precautions to take during the lesson.
- In the same groups they did activity 12.4, let learners carry out the experiment. They should then engage in the discussion corner.
- Let group leaders present their findings to the rest of the class. Guide learners through a discussion of the facts in the learners' book.

c) Action of heat on nitrates

- Let learners in groups do activity 12.6 in the learners' book.
- Monitor how they go about the experiment. After the experiment, let learners discuss their observations. This will boost their **cooperation** and **interpersonal skills**.
- Allow group leaders to present their findings to the rest of the class.

Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Slow learners should carry out simple procedures like heating salts in a spatula. • Bright learners should be keen on making observations.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners should be given priority during observations. • Learners with sight problems can be placed in front of the class. • Remember Disability is not inability!

Cross cutting issues covered

- Inclusive learning – All learners whether disabled or normal should participate actively in the lesson.
- Gender education – Let all learners participate in the activities. Learners should work in groups that are balanced in terms of gender.

Generic competencies covered

- Co-operation and interpersonal skills – as learners interact in pairs and engage in class discussion.
- Communicating in English – as learners interact during group work and during class presentations
- Critical thinking – As learners try to derive the name of a salt from an acid used to prepare it.
- Problem solving skills – As the learners discuss and solve given tasks.
- Lifelong skills-as learners use the internet to research and get the correct information.

Formative assessment

1. Monitor the ability of learners to follow procedures. Check also that they are able to take precautions to avoid accidents in the lab.
2. Ask oral questions on action of heat on salts. Mention a salt and let learners say how it's affected by heat. They also should give the products.
3. To assess knowledge and understanding, let learners do self evaluation test 12.4. Mark in class and award marks. Revise the exercise with the learners

Answers to Self-evaluation Test 12.3

1. a) Potassium and sodium carbonates.

   b) (i) zinc oxide and carbon IV oxide

   (ii) lead oxide and carbon IV oxide

   c) $ZnCO_3(s) \xrightarrow{heat} ZnO(s) + O_2(g)$

   $PbCO_3(s) \xrightarrow{heat} ZnO(s) + O_2(g)$

   d) $NaHCO_3(s) \xrightarrow{heat}$

   $NaCO_3(s) + CO_2(g) + H_2O(g)$

2. a) On gentle heating it loses water of crystallization to form white anhydrous copper (II) sulphate. On strong heating it decomposes to form a black copper II oxide and sulphur trioxide gas.

   b) White solid of anhydrous iron II sulphate forms on gentle heating. On strong heating a red brown iron II solid forms and a mixture of sulphur dioxide and sulphur trioxide gases forms.

   c) $CuSO_4 .5H_2O(S) \xrightarrow{heat}$

   $CuSO_4(s) + 5H_2O(l)$

   $CuSO_4(s) \xrightarrow{heat} CuO(s) + SO_3(g)$

   $FeSO_4 . 7H_2O(s) \xrightarrow{heat}$

   $FeSO_4(s) + 7H_2O(l)$

   $2FeSO_4(S) \xrightarrow{heat}$

   $Fe_2O_3(g) + SO_2(g) + SO_3(g)$

3. (i) Calcium oxide, nitrogen (IV)oxide and oxygen.

   (ii) Magnesium oxide, nitrogen (IV) oxide and oxygen.

   b) $2Ca(NO_3)_2(s) \xrightarrow{heat}$

   $2CaO(s) + 4NO_2(g) + O_2(g)$

   (c) $2Mg(NO_3)_2(s) \xrightarrow{heat}$

   $2Mg(s) + 4NO_3(g) + O_2(g)$

Table 12.5 Extended exercises/Activities

Remedial exercises for slow learners	Additional exercises for fast learners
1. When zinc carbonate is heated a white solid is formed. Name the solid. 2. Name two gases produced when lead nitrate is heated	1. Sodium nitrate decomposes on heating to give sodium nitrite and oxygen gas while silver nitrate gives silver nitrogen IV oxide and oxygen. Explain this difference. 2. Write a chemical equation to show decomposition of ammonium nitrate by heat. 3. What do you think would happen if water was added on anhydrous copper II sulphate? Explain.

