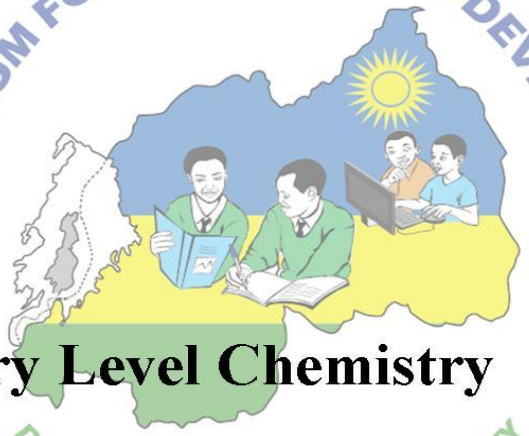
REPUBLIC OF RWANDA

MINISTRY OF EDUCATION

Rwanda Education Board

CURRICULUM FOR SUSTAINABLE DEVELOPMENT



DIGNITY AND NATIONAL IDENTITY

Ordinary Level Chemistry Syllabus

Kigali, 2015

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Kigali, 2015

FOREWORD

The Rwanda Education Board is honoured to provide syllabuses that serve as both official documents and as a guide to competency-based teaching and learning. These syllabuses ensure consistency and coherence in the delivery of quality education across all levels of general education in Rwandan schools.

The Rwandan education philosophy aims to ensure that young people at every level of education achieve their full potential in terms of relevant knowledge, skills and appropriate attitudes in order to prepare them to be well integrated into society and harness employment opportunities.

In line with efforts to improve the quality of education, the government of Rwanda emphasises the importance of aligning the syllabus, teaching and learning and assessment approaches in order to ensure that the system is producing the kind of citizens the country needs. Many factors influence what children are taught, how well they learn and the competencies they acquire, in particular the relevance of the syllabus, the quality of teachers' pedagogical approaches, the assessment strategies and the instructional materials available. The ambition to develop a knowledge-based society and the growth of regional and global competition in the jobs market has necessitated the shift to a competency-based syllabus. With the help of the teachers, whose role is central to the success of the syllabus, learners will gain appropriate skills and be able to apply what they have learned in real life situations. Hence they will make a difference not only to their own lives but also to the success of the nation.

I wish to sincerely extend my appreciation to the people who contributed to the development of this document, particularly the REB and its staff who organised the whole process from its inception. Special appreciation goes to the development partners who supported the exercise throughout.

Any comment and contribution would be welcome for the improvement of this syllabus.

GASANA I. Janvier

Director General REB

ACKNOWLEDGEMENT

I wish to sincerely extend my special appreciation to the people who played a major role in the development of this syllabus. It would not have been successful without the participation of a range of different education stakeholders and the financial support from different donors. For this I would like to express my deep gratitude.

My thanks firstly goes to the Rwanda Education leadership who supervised the curriculum review process and the Rwanda Education Board staff who were involved in the conception and writing of the syllabus. I wish to extend my appreciation to teachers from pre-primary to university level for their valuable efforts during the conception of the syllabus.

I owe gratitude to the different education partners such as UNICEF, UNFPA, DFID and Access to Finance Rwanda for their financial and technical support. We also value the contribution of other education partner organisations such as CNLG, AEGIS trust, Itorero ry'Igihugu, Center for Gender Studies, Gender Monitoring Office, National Unit and Reconciliation Commission, RBS, REMA, Handicap International, Wellspring Foundation, Right To Play, MEDISAR, EDC/L3, EDC/Akazi Kanoze, Save the Children, Faith Based Organisations, WDA, MINECOFIN and Local and International consultants. Their respective initiatives, co- operation and support significantly contributed to the successful production of this syllabus by the Curriculum and Pedagogical Material Production Department (CPMD).

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1. INTRODUCTION

1.1. Background to curriculum review

The rationale behind the chemistry syllabus review process was to ensure that the syllabus is responsive to the needs of the learner and to shift from objective and knowledge based learning to competence-based learning. Emphasis in the review has been on building skills and competencies, as well as streamlining the coherence of the existing content by benchmarking against a number of best practice syllabi.

The new chemistry syllabus guides the interaction between the teacher and the learner through the learning processes and highlights the essential practical skills and competencies a learner should acquire during and at the end of each unit of learning.

1.2. Rationale of teaching and learning of chemistry

1.2.1 Chemistry and society

Chemistry, one of the natural science subjects, is an important discipline that has contributed significantly to the global socio-economic transformation. This level of contribution has been achieved through the range of important life changing discoveries by chemists. These discoveries have led to new technologies in the production of small scale and industrial products that are beneficial to both people and the environment.

Application of the knowledge of chemistry is evident across a number of industries including, medicine, pharmaceuticals, textiles, petrochemicals and food processing. In particular, chemistry has played a role in the harmonisation of man's needs with the conservation of nature and environment.

Chemistry plays a role in Rwanda's ambitions to develop a knowledge-based society, to promote science and technology competitiveness in regional and global job markets, and to address the issues of a lack of appropriate skills in the Rwandan education system.

1.2.2. Chemistry and learners

Chemistry is a worthwhile subject because it prepares students for the real world of work through career paths like medicine, agriculture, pharmacy, chemical engineering, food science, environmental studies and many others. Chemistry provides skills that guide the construction of theories and laws that help to explain natural phenomenon and manage people and the environment.

Chemistry provides answers to the problems faced in our modern society through empowering students to be creative, innovative and to use independent approaches to solve problems. Students come to know and explore the properties of substances, as well as the processes in which those substances take part, and of materials obtained through modern industry.

1.2.3. Competences

Competence is defined as the ability to use an appropriate combination of knowledge, skills, attitudes, values and behavior to successfully accomplish a particular task. That is, the ability to apply learning with confidence in arrange of situations. Basic competences are addressed in the stated broad subject competences, in the objectives highlighted on year by year basis and in each of the units of learning. The generic competences are basic competences that must be emphasised and reflected in the learning process. These are briefly described below and teachers will ensure that learners are exposed to tasks that help them acquire these skills.

Generic competences

- ***Critical and problem solving skills:*** The acquisition of such skills will help learners think imaginatively, innovatively and broadly to evaluate and find solutions to problems encountered in our surroundings.
- ***Creativity and innovation****:* The acquisition of such skills will help learners take initiative and use imagination beyond knowledge provided in classroom to generate new ideas and construct new concepts.
- ***Research*****:** This will help learners find answers to questions based on existing information and concepts and use it explain phenomena from gathered information.
- ***Communication in official languages:*** Teachers, irrespective of being language teachers, will ensure the proper use of the language of instruction by learners. This will help learners communicate clearly and confidently and convey ideas effectively through speaking and writing and use the correct language structure and relevant vocabulary.
- ***Cooperation, inter personal management and life skills:*** This will help learners to co-operate as a team in whatever tasks are assigned and to practice positive ethical moral values while respecting rights, feelings and views of others. Leaners will perform practical activities related to environmental conservation and protection. They will also advocate for personal, family and community health, hygiene and nutrition and respond creatively to a variety of challenges encountered in life.
- ***Lifelong learning:*** The acquisition of such skills will help learners update their knowledge and skills with minimum external support. The learners will be able to cope with the evolution of advances in knowledge for personal fulfillment in areas that are relevant to their improvement and development.