Table 12.6 Answers to additional exercises/Activities

Remedial exercises for slow learners	Extended exercises for fast learners
1. Zinc oxide 2. Nitrogen IV oxide and oxygen gas.	1. Sodium is higher in the reactivity series than silver and hence its nitrate decompose only partially. 2. $NH_4NO_3(s) \xrightarrow{heat} N_2O(g) + 2H_2O(g)$ 3. Crystals of blue hydrated copper II sulphate would form. The reaction is a reversible chemical reaction.

Consolidation activities

1. *After a substance X was heated in a test tube, a yellow substance Q was formed which turned white on cooling. Suggest the identity of substances X and Q.*

   Ans: X is zinc carbonate while Q is zinc oxide.

2. *When potassium nitrate is heated, it decomposes to potassium nitrite and oxygen. However, heating zinc nitrate yields zinc oxide, nitrogen dioxide and oxygen gas. Explain.*

   Ans: Potassium is more reactive than zinc and hence forms a more stable nitrate that does not decompose completely.

3. *Give two importances of salt to the economy of our country.*

   Ans:

   - Some salts are used to regulate soil pH for agricultural practices for example calcium carbonate.
   - Some salts are used as fertilizers. An example is ammonium sulphate.
   - Some salts are used in industries. Sodium hydrogen carbonate is used in the baking industry.

4. *Sodium chloride salt does not conduct electricity in solid state but conducts electricity in solution form. Explain.*

   Ans: In solid form the ions are not mobile. In solution form, the ions become free and so carry electric current.

5. *When calcium metal was reacted with dilute sulphuric acid, the reaction continued for sometime but eventually stopped. Explain.*

   Ans: The reaction stopped due to the formation of an insoluble layer of calcium sulphate that coats the metal preventing further reaction.

Answers to Test Your Competence 12

1. (a) Learners may give different definitions. Check that the definitions are related to the knowledge learnt in this unit.
   (b) Ammonium sulphate $(NH_4)_2SO_4$)

(2) (i) On gentle heating blue hydrated copper II sulphate changes to white anhydrous copper II sulphate. On strong heating a black solid is formed.

(ii) $CuSO_4.5H_2O(S) \xrightarrow{heat} CuSO_4(s) + 5H_2O(l)$

$CuSO_4(s) \xrightarrow{heat} CuO\ (s) + SO_3\ (g)$

3. (i) Carbon dioxide gas
   (ii) Zinc oxide
   (iii) white
   (iv) Zinc
4. (a) Sodium carbonate, carbon dioxide and water.
   (b) $2NaHCO_3(s) \xrightarrow{heat} Na_2CO_3(s) + H_2O(l) + CO_2(g)$
5. (a) Nitrates
   (b) Carbonates
   (c) Sulphates
6. (a) White
   (b) (i) The bulb lights.
   (ii) Graphite
   (iii) It is a good conductor of electricity
7. a) Normal
   b) Acid
   c) Normal
   d) Normal
8. .

Soluble	Insoluble
$ZnNO_3$	$CaCO_3$
$AgNO_3$	AgCl
$MgSO_4$	$PbCl_2$
$NaHSO_4$	$BaSO_4$

NB: Lead chloride is soluble in warm water.

Unit 13 Preparation of Oxygen and its properties

(Number of Periods - 12)

Refer to learner's book

Key unit competency

After studying this unit, the learners should be able to:

- Recall the physical properties of oxygen.
- Describe the reaction of oxygen with metals and non-metals.
- Describe different methods of gas collection and explain when they are appropriate.
- Explain the importance of O_2 and O_3 in daily life.
- Explain the consequences of ozone layer depletion.

Unit outline

- Methods of Oxygen gas preparation.
- Physical properties of oxygen
- Chemical properties of oxygen
- Methods of collecting gases
- Uses of oxygen
- Ozone

Learning objectives

Unlike in knowledge-based curriculum, competence-based curriculum embraces three categories of learning objectives that is, knowledge and understanding, skills acquisition attitude and values. At the end of the lesson, the learner should be have knowledge and understanding of the various concept areas, acquire the necessary skills, change their attitude towards various life aspects and subscribe to certain values that are acceptable in the society they live in. Therefore, emphasise attainment of these three objective areas during the learning process.

Table 13.1 Knowledge, Skills and values to be attained

Knowledge and understanding	Skills	Attitudes and values
• By the end of this unit, learners should be able to: • Recall the physical properties of oxygen. • Describe the reaction of oxygen with metals and non-metals. • Describe different methods of gas collection and explain when they are appropriate. • Explain the importance of O_2 and O_3 in daily life. • Explain the consequences of ozone layer depletion.	• By the end of this unit learners should be able to: • Prepare and test oxygen gas. • Collect gases using appropriate methods. • Write equations for the reactions of oxygen with other elements.	• By the end of this unit learners should be able to: • Develop a sense of responsibility when carrying out experiments. • Develop orderliness in handling apparatus and chemicals. • Appreciate the importance of oxygen gas and the ozone layer in daily life. • Develop a sense of environmental protection.

Link to other subjects

The contents of this unit are linked to Biology. This will be seen when discussing topics such as respiration and photosynthesis.

Formative assessment criteria

Assessment method used should help you to confirm that the key competency of the unit has been met. It should provide avenues for assessing knowledge acquisition, skills attainment and attitude change.

- To assess knowledge and understanding of concepts – use the knowledge checks and specific questions in the Test your Competence at the end of each unit. You can also formulate your own questions or exercises suggested in this unit targeting fast learners and remedial exercises.
- To assess skills acquisition – you may present to the learners a problem and ask them to suggest the methods of extracting juices from flowers to form indicators. Also, particular questions have been suggested in the Test your Competence that target assessing skills acquisition.
- To assess attitude change - you may ask probing questions aimed at finding out if they have developed orderliness and a careful approach when handling acids and bases. Also, specific questions have been provided at the end of unit, in the Test your competence test which target attitude change and societal values.

You should continuously assess learners to gauge the extent of knowledge and skills acquisition. The general criteria to use to gauge the various generic competencies are given in the table below.

Table 13.2 Assessment criteria

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red – Poor
Green – Good
Yellow – Excellent
Blue – Average

COMM – Communication in English,
I & C – Interpersonal skills & Co-operation
CT – Critical Thinking
RS – Research Skills
LL – Lifelong skills
PS – Problems solving skills
C &I – Creativity & Innovation

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Background Information

Green plants produce oxygen during photosynthesis and make it available to the animals. Plants and animals use oxygen for respiration.

Away from the earth in the stratosphere, there is the ozone layer, O_3, which is an allotrope of oxygen. This layer protects living organisms from harmful radiations from the sun. Human activities leading to air pollution cause depletion of the layer. When this layer is depleted, the harmful radiations reach the earth surface and can cause skin cancer, eye problems and damage to crops.

It is hence important that we keep the atmosphere free of pollution.

Additional information for the teacher

Air pollution

Our planet is becoming choked with poisonous gases mostly from our daily activities like driving cars, warming our houses and running power stations. The problem is worst in Latin America and Asia. In cities like Seoul and Mexico City, the air is so bad, some people wear face masks to filter the air they breathe. In cities like Beirut and Damascus, dust storms make it even worse! Pollution from factories and power stations in Europe, North America and Russia ends up in the Arctic region.

Human health

Air pollution is a risk factor in to humans health. Tuberculosis, bronchitis, heart and chest diseases, stomach disorders, asthma and cancers can all be traced to chemicals in the air. Pesticides and fertilisers release gases and particles into the air that are poisonous people and kill animals.

Imagine that the Earth has a sunshade around it protecting it from the heat of the sun. This is called the ozone layer but the sunshade has holes so that harmful rays get through, causing cancer. To prevent it, we wear sun glasses to protect our eyes, and sun cream to protect our skin. Ling So Low, Malaysia.

Ozone depletion

For years, chlorofluorocarbons (CFCs) were used as a cooling device in freezers and air conditioners. Scientists discovered, however, that CFCs destroy the ozone layer (the layer that filters ultraviolet radiation from the sun). Ultraviolet radiation causes eye damage and skin cancer. An international agreement commonly called the Montreal Protocol, signed in 1989, has helped stop the production of CFCs. If we keep to this agreement, ozone-depleting substances will stop being produced and the ozone layer will begin to repair itself over the next 100 years.