Broad chemistry competences

During the learning process, the learner should be able to:

- Demonstrate knowledge, understanding and skills of chemistry subject matter (concept) that would enable him/her to access chemistry and related courses in advanced level.
- To develop skills in laboratory procedures and techniques, carried out with due regard for safety, together with the ability to assess the use and limitations of these procedures.
- Analyse scientific phenomena relating to real life experiences. Use the principles of scientific methods and the application of experimental techniques to solve specific problems.
- Demonstrate curiosity, research skills, creativity and innovative skills.
- Conduct scientific research: collect data, present, analyse, interpret and draw appropriate conclusions.
- Contribute to sustainable development by reducing the impact of chemical waste on the environment.
- Apply the knowledge of chemistry to make scientifically informed decisions on the choice of chemical products on the market.
- Develop attitudes relevant to chemistry such as concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness.
- Promote awareness that scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals.
- Develop attitudes on which scientific investigations depend, such as honesty, persistence, critical thinking and tolerance of uncertainty.

Chemistry and developing the competencies

The national policy documents which are based on the national aspirations identify some **"Basic Competencies"** alongside the **"Generic Competencies''.** These competencies aim to develop higher order thinking skills, help subject learning and promote the application of what has been learnt in real life situation.

Through experimentation, observation and presentation of information during the learning process, the learner develops not only deductive and inductive skills but also communication, critical thinking and problem solving skills as they try to make inferences and conclusions.

The manipulation of numerical and other data, performing practical experiments and undertaking project assignments involves not only analytical and problem solving skills but also innovation, creativity and research.

Group work and cooperative learning of chemistry promotes interpersonal relations and teamwork. Learning chemistry prepares responsible citizens who are aware of the power, impact and influence chemistry has in a modern scientific world. The syllabus emphasises the development of values and positive attitudes so that what is learnt is used for the good of the society and for the preservation of the environment.

2. PEDAGOGICAL APPROACH

Learners learn best when they are actively involved in the learning process through a high degree of participation, contribution and production. At the same time, each learner is an individual with their own needs, pace of learning, experiences and abilities. Teaching strategies must therefore be varied but flexible within well-structured sequenced lessons. Learner-centred education does not mean that the teacher no longer has responsibility for facilitating and guiding so that learning takes place.

2.1 Role of the learner

The activities of the learner are indicated against each learning unit and reflect appropriate engagement of the learner in the learning process. The teaching learning processes will create a learner friendly environment based on the capabilities, needs, experience and interests of the learner.

The learning activities will be organised in a way that encourages learners to actively construct knowledge either individually or in groups. Learners work on one competency at a time in form of concrete units with specific learning outcomes broken down into knowledge, skills and attitude. In practical lessons learners will work in groups or individually depending on the nature of the task, the intended objective of the activity, and availability of apparatus. However, learners are encouraged to do simple project work individually.

2.2. Role of the teacher

The change to a competence-based curriculum is about transforming learning and ensuring that learning is deep, enjoyable and habit-forming. Therefore, lessons should be engaging and stimulate students' curiosity, critical thinking and problem solving.

Teachers ought to shift from the traditional method of instruction to the role of a facilitator in order to value learners' individual needs and expectations. The teacher must identify the needs of each individual learner, the nature of the learning to be done, and the means to shape learning experiences accordingly.

The teacher's role is to organise the learners in the classroom or outside and engage them through participatory and interactive methods through the learning processes as individuals, pairs or groups. This ensures that the learning is personalised, active, participative and co-operative.

The teacher will design and introduce the tasks for the class to perform or for immediate discussion. The role of the teacher will be to guide learners in constructing their own knowledge. Learners are taught how to use textbooks and other resource materials in different ways e.g. to search for and make use of information in writing their own notes.

The teacher must select and develop appropriate materials such as teaching models or charts for the learners to use in their work. In practical lessons, the teacher first demonstrates the handling of the apparatus and the way the experiment should be carried out before exposing learners, as the task can be dangerous if not performed correctly. The teacher ought to demonstrate how to mix the reagents in the correct proportions before leaving the learners to do it on their own.

The teacher must devise remedial strategies both in and outside the classroom to address the issue of low achievers and those with learning difficulties. The teacher must ensure these learners keep pace with the rest of the group in acquiring the required competences.

To make learning relevant, real life examples should be given to make connections between chemistry and the learner's environment. In addition to emphasising the application of scientific concepts and principles and to minimise memorisation, the teacher should also facilitate students' learning based on accurate and unbiased information. This will contribute to a more scientifically literate citizen that is capable of making educated decisions regarding the world in which we live.

2.3. Special needs education and inclusive approach

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 challenged, 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 for them. The teacher therefore is requested to consider each learner's needs during the teaching and learning process. Assessment strategies and conditions should also be standardised to the needs of these learners. Detailed guidance for each category of learners with special education needs is provided for in the guidance for teachers' documents.

3. ASSESSMENT APPROACH

Assessment evaluates the teaching and learning processes through collecting and interpreting evidence of an individual learner's progress and makes a judgment about the learner's achievements measured against a set of defined standards. Assessment is an integral part of the teaching 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.

Assessment will be organised at the following levels: School-based assessment, District examinations, National assessment (LARS) and National examinations.

3.1 Types of assessment

3.1.1. Formative and continuous assessment (assessment for learning)

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 behavioral 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 based on the criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject and the generic competencies 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: (a) observation (b) pen and paper (c) oral questioning.

3.1.2. Summative assessment (assessment of learning)

When assessment is used to record a judgment of the competence or the performance of the learner, it serves a summative purpose. Summative assessment provides 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. The results of summative assessment are also used 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.

Summative assessment can be internal school based or external 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 based summative assessment average

scores for each subject will be weighted and included in the final national examinations grade. School based assessment average grades will contribute a certain percentage of marks as teachers gain more experience and confidence in assessment techniques. 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 initiatives to organise a common test per class for all the schools to evaluate the performance and the achievement level of learners in each individual school. External summative assessment will be done at the end of senior three.

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. Assessment procedures generate data in the form of scores which will be carefully recorded and stored in a portfolio. These scores will contribute to remedial actions and alternative instructional strategies. They will also be used to provide feedback to the learners and their parents to check learning progress and to provide advice, as well as be used in 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 their work. Portfolios reflect not only the work produced (such as papers and assignments), but also provide a record of the activities undertaken over time as part of student learning. The portfolio output (formative assessment) will be considered only enough for three years of O' level. It will also serve as a verification tool for each learner that he/she attended the whole learning activity before he/she undergoes the summative assessment for the subject.

3.3 Item writing in summative assessment

Before writing a question paper, a plan or specification of what is to be tested or examined must be developed that shows 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

competence-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 competence- based assessment by doing the following:

- Identify units 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 memorisation or recall answers only but test for broad competencies as stated in the syllabus.

Structure and format of the examination

There will be two papers for chemistry subject at ordinary level. Paper 1 consists closed, semi-structured and open/ extended questions and paper 2 is practical. Time will depend on the paper's items and weight. Extra time will be given to learners with special education needs if found necessary.

Paper	**Component**	**Weight**
Paper 1	The paper will measure both knowledge and understanding of the subject matter and acquisition of competences. The question items will be balanced as follows:	70%

	• Assessment of Knowledge and understanding (questions from low levels of Bloom's taxonomy) 30 % • Assessment of Skills and competences (questions from higher levels of Bloom's taxonomy :application, analysis, evaluation and synthesis) 40%	
Paper 2	Practical skills: The paper to measure practical/experimental skills (Observation, Recording & report writing, Manipulation, Measurement, Planning & designing) The experiments should be drawn from different topic areas of the syllabus.	30%

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 a learner's progress with his/her parents. A single mark is not sufficient to convey the different expectations of learning that are in the learning objectives. The most helpful reporting is to share what students are doing well and where they need to improve. A simple scale of "Meeting expectations very well", "Meeting expectations", and "Not meeting expectations" for each of knowledge/understanding, subject skills and competencies in a subject will convey more than a single mark. For school-based assessments these scores do not need to be added up.

4 RESOURCES

4.1 Material resources:

Teaching and learning of chemistry necessitates practical activities and experiments for better understanding of facts. The successful implementation of this curriculum requires a chemistry laboratory, textbooks, charts and ICT tools like computers and projectors. However, there are some chemistry concepts that cannot be easily explained and some experiments that cannot be done in our school laboratories due to safety reasons. Thus the use of ICT in teaching and learning is vital. With ICT these concepts can be understood by

the use of animations and simulations. Similarly, both teachers and learners are encouraged to use the internet for research as well as other ICT tools for teaching and learning purposes.

4.2 Human resource:

The effective implementation of this curriculum requires a joint collaboration of educators at all levels. Given the material requirements, teachers are expected to accomplish their noble role as stated above.

The following are some of the skills required for the teacher:

- Engage students in variety of learning activities.
- Use multiple teaching and assessment methods.
- Adjust instructions to the level of the learner.
- Adjust instructions to the level of the learner.
- Creativity and innovation.
- Makes connections/relations with other subjects.
- Should have high level of knowledge of the content.
- Effective discipline skills.
- Good classroom management skills.
- Good communicator.
- Guide and counselor.
- Passion for children teaching and learning.

School head teachers and directors of studies are requested to follow-up and assess the teaching and learning of this subject due to its important contribution to the profile, future careers and lives of learners as well as the development of the country.

5 SYLLABUS UNITS

5.1 Presentation of syllabus units

Chemistry is taught and learned in lower secondary education as a core subject, i.e. in S1, S2 and S3 respectively. At every grade, the syllabus is structured in Topic Areas, sub-topic Areas where applicable and then further broken down into Units. The units have the following elements:

- Units are 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 down into three types of Learning Objectives as follows:
  a. *Type I:* Learning Objectives relating to Knowledge and Understanding (*Type I* Learning Objectives are also known as Lower Order Thinking Skills or LOTS).
  b. –*Type II a*nd *Type III:* These Learning Objectives relate to acquisition of Skills, Attitudes and Values (*Type II* and *Type III* Learning Objectives are also known as Higher Order Thinking Skills or HOTS). These Learning Objectives are actually considered to be the ones targeted by the present reviewed curriculum.

- Each Unit has a Content which indicates the scope of coverage of what should be taught and learnt 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 the teaching and learning process.

In all, the syllabus of chemistry for ordinary level has 5 Topic Areas (Scope of chemistry and particulate nature of matter, states of matter and kinetic theory, chemistry and environment, chemical reactions and introduction to organic chemistry). There are 13 units in S1, 10 in S2 and 11 in S3.

5.2 Senior one

5.2.1 Key competences at the end of senior one

- Appreciate the scientific, social, economic, environmental and technological implications of chemistry.
- Use appropriate laboratory equipment/ materials to carry out experiments.
- Relate properties of matter to some physical and chemical phenomena in daily life.
- Explain how the rate of diffusion depends on molecular mass.
- Determine the compositions of mixtures and use appropriate techniques to separate them.
- Comprehend the structure of an atom and relate the valency to the chemical formulae of compounds.
- Use valence electrons and the number of shells to classify the first 20 elements in the periodic table.

- State standard requirements for different categories of water and explain steps involved in water treatment.
- Assess the components of air and analyse the causes and effects of air pollution and prevention.
- Minimise and properly manage chemical waste.
- Apply the law of conservation of matter to write and balance chemical equations.
- Prepare an indicator and use it to explain the observable properties of acids and bases.
- Analyse properties of different types of salts.
- Prepare, collect, test and show how oxygen reacts with other substances.

5.2.2. Senior one units

<table>
<tr><td colspan="2">TOPIC AREA: SCOPE OF CHEMISTRY AND PARTICULATE NATURE OF MATTER</td><td colspan="3">SUB-TOPIC AREA: INTRODUCTION TO CHEMISTRY AND EXPERIMENTAL TECHNIQUES</td></tr>
<tr><td>S1 Chemistry</td><td colspan="3">Unit 1: Chemistry and society.</td><td>Number of Periods: 6</td></tr>
<tr><td colspan="5">Key unit competency: To be able to assess the application of chemistry in our daily life and its contribution to our economy today.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Explain the importance of chemistry in daily life.
– Explain the reasons for studying chemistry in</td><td>– Link chemistry applications to culture and work.
– Write a standard report on field visits and findings of</td><td>– Appreciate the need to study chemistry in secondary schools.
– Appreciate the importance of chemistry in</td><td>Definition of chemistry
Why do we study chemistry?
Careers in chemistry:
– Human and animal medicine, pharmacy.
– Chemical engineering.
– Teaching.
Applications of chemistry in:</td><td>– Learners brainstorm the meaning of chemistry, the reasons why chemistry is studied in secondary schools and chemistry related careers.
– Group research work to explore the common industrial products in our country and relate their uses to the importance of chemistry (writes a</td></tr>
</table>