Global warming

The world is warming up because carbon dioxide (CO_2) from smoke and car exhausts collects in the atmosphere and traps some of the heat from going back to space, like a greenhouse. CO_2 and other greenhouse gases are expected to raise global temperature

by an average of 2°C by the year 2100 causing the polar icecaps to melt, sea levels to rise and freak weather conditions which may cause millions of deaths.

13.1 Methods of preparation of Oxygen gas

Refer to Learner's Book

PERIODS 1, 2 & 3: Methods of preparation of Oxygen gas

Specific objective

By the end of these lessons, learners should be able to prepare and test oxygen gas.

Suggested materials and learning resources

No cost/ Low cost	High cost
Water, beaker, stopper, delivery tube, flat-bottomed flask, dropping funnel, matches, splints, litmus paper, gas jars, hydrogen peroxide, manganese dioxide, boiling tube, trough, test tubes, delivery tube, wooden splints, wet blue and red litmus paper. Wall charts	Bunsen burner Reference materials and textbooks Laboratory equipment and chemicals

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Suggested lesson preparation

- This is a practical lesson that will involve mainly activities by the learners.
- You will engage the learners in a discussion regarding the activities and assess their learning achievements.
- You are therefore required to get the various materials and equipment and also reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.
- You can use the first two lessons to do the experiment and then reserve the last lesson for discussions.

Suggested teaching/learning activities/approach

Period 1

1. Introduce the unit by asking learners to explain their understanding of oxygen and how important they think it is.
2. From their answers, begin a discussion on preparation of oxygen. Ask them to do Activity 13.1.
3. Organise the learners in the classroom into pairs to carry out the Discussion corner coming after the activity. These help to instil **communication, team work** and **interpersonal skills**.

Caution them not to eat or taste anything in the laboratory

4. Allow them to present their findings to the class. From their presentation, build up on it as you explain how oxygen is prepared. Use examples to show this.
5. Begin a class discussion and give learners an opportunity to share ideas.
6. End the class. If a double lesson, proceed on with lesson 2.

Period 2

1. Ask learners to do Activity 13.2. They should do this in groups of 6 with your supervision.
2. Explain on the reactants and have learners attempt to balance the equation of the reactants.
3. Have them do Activity 13.3, again in groups of 6. End the lesson and ask learners to take notes of the results and prepare to present their findings in the next lesson.

Period 3

1. Allow learners to discuss their findings of Activity 13.3.
2. Begin a general class discussion and help learners to balance the chemical equation.
3. Instruct them to record their observations in a table format. Allow them to do a presentation on their findings to the class.
4. End the lesson by instructing learners to attempt self-evaluation test 13.1.

13.3 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Assist slow learners in testing for acidity and alkalinity. Fast learners can be given additional task of finding out the different definitions of acid and bases.	All learners whether physically challenged or not should participate actively in the lesson. Physically challenged learners showed be given priority during discussions. Learners with sight problems can be placed in front of the class. Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners participate actively in all class activities.
- Peace and values education – Bring to the attention of learners the need to accommodate other people's views. Discipline should be observed at all times in these groups since some cases can make learners diverge from the main objectives.
- Environment, climate change and sustainability – Emphasise to learners the need to properly dispose of used chemicals and any other products to protect the environment.

Generic competencies covered

- Critical thinking – As learner's use guiding questions to study subject content.

- Problem solving skills – As the learners solve given tasks.
- Cooperation and interpersonal skills – As learners interact through group work.
- Communication – As learners discuss and interact during group work.

Formative Assessment

1. Find out if learners are able to prepare and test oxygen gas.
2. Check learner's ability to effectively do Activities 13.1, 13.2 and 13.3.
3. Assess learners' attitudes in how they develop orderliness and a careful approach when handling reactants and their respect for procedures when carrying out experiments.
4. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

Answers to self-evaluation test 13.1

1. (a) Learners should apply the knowledge learnt in activity 13.2.
   (b) Check that diagrams are correctly arranged and labelled.
2. (a) Allow learners to have a debate on this question.
   Hint: Some organisms are anaerobic.
   (b) This is because lead is poisonous.
3. Ask learners to research on the preparation of oxygen using sodium nitrate.