secondary schools. – Identify chemistry related careers. – State the contribution of chemistry to the Rwandan economy.	research. – Present the findings of the research and field visits in a convincing way.	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.	– Pharmaceuticals and cosmetics. – Plastics. – Food and beverages. – Soaps and detergents. – Water treatment. – Note: indicate how chemistry is applied in the Rwandan traditional context (e.g. production of local drinks, cheese making and traditional medicines). **Contribution of chemistry to the economy of the country:** – Medicines. – Industries and mining. – Transport. – Agriculture sectors.	simple report on their research and presents it in class). – Field visit to any nearby industry, mining site, agricultural farm to appreciate the importance of chemistry to the Rwandan society (write a field report) and make a presentation.
Link to other subjects: *Geography: mining. Farming: fertilisers. Economics: industrialisation.*				
Assessment criteria: *Can assess the applications of chemistry in daily life and its contribution to Rwandan economy today.*				
Materials: *Computers, projectors, flip charts and internet connection.*				

TOPIC AREA: SCOPE OF CHEMISTRY AND PARTICULATE NATURE OF MATTER			SUB-TOPIC AREA: INTRODUCTION TO CHEMISTRY AND EXPERIMENTAL TECHNIQUES	
S1 Chemistry	**Unit 2:** Laboratory safety and apparatus.			**Number of Periods:** 15
Key unit competency: To be able to use effectively laboratory equipment/materials to carry out experiments.				
Learning objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– State the safety rules and precautions usually followed in a chemistry laboratory. – Explain the uses of common laboratory apparatus.	– Appropriately interpret warning signs about dangers and hazards. – Effectively use and handle common laboratory apparatus /equipment (e.g. fire extinguishers, measuring cylinder, separating funnel, thermometer, Bunsen burner and balance). – Draw common	– Respect laboratory rules and regulations. – Show vigilance and caution when handling chemicals and apparatus. – Take care of oneself, colleagues, individual and public materials. – Develop confidence in the use of laboratory apparatus.	**Definition of a laboratory.** **Laboratory safety:** – Laboratory rules. – Safety precautions and warning labels. – Measures to take in case of accidents e.g. fire, burns caused by acids and bases, or cuts caused by broken glasses. **Laboratory apparatus (names, diagrams and uses) e.g. apparatus for:** – Measuring volume: measuring cylinder, separating funnel, pipette and burette. – Measuring temperature: thermometer – Measuring mass: balance – Source of heat: Bunsen burner	– In groups, research and make a presentation about the laboratory rules and regulations. – Make a laboratory visit and observe: o Different equipment and reagents. o Safety precautions charts o Compare the signs on different chemical containers. –Perform role plays on measures that can be taken in case of a fire in a laboratory. Demonstrate how a fire extinguisher is used. –Carry out practical experiments using some laboratory apparatus (e.g. measuring cylinder, separating funnel, thermometer, Bunsen burner and balance)

	laboratory apparatus.			
Link to other subjects: *Biology: laboratory safety and apparatus. Physics: laboratory safety and apparatus.*				
Assessment criteria: *Can recognise and effectively use laboratory equipment/materials to carry out experiments.*				
Materials: *Laboratory apparatus, chemicals, computers, projectors, first aid kit, and fire extinguisher.*				

TOPIC AREA: SCOPE OF CHEMISTRY AND PARTICULATE NATURE OF MATTER		SUB-TOPIC AREA: STATES OF MATTER AND KINETIC THEORY
S1 Chemistry	**Unit 3:** States and changes of states of matter.	**Number of periods:** 8
Key unit competency: To be able to relate properties of matter to daily life physical and chemical phenomena.		

Learning objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the states of matter using kinetic theory. – 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	– Develop a teamwork approach during group activities and experiments. – Show curiosity and inquiry in exploring physical phenomena in daily life. – Appreciate the importance of following procedures during experiments. – Develop self-confidence in	**Definition of matter.** – States of matter and examples (solid state, liquid state, gaseous state). – Change of the states of matter (e.g. melting, boiling, evaporating, condensing, solidifying, subliming). – Differences between physical and chemical changes and give examples of each. – Description of kinetic theory of matter in terms of particle arrangement, inter-particle forces and movement of particles in solids, liquids and gases. o Definition of diffusion and the factors which affect diffusion of particles. o Brief description of Brownian motion. – Changes of states in terms of kinetic	– Group activity to classify different given substances according to whether they are solids, liquids or gases. This is followed by a discussion with an emphasis on the physical states. – Experiments/activities to show the change of states of matter: lighting a candle, melting ice, boiling water (observe the change of state with temperature), heating iodine or naphthalene. Make observations and conclusions. – Carry out an experiment to show the difference between chemical and physical changes: o Boiling and condensing water, heating and cooling candle wax, sublimation of iodine, breaking a wooden stick, etc.

	arrangement of particles in solids, liquids and gases. – Demonstrate Brownian motion through a simple experiment.	experiments and the presentation of findings.	theory.	○ Burning a piece of wood, burning magnesium ribbon, ripening of fruits, and fermentation of sugars, rusting of iron, etc. – Research and make a diagrammatic presentation on the arrangement of particles in solids, liquids, and gases. – Experiments to: ○ Illustrate a similar effect to Brownian motion E.g. boiling water with visible particles like chalk powder. ○ Show the diffusion of ammonia, from concentrated ammonia, and hydrogen chloride, from concentrated hydrochloric acid, to form ammonium chloride. ○ Illustrate diffusion of potassium manganate(VII) in water and write a report of the findings.
Link to other subjects: *Physics: states of matter. Biology: diffusion.*				
Assessment criteria: *Can relate properties of matter to some physical and chemical phenomena in daily life.*				
Materials: *Candle wax, computer, projector, microscope, smoke cell, potassium manganate (VII).*				

TOPIC AREA: SCOPE OF CHEMISTRY AND PARTICULATE NATURE OF MATTER			SUB-TOPIC AREA : CLASSIFICATION OF SUBSTANCES AND SEPARATION TECHNIQUES	
S1 Chemistry	**Unit 4:** Pure substances and mixtures.			**Number of periods:** 16
Key unit competency: To be able to separate mixtures and determine their composition.				
Learning objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Differentiate between pure substances and mixtures. – Identify different types of mixtures. – Describe different methods of separating mixtures. – State applications of each separation technique.	– 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 and mixtures in daily life.	**Pure substances:** – Definition and physical properties. **Mixtures:** – Definition. – Types of mixtures (Homogeneous and heterogeneous). **Separation of mixtures (Include the criteria for the choice of a certain method and its application):** – Manual sorting, sieving, winnowing, filtration, decanting, simple distillation and fractional distillation, paper chromatography, magnetic separation, centrifugation, crystallisation and evaporation, and sublimation. – Calculating percentage composition by mass and by volume of a component in a mixture.	– Group activity to: ○ Classify given substances into mixtures and pure substances. ○ Classify mixtures as homogeneous and heterogeneous. Present findings. – Experiments about the different methods of separating mixtures e.g. simple distillation, paper chromatography, magnetic separation using iron powder and sand, decanting, and filtration. Make an appropriate report on the findings. – Exercises to: ○ Examine the percentage composition by mass and by volume of different substances. E. g. drinks, drugs, food, toothpaste, and chemicals.