13.2 Physical properties of oxygen

Refer to learner's book

Period 4 & 5: Physical properties of oxygen

Specific objective

By the end of the lesson, learners should be able to recall the physical properties of oxygen.

Suggested materials and learning resources

No cost /Low cost	High cost
Distilled water Trough Two test tubes full of oxygen	Litmus papers

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a practical lesson that will involve activities by the learners. They will carry out laboratory experiments to find out properties of oxygen.
- You will also engage the learners in a discussion regarding the activities and assess their learning achievements.

- You are therefore required to get the various materials and reference materials in advance and organise the class in a way that will encourage the teaching methods suggested. Arrange for learner to use the laboratory in advance.

Suggested teaching/learning activities/approach

Period 1

1. Begin the lesson by Activity 13.4. Let learners do the activity in groups of 6 using the guiding procedure in the activity.
2. Guide learners as they go through the activity.
3. Give them time to engage in the discussion corner.
4. Have an open discussion on the Discussion corner and allow learners to freely contribute during the lesson.
5. End the lesson by asking learners to do Self-evaluation Test 13.2.

Period 2

Let learners exchange their notebooks and mark each other's books. Let it be a discussion and any difficulties should be discussed during the lesson.

Table 13.4 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Guide slow learners through the activity to differentiate colour changes in acids and bases. Fast learners can be given additional exercises of finding various indicators and their colour changes.	All learners whether physically challenged or not should participate actively in the lesson. Physically challenged learners should be given priority during discussions. Learners with sight problems can be placed in front of the class. Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class.
- Financial education – Bring to learners' attention the need to make use of laboratory apparatus and chemicals efficiently to prevent damages and misuse.
- Health check – Make learners aware of the dangers of mishandling chemicals especially acids.

Generic competencies covered

- Lifelong skills – as learners test for acidity and alkalinity during the experiment.
- Critical thinking – as learner's use guiding questions to come up with subject content.
- Problem solving skills – as the learners solve given tasks.
- Cooperation and interpersonal skills-as learners interact through group work.
- Communication – as learners interact during the activities.

Answers to Self-evaluation Test 13.2

1. Discuss with learners to find out what they know.
2. Oxygen will have no effect on red or blue litmus papers.

13.3 Chemical properties of oxygen

Periods 6, 7 & 8: Chemical properties of oxygen

Specific objective

By the end of the lesson, learners should be able to;

- Define pH of a solution.
- Explain the pH scale and pH metre.
- Describe pH of common commodities in daily life.

Materials and learning resources

No cost /Low cost	High cost
Candle, trough, match box and gas jar.	Sodium hydroxide

Suggested teaching methodology

- Case studies
- Role playing
- Guided discovery
- Research
- Questions and answers
- Discussions
- Games

Lesson preparation

- This is a practical lesson that will involve activities by the learners. They will carry out laboratory experiments to test for acids and bases.
- You will also engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various materials and reference materials in advance and organize the class in a way that will encourage the teaching methods suggested. Arrange for learners to use the laboratory in advance.
- You can decide to use the first two lessons in carrying out the experiments and reserve the last lessons for explaining the results to the learners.

Suggested teaching/learning activities/approach

Period 6

1. Begin the lesson by introducing activity 13.5. Let learners follow the procedure in groups of 6.
2. Allow them to engage in Discussion corner, still in their groups. Have a class discussion afterwards and guide them through it.
3. Organise for learners to carry out activity 13.6. Provide them with the apparatus they will need and divide them into groups of 6 so as to do the activity.
4. Tell them to prepare to present their findings during the next lesson.

Period 7

1. Guide them in handling the Discussion.
2. Help leaners in balancing the equations. Discuss the reactants and products of each of the experiments.

3. Explain each of the reactants.

Period 8

1. Ask learners to do Activity 13.7. Let learners follow the procedure in groups of 6.
2. Allow them to engage in Discussion corner, still in their groups. Have a class discussion afterwards and guide them through it.
3. Ask learners to do Self-evaluation Test 13.3 as a home assignment.