				○ Calculate the percentage composition of mixtures.
Link to other subjects: *Physics: magnetism. Biology: microbiology, function of the kidneys, and digestive system. Environmental science: pollution. Geography: mining. Mathematics: calculation of percentages.*				
Assessment criteria: *Can identify pure substances and mixtures. Can separate mixtures and determine their compositions.*				
Materials: *Computers, projectors, centrifuge, videos on chromatography, and videos on using centrifuge as a separation technique.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: ATOMIC AND MOLECULAR STRUCTURE**
S1 Chemistry	**Unit 5:** Atoms, elements and compounds.	**Number of periods:** 18
Key unit competency: To be able to comprehend the structure of an atom and relate the valency to the chemical formulae of compounds.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Name the different sub-particles of an atom and their properties. – Explain the concept of isotopes. – Explain how simple molecules are formed. – Distinguish between an element and a compound.	– Write the symbols of different chemical elements. – Write the electronic configuration of the first 20 elements in terms of energy levels. – Determine the number of protons, neutrons and electrons from atomic numbers and mass	– Appreciate the uniqueness of atoms of elements. – Appreciate the role of an atom as the building block or unit of matter. – Appreciate that atoms of elements combine to form compounds.	– Definition of element, atom and molecule. – Symbols of chemical elements – first 20 elements and some other common elements. – Main components of an atom (protons, electrons, neutrons) and their properties (relative charge, symbol and relative mass). – Definition of atomic number, mass number and isotope. – Electronic configuration of the first 20 elements of the Periodic Table (avoid the s, p, d, f etc. notation). – Instability of atoms and the tendency to gain or lose electrons (formation of cations and anions). – Definition of radicals. – Valence of elements and radicals.	– Watch simulations/videos or diagrams that illustrate the structure of an atom and make an appropriate report. – Exercises to calculate the number of protons, neutrons, and electrons from mass numbers and atomic numbers. – Examples and exercises of writing: ○ Electronic configurations of elements. ○ Formulae and names of some chemical substances. – Representations of simple molecules using atomic models.

	numbers. – Represent atoms of an element by giving the symbol, atomic number and mass number. – Use the valence of different elements and radicals to write the formulae and names of chemical substances.		– Elements and compounds. – Formulae and nomenclature of chemical substances (oxides, elementary molecules, chlorides, nitrides, phosphates, bromides, iodides, hydroxides, acids, bases and salts).	
Links to other subjects: *Physics: atomic structure. Mathematics: geometry, and calculation.*				
Assessment criteria: *Can comprehend the structure of an atom and relate the valence to the chemical formulae of substances.*				
Materials: *Periodic Table chart, atomic and molecular models, computers, projectors, etc.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: PERIODIC TABLE**
S1 Chemistry	**Unit 6:** Arrangement of elements in the Periodic Table.	**Number of periods:** 6

Key unit competency: To be able to use the atomic number, valence electrons and number of shells to classify the first 20 elements in the Periodic Table.

Learning Objectives			**Content**	**Learning Activities**
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 of 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 to 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.	– Description of early attempts to classify known elements e.g. o Dobereiner's triads and Newlands octaves. o Briefly description of the historical development of the modern Periodic Table (Mendeleev and Henry Mosley). – Relationship between electronic structure of elements and their position on the Periodic Table. – Metallic and non- metallic trend in the Periodic Table. (Horizontal and vertical).	– Research and make a presentation on the history of the modern Periodic Table by Mendeleev and Henry Mosley. – Do exercises locating the first 20 elements in the Periodic Table. Focus on periods and groups. – Group activity to discuss the trends in metallic and non-metallic character of elements in the Periodic Table.

Links to other subjects: *Mathematics: set of numbers.*

Assessment criteria: *Can use atomic numbers, valence electrons and number of shells to classify the first 20 elements in the Periodic Table.*

Materials: *Periodic Table chart, computers, projectors, etc.*

TOPIC AREA: CHEMISTRY AND ENVIRONMENT		SUB-TOPIC AREA: WATER AND AIR
S1 Chemistry	**Unit 7:** Water and its composition.	**Number of periods:** 8

Key unit competency: To be able to state standard requirements for different categories of water and explain steps involved in water treatment.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– State the physical properties of pure water. – Outline the steps involved in the treatment and purification of water. – Explain the water cycle and its importance in daily life. – Differentiate between pure water and clean water.	– Perform experiments to the show properties of water. – Test for the presence of water in any given substance in the laboratory. – Illustrate the water cycle through a labelled diagram. – Relate the characteristics of water to its	– Develop the sense for the importance of managing natural resources correctly. – Appreciate the value of clean water for our health.	– Sources of water. – Physical properties of pure water (density, boiling point, melting point, taste, colour and smell). – Testing for the presence of water using anhydrous copper(II) sulphate, and cobalt(II) chloride paper. – Characteristics of different categories of water: (distilled water, mineral water, tap water, waste water, rain water, drinking water, irrigation, swimming pool water and livestock drinking water). – Treatment and purification of water. – Uses of water. – Water cycle.	– In groups: ○ Perform experiments to show the process of boiling and the condensation of water. Make an appropriate report. ○ Carry out experiments to test for the presence of water in any given substance and report the observations made. ○ Research and make a presentation on treatment, purification and the uses of water. – Field visit to industries that purify and pack water for drinking (e.g. Inyange, SULFO, Alpine Huye, Enterprise Urwibutso etc.). Make a field report. – Field visit to the nearby water treatment and distribution plant

	uses. – Write a standard report of field visits and research. Present findings in a convincing way.			(e.g. WASAC Ltd).
Links to other subjects: *Biology: microbiology. Geography: water cycle.*				
Assessment criteria: *Can state the properties of pure water. Can recall the standard requirements for different categories of water and explain steps involved in water treatment.*				
Materials: *Flow chart of a water treatment plant.*				

TOPIC AREA: CHEMISTRY AND ENVIRONMENT		**SUB-TOPIC AREA: WATER AND AIR**
S1 Chemistry	**Unit 8:** Air composition and pollution.	**Number of periods:** 9
Key unit competency: To be able to assess the components of air and analyse the causes of air pollution and its prevention.		

Learning Objectives			**Content**	**Learning Activities**
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.	– Carry out an experiment to determine the percentage of oxygen in the atmosphere. – Write a standard report and present the research findings in a convincing way.	– Develop a culture of managing natural resources. – Develop confidence in the presentation of research work.	– Components of air and their percentages. – Oxygen as the active part of air. – Importance of air (respiration of living organisms, climate, raw material for industries, combustion, etc.). – Definition of pollution. – Major pollutants of air and their sources e.g.: o Exhaust gases from vehicles. o Gases released by industries. o Carbon oxides from combustion of organic substances. o Dust particles and CFCs from aerosol, refrigerators, methane from farm animals, landfills, radioactive pollutants produced by nuclear explosions, nuclear plants, etc. – Ways of preventing air pollution	– Carry out an experiment to determine the percentage of oxygen in the atmosphere and show that it is the most active part of air. Make an appropriate report. – Watch a video clip on how the percentage of oxygen can be determined and compare with the processes carried out in the laboratory. – Research and deliver a presentation on the findings about the importance and application of air to daily life and industries. – Research and hold interactive discussions on the various ways of preventing air pollution. Make a presentation at the end of the discussion.

			(e.g. recycling and neutralising harmful gases from industries, catalytic converters, afforestation and re-afforestation and conservation policy).	
Links to other subjects: *Biology: physiology. Geography: people and the environment. Physics: radioactive pollutants.*				
Assessment criteria: *Can assess the components of air and analyses the causes of air pollution and prevention.*				
Materials: *Computer, projector, internet access, videos on determination of percentage of oxygen, etc.*				

TOPIC AREA: CHEMISTRY AND ENVIRONMENT		**SUB-TOPIC AREA: WASTE MANAGEMENT**
S1 Chemistry	**Unit 9:** Waste materials.	**Number of periods:** 4
Key unit competency: To be able to minimise and properly manage waste materials.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– 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.	– 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	– Develop a sense of responsibility to maintaining a clean environment.	**Definition of waste.** **Types of waste materials:** – Solid waste (biodegradable and non-biodegradable). – Liquid waste. – Gaseous waste. **Sources of waste:** – Municipal sources. – Medical sources. – Industrial sources. **Sources of waste materials at school level and their management:** – Wastes from the laboratory (used chemicals, and broken apparatus). – Wastes from the kitchen. – Wastes from the classroom. **Hazards of waste to the environment.**	– Research and make presentations on the different types, sources and hazards of waste materials. – Carry out an assessment on different types of waste materials and their sources in the school, and the possible dangers to the environment. – Design a simple project to collect, prevent and minimise waste materials at or around the school. – Learners identify the types of waste materials and their sources around their homesteads, and suggest ways of minimising them. Make a report.

	the school environment.			
Links to other subjects: *Biology: ecology. Geography: People and the environment.*				
Assessment criteria: *Can minimise and properly manage waste materials.*				
Materials: *Computers, projectors, and flip charts.*				

TOPIC AREA: CHEMICAL REACTIONS		**SUB-TOPIC AREA: TYPES OF REACTIONS**
S1 Chemistry	**Unit 10:** Chemical equations.	**Number of periods:** 18
Key unit competency: To be able to write and use balanced chemical equations.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– State the law of conservation of matter. – Explain how a chemical equation relates to the law of conservation of matter. – State the rules of balancing equations.	– 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.	– Develop a team approach when performing experiments in a group. – Develop confidence in writing and interpreting chemical formula and equations.	**Chemical reactions:** – Definition. – Writing word equations. – Writing chemical equations. – Writing chemical equations with state symbols. **Balancing chemical equations:** – Rules of balancing chemical equations. – The law of conservation of matter. **Interpreting and translating word equation into chemical equations.**	– Learners research in groups and make presentations about the law of conservation of matter. – Carry out an experiment to verify the law of conservation of matter. E.g. by heating magnesium ribbon and making an appropriate presentation of results. – Perform exercises on writing and balancing chemical equations.

Links to other subjects: *Biology: respiration and chemicals of life. Mathematics: algebra.*

Assessment criteria: *Can write and use chemical equations.*

Materials: *Appropriate chemicals and apparatus, computer, projector, and internet access.*

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: ACIDS, BASES AND SALTS
S1 Chemistry	**Unit 11:** Acids and bases and pH.	**Number of periods:** 9

Key unit competency: To be able to extract indicators from flowers and use them to test the observable properties of acids and bases in common domestic substances.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– 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.	– Test acidity and alkalinity in different solutions using indicators. – Extract indicators from flowers. – Use common laboratory indicators such as litmus, phenolphthalein and methyl orange. – Use Universal indicators and pH paper to measure acidity and alkalinity of solutions.	– Develop orderliness and a careful approach when handling acids and bases. – Respect the procedures described for carrying out experiments involving acids and bases.	– Definition of an acid/base, and alkali in terms of H+ and OH- ions, and acid-alkali indicators. – Properties of acids and alkalis (effect on indicators, pH, corrosive, sour taste for acids, bitter taste and soapy feel for alkalis). – Existence of indicators for acids and alkalis in nature and in common products. – Definition of the pH of a solution as a measure of	– Practical activities involving the extraction of indicators from coloured flowers (e.g. Hibiscus flower, red cabbages, bougainvillea) and use them to test the nature of different solutions (acidity, alkalinity or neutrality). A report for every activity is required. – Testing different solutions using the common indicators in order to compare them to the extracted ones. Make a report of results and present them. – Determine the pH of different substances using a pH-meter.

	– Use a pH-meter to measure the acidity and alkalinity of solutions. – Relate pH values to the acidity, alkalinity and neutrality of different solutions.		acidity, neutrality and alkalinity. – Explanation of the pH-scale and pH-meter. – pH of common commodities in daily life. – Applications of acids and bases. – Dangers associated with acids and bases.	(Water (mineral, rain and distilled water), milk, milk of magnesia, soap solution, common laboratory solutions, common household acids and bases, etc.). – Group discussion and presentations on the uses of acids and bases in daily life and dangers associated with bases and acids (e.g. effect on the environment).
Links to other subjects: *Agriculture: soil. Biology: gastric juices, blood, urine and other body fluids. Ecology: acid rain.*				
Assessment criteria: *Can prepare an indicator and use it to test the acidity and alkalinity of solutions of common domestic substances. Has an awareness of the dangers associated with handling acids and bases.*				
Materials/equipment: *Flowers (e.g. hibiscus, red cabbages, etc.) and common indicators.*				