Table 13.5 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
Guide slow learners through the activity to differentiate colour changes in acids and bases. Fast learners can be given additional exercises of finding various indicators and their colour changes.	All learners whether physically challenged or not should participate actively in the lesson. Physically challenged learners to be given priority during discussions. Learners with sight problems can be placed in front of the class. Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class activities.
- Financial education – learners should use chemicals efficiently to avoid wastage.
- Health check – learners should be careful when handling chemicals and laboratory equipment.

Generic competencies covered

- Critical thinking – As learner's use of guiding questions to study subject content.
- Problem solving skills – As the learners solve given tasks.
- Cooperation and interpersonal skills – As learners interact through group work.
- Communication – As learners discuss the meaning and importance of Biology.

Answers to Self-evaluation 13.3

Discuss the answers with the learners

13.4 Methods of collecting gases

Period 9, 10 & 11: Methods of collecting gases

Specific objective

By the end of the lesson, learners should be able to describe different methods of gas collection and explain when they are appropriate.

Suggested materials and learning resources

High cost
Reference materials and textbooks

Suggested teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a discussion lesson that will involve activities by the learners.
- You will also engage the learners in a discussion regarding the activities and assessing learning achievements.
- You are therefore required to get the various reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.
- Two lessons can be used in preparing and collecting some gases.The other lesson can be used in discussing the facts.

Suggested teaching/learning activities/approach

1. Begin the lesson with a class discussion on the methods of collecting gases.
2. Help learners to draw each of the methods.
3. End the lesson by instructing learners to attempt self-evaluation test 13.4.

Table 13.6 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners during the discussions, make sure they participate actively. • Fast learners can be given additional research work on the dangers associated with abuse of drugs.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners should be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class activities.
- Environment and sustainability – make learners aware of the need to take care of the environment to prevent effect of acidic rain.
- Standardisation culture – bring to learners attention the need to go for quality products.

Generic competencies covered

- Critical thinking – As learner's use guiding questions to study subject content.
- Problem solving skills – As the learners solve given tasks.
- Cooperation and interpersonal skills – As learners interact through group work and sharing a dictionary.
- Communication – As learners interact during class activities.

Answers to Self-evaluation Test 13.4

1. Density and solubility in water.
2. (a) Collection over water.
   (b) Collection by downward delivery.
   (c) Collection by upward delivery.
3. Check that learners draw the diagrams correctly.

Formative assessment

1. Find out if learners can prepare oxygen and collect it as required.
2. Test their understanding of the various properties of oxygen by asking probing questions.
3. Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored on the various competencies and the tests given to assess skills acquisition and attitude change.

13.5 Uses of Oxygen gas & 13.6 Ozone

Period 12: Uses of oxygen and ozone layer

Specific objective

By the end of the lesson, learners should be able to:

- Explain the importance of O_2 and O_3 in their daily lives.
- Explain the consequences of Ozone layer depletion.

Suggested materials and learning resources

High cost
Reference materials and textbooks

Suggested teaching methodology

- Case studies
- Guided discovery
- Research
- Brainstorming
- Discussions
- Games

Lesson preparation

- This is a discussion lesson.
- You will also engage the learners in a discussion regarding the activities and assess their learning achievements.
- You are therefore required to get the various reference materials in advance and organise the class in a way that will encourage the teaching methods suggested.
- Wisely divide the lesson so that there is enough time for learner's to discuss among themselves and also for your remarks on the sub-unit.

Suggested teaching/learning activities/approach

1. Begin the lesson with a class discussion on the methods of collecting gases.
2. Help learners to draw each of the methods.
3. End the lesson by instructing learners to attempt self-evaluation test 13.5.

Table 13.7 Special needs and multi-ability learning

Support for multi-ability learning	Support for special needs learning
• Guide slow learners during the discussions, make sure they participate actively. • Fast learners can be given additional research work of the dangers associated with abuse of drugs.	• All learners whether physically challenged or not should participate actively in the lesson. • Physically challenged learners should be given priority during discussions. • Learners with sight problems can be placed in front of the class. • Disability is not inability.