TOPIC AREA: CHEMICAL REACTIONS		**SUB-TOPIC AREA: ACIDS, BASES AND SALTS**	
S1 Chemistry	**Unit 12:** Inorganic salts and their properties.		**Number of periods:** 15
Key unit competency: To be able to analyse properties of different types of salts.			
Learning Objectives			**Content** / **Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**	
– Define the term salt. – Distinguish between soluble and insoluble salts. – State the physical properties of salts. – Describe the effect of heat on different salts.	– 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.	– Develop a keen eye for detail when observing experiments. – Get into the habit of repeating an experiment where there is any doubt as to what has happened.	**Content:** – Definition of a salt. – Nomenclature and chemical formulae of simple salts i.e. chlorides, nitrates and sulphates. – Physical properties of inorganic salts: o Physical state. o Colour. o Solubility in water. o Electric conductivity. – Action of heat on carbonates, hydrogencarbonates, sulphates and nitrates. **Learning Activities:** – Carry out experiments to show whether salts are insoluble or soluble. Attempt to dissolve each salt in cold water, and then in hot water. Present results in a three-column table indicating the salt, if it is soluble in cold water, if it is soluble in hot water or if it is insoluble. (Salts could include: magnesium sulphate, calcium sulphate, barium sulphate, sodium carbonate, magnesium carbonate, lead nitrate, potassium nitrate, silver chloride, sodium chloride and lead(II) chloride). – Experiment to show the electric conductivity of salts in solution. – Carry out experiments to show thermal decomposition of different salts. E.g. zinc carbonate, lead

				carbonate, hydrated copper(II) sulphate, lead nitrate, sodium hydrogencarbonate, hydrated iron (II) sulphate, sodium carbonate, etc.). Present the findings.
Links to other subjects: *Geography: identification of carbonate rocks. Biology: digestion, enzyme activity.*				
Assessment criteria: *Can analyse properties of different types of salts.*				
Materials/equipment: *Appropriate chemicals and apparatus, computer, projectors, and internet access.*				

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: OXYGEN AND OXIDES
S1 Chemistry	**Unit 13:** Preparation of oxygen and its properties.	**Number of periods:** 12

Key unit competency: To be able to prepare oxygen and show how it supports burning and reaction with some elements. Prepare other gases to demonstrate different methods of collection.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– 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	– Prepare and test oxygen gas. – Collect gases using appropriate methods. – Write equations for the reactions of oxygen with other elements.	– 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.	**Methods of preparation of oxygen gas:** – Heating nitrates of Group 1 metals. – Decomposition of hydrogen peroxide. – Decomposition of oxides of heavy metals e.g. PbO2. – Heating potassium manganate (VII). – Heating potassium chlorate. **Testing for oxygen gas.** **Physical and chemical properties of oxygen.** **Methods of collecting gases:** – Over water collection. – Downward delivery. – Upward delivery. – Liquefaction or freezing. **Uses of oxygen (**e.g. respiration of	– Carry out experiments to prepare oxygen from: o Decomposition of oxides of heavy metals: (e.g. PbO2) heating potassium manganate (VII), heating potassium chlorate). – Test oxygen using a glowing splint after each experiment. Observe, record and present the findings. – Practical activities to show: o That parts of air are used for burning. o The reactions of oxygen with metals and non-metals. o Preparation of different gases to illustrate different methods of collection. – Discuss the results and make conclusions.

daily life. – Explain the consequences of ozone layer depletion.			living organisms, hospitals, and welding). **Allotropes of oxygen.** **Ozone:** – Molecular structure. – Ozone layer and its importance. – Dangers related to ozone layer depletion.	– Research and present the findings on the uses of oxygen and the effects of ozone layer depletion on environment.
Links to other subjects: *Biology: respiration, photosynthesis.*				
Assessment criteria: *Can prepare oxygen, collect the gas, carry out a test to demonstrate it is oxygen and show how oxygen reacts with other substances. Can prepare other gases to demonstrate different methods of collection.*				
Materials/ equipment: *Appropriate chemicals and apparatus, computers, and internet access.*				

5.3 Senior Two

5.3.1. Key competencies at the end of senior two

- Relate the nature of the bond to properties of compounds.
- Describe the trends and patterns in properties of elements in groups and periods.
- Suggest ways of water pollution control.
- Suggest different ways of transforming wastes into useful materials.
- Differentiate between the types of chemical reactions.
- Determine the pH of aqueous solutions using a pH-meter.
- Prepare a salt from suitable starting materials.
- Determine the composition of compounds by mass, volume and number of moles.
- Identify cations and anions present in a solution.
- Prepare and classify oxides based on their properties.
- Distinguish between non-electrolyte, weak and strong electrolytes.
- Compare the properties of organic and inorganic compounds and explain the uses of alkanes in daily life.

5.3.2. Senior two units

<table>
<tr><td colspan="3">TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE</td><td colspan="2">SUB-TOPIC AREA: ATOMIC AND MOLECULAR STRUCTURE</td></tr>
<tr><td>S2 Chemistry</td><td colspan="3">Unit 1: Chemical bonding.</td><td>Number of periods: 10</td></tr>
<tr><td colspan="5">Key unit competency: To be able to relate the nature of bonding to properties of substances.</td></tr>
<tr><td colspan="3">Learning Objectives</td><td rowspan="2">Content</td><td rowspan="2">Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr>
<td>– Explain the nature of ionic, covalent and metallic bonding.
– State the typical physical properties of ionic compounds, and of covalent compounds.
– Explain the physical properties of metals in terms of their structure.</td>
<td>– Show the formation of bonds using dot and cross diagrams.
– Classify various chemical compounds as ionic or covalent.
– Perform experiments to show the physical properties of metals, ionic compounds and covalent</td>
<td>– Develop a sense of orderliness and self-confidence in presentations of results.
– Respect the procedures while carrying out experiments.
– Appreciate that being soluble in water is not sufficient evidence to indicate a compound is</td>
<td>Stability of atoms by losing, gaining and sharing valence electrons.
Formation of ions from atoms.
Ionic bonding:
– Formation.
– Properties of ionic compounds.
Covalent bonding:
– Formation.
– Properties of covalent compounds.
– Giant covalent structures (graphite and diamond) their properties and uses.
Metallic bonding:
– Formation (electron sea).
– Physical properties of metals (ductility, malleability, heat and electric conductivity).</td>
<td>– In groups, perform exercises on the formation of ions from atoms.
– Using atomic models discuss the formation of covalent bonds and make a presentation.
– Given a list of compounds, learners classify them according to the nature of bonds formed. E.g. sodium chloride, water, magnesium, calcium carbonate, ammonium chloride, etc.
– Carry out experiments which illustrate the physical properties of ionic and covalent compounds:
○ Solubility (e.g. dissolving NaCl in water, mixing water and cooking oil, mixing cooking oil and ethanol, etc.).</td>
</tr>
</table>