Cross cutting issues covered

- Inclusive learning – All learners should participate actively in class activities.
- Environment and sustainability – make learners aware of the need to take care of the environment to prevent effect of acidic rain.
- Standardisation culture – Bring to learners attention the need to go for quality products.

Generic competencies covered

- Critical thinking – As learner's use of guiding questions to study subject content.
- Problem solving skills – As the learners solve given tasks.
- Cooperation and interpersonal skills – As learners interact through group work and sharing a dictionary.
- Communication – As learners interact during class activities.

Consolidation activities

1. *The decomposition of hydrogen peroxide is one of the methods used to prepare oxygen in the laboratory. In this process, manganese dioxide is added.What is the role of manganese dioxide?*

   Ans: Manganese dioxide acts as a catalyst to speed up the decomposition process.

2. *Galvanising is used to protect metals from rusting.*

   a) What is galvanisation?

   b) What is rust?

   c) Explain how galvanising prevents rusting?

   Ans: Galvanisation is the process of coating iron with zinc to protect it from corrosion. Rust is an oxide of iron. Zinc is more reactive than iron. It thus reacts with oxygen on behalf of iron hence preventing the iron from rusting.

3. *Oxygen is collected over water. However, ammonia and hydrogen chloride cannot be collected over water.*

   a) Why is it so?

   b) What is the best way to collect ammonia and hydrogen chloride gas?

   c) Why do you think the method you have mentioned in (b) above is the best?

   Ans: Ammonia and hydrogen chloride gases are very soluble in water. They are collected by upward delivery because they are less dense than air.

4. *Why is it not advisable for a mountain climber to go up the mountain very fast?*

Ans: Oxygen concentration decreases with increase in altitude. Climbing slowly enables them to acclimatise to the low oxygen concentration levels.

Answers to Self-evaluation Test 13.5

1. Ask learners to research and present their answers.
2. This helps in replenishing the lost oxygen and using up the accumulating carbon dioxide in the atmosphere.
3. Oxygen is the main element used in many activities that support life here on earth.

Table 13.8 Extended exercises/Activities

Remedial exercises for slow learners	Additional exercises for fast learners
1. Why is oxygen important?	1. How can we reduce global warming?
2. Why should we plant trees?	2. How is the ozone layer depleted?

Table 13.9 Answers to extended exercises/Activities

Remedial exercises for slow learners	Additional exercises for fast learners
1. It supports life and other life-supporting activities.	1. Recycling gases that cause air pollution.
2. Trees help by using carbon dioxide and emitting oxygen which we breathe in for respiration.	2. Through use of chlorofluorocarbons.

Answers to Test Your Competence 13

1. a) i) Managanese (IV) oxide
   ii) Flat bottomed flask, gas jar.
   b) i) It is slightly soluble in water.
   ii) Collection over water
   c) i) Introduce a glowing splint at the mouth of the delivery tube. The glowing splint will relight.
   ii) - Used in hospitals to aid patients with breathing problems.
   - Used by mountain climbers and deep sea divers.
   - A mixture of oxygen and acetylene is used in welding.

2. a) (i) $2Mg(s)+O_2(g) \longrightarrow 2MgO(s)$
   (ii) $Fes + O_2(g) \longrightarrow Fe_2O_3(s)$
   (b) (i) Sodium burned with a bright flame and white substance was formed.
   (ii) Red litmus paper turned blue but there was no effect on blue litmus paper. Sodium oxide is basic oxide.
   iii) $4Na(s) + O_2(g) \longrightarrow 2Na_2O_2(s)$

3. a) O_3
   b) It absorbs most of the sun's ultraviolet rays that would otherwise cause skin diseases.
   c) Aerosols

4. a) A. Over water B. Upward delivery
   b) A. Oxygen and nitrogen B. Hydrogen and ammonia
   c) A. It is slightly (or not) soluble to water.
      B. It is less denser than air.
5. a) 21%
   b) Nitrogen
6. (a) To remove air from the water
   (b) It helps to prevent air from entering into the water
   (c) It helps to dry the air.
   (d) They rusted
   (e) The presence of oxygen and moisture
7. SO_2
8. To supplement the less oxygen available.