	compounds.	ionic.		○ Melting and boiling points (e.g. melting candle wax, boiling water, heating NaCl, etc.). ○ Electric conductivity (e.g. comparing the conductivity of distilled water with that of a NaCl solution). – Make a report of the findings in each case. – Practical activities to illustrate the physical properties of metals (e.g. a piece of metal and a non-metallic object).
Links to other subjects: *Physics: electricity.*				
Assessment criteria: *Learners can relate the nature of bonding to the properties of substances.*				
Materials: *Molecular models, appropriate chemicals, electrolytes, wires, bulbs, computer, and projector.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: PERIODIC TABLE**		
S2 Chemistry	**Unit 2:** Trends in properties of elements in the Periodic Table.			**Number of periods:** 8
Key unit competency: To be able to describe the trends and patterns in properties of elements in groups and periods.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe trends in reactive elements with acids, water, and halogens. – Explain the trends in the physical properties across a period and down a group.	– Classify elements into metals, metalloids and non-metals. – Compare and contrast the physical properties of metals and non-metals using simple experiments. – Compare the reactivity of metals across the period and down the group with the help of	– Respect the procedures during practical activities. – Develop teamwork in group activities. – Appreciate that some elements exhibit a mixture of the properties of metals and non-metals and are therefore best described as metalloids.	– Classification of elements into metals, metalloids and non-metals. – Physical properties of metals and non-metals. – Trends in reactivity for metals and non-metals. – Chemical properties (reaction with water, acids and halogens).	– In groups, use the Periodic Table to classify elements into metals, metalloids and non-metals. – Carry out experiments illustrating the difference between properties of metals and those of non-metals. E.g. comparing thermal conductivity and electrical conductivity of rods of iron, copper, carbon and sulphur. – Carry out experiments to show the reaction of metals with water, acids and oxygen. Write an appropriate report on the findings.

	simple experiments.			
Links to other subjects: *Physics: heat and electricity.*				
Assessment criteria: *Can describe the trends and patterns in the properties of elements in groups and periods.*				
Materials: *Bulb, dry cells, wires, and samples of metallic elements and non-metallic elements.*				

TOPIC AREA: CHEMISTRY AND ENVIRONMENT		**SUB-TOPIC AREA: WATER AND AIR**		
S2 Chemistry	**Unit 3:** Water pollution.			**Number of periods:** 8
Key unit competency: To be able to assess the causes and effects of water pollution and suggest ways of control.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define water pollution. – Identify the main water pollutants. – Describe the dangers of polluted water. – Suggest the ways of preventing water pollution.	– Develop research skills – Evaluate ways of minimising pollution.	– Develop awareness of the dangers of polluted water. – Develop a sense of responsibility for caring about the environment.	**Definition of water pollution.** – Main water pollutants (e.g. sewage, nutrient-rich waste water such as run off from fields, chemical waste, radioactive waste, oil pollution, plastic, alien species e.g. water hyacinth and other forms e.g. heat pollution.). – Dangers of polluted water (eutrophication, acidification, health hazards, etc.). – Prevention of water pollution (e.g. education, laws, and economics.).	– Research and make presentations on water pollutants, effects of polluted water and ways of preventing water pollution. – Study field visit to any nearby polluted water body and make a report. (During the field visit learners will collect samples of water to carry out experiments to show its pH compared with that of tap water).
Links to other subjects: *Biology: microbiology. Geography: people and the environment.*				
Assessment criteria: *Can explain the causes and effects of water pollution and suggest ways of control.*				
Materials: *Appropriate chemicals and apparatus, computers, and projectors.*				

TOPIC AREA: CHEMISTRY AND ENVIRONMENT		SUB-TOPIC AREA: WASTE MANAGEMENT
S2 Chemistry	**Unit 4:** Effective ways of waste management.	**Number of periods:** 12

Key unit competency: To be able to transform waste materials into different useful materials e.g. fuel (briquettes) and fertilisers (composted manure).

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe the steps involved in effective waste management. – Explain the importance and benefits of waste recycling. – Discuss the various effects of waste materials and poor waste disposal.	– Make some useful materials from waste.	– Develop a sense of managing natural resources while discussing effective ways of waste management. – Develop teamwork and confidence in group activities and presentations. – Develop a sense of responsibility in minimising waste materials.	– Steps to effective waste management (prevention, minimisation, reuse, recycling, energy recovery and disposal). – Importance and benefits of waste recycling (environmental protection, conservation of natural resources, energy saving, job creation). – Effects of waste and poor disposal.	– In groups discuss the different steps of waste management from the most recommended to the least, and make presentations. – Research how to make useful products from waste (like fertilisers, briquettes, biogas, etc.). – Make a small-scale biogas generator. – Field visits and study tours to different industrial sites e.g. garbage pits, or biogas production plants.

Links to other subjects: *Biology: ecology. Geography: people and the environment.*
Assessment criteria: *Can explain how different useful materials can be made from waste materials.*
Materials: *Computer, projector, chemical fertiliser, briquettes, and flow charts.*

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: TYPES OF REACTIONS
S2 Chemistry	**Unit 5:** Categories of chemical reactions.	**Number of periods:** 16

Key unit competency: To be able to differentiate between the types of chemical reactions.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the difference between a decomposition reaction and combination reaction. – Explain single displacement, double displacement (precipitation and neutralisation) and combustion reactions. – Write and balance ionic equations.	– Apply the rules of balancing equations to write balanced chemical reactions. – Carry out experiments to show precipitation reactions, and to differentiate endothermic and exothermic reactions – Classify chemical reactions as endothermic and exothermic using simple experiments. – Properly use a thermometer to measure changes in temperature.	– Develop a team spirit, sense of responsibility when performing experiments.	– Types of reactions: o Combination. o Decomposition. o Single replacement. o Double displacement (precipitation and neutralisation). o Combustion. – Classification of chemical reactions as endothermic and exothermic reactions. – Ionic equations/rules of writing ionic equations.	– Experiments to show how magnesium combines with oxygen, hydrogen chloride combines with ammonia gas, and hydrated copper(II) sulphate decomposes. – Perform exercises to write well balanced chemical reactions. – Carry out experiments to show precipitation reactions (e.g. reaction between sulphuric acid and barium nitrate solution), show how zinc displaces copper from its solution. – Carry out experiments to differentiate endothermic and exothermic reactions.

Links to other subjects: *Biology: respiration, chemicals of life., Mathematics: algebra.*
Assessment criteria: *Can differentiate between the types of chemical reactions.*
Materials/equipment: *Appropriate chemicals and apparatus, computers, and projectors.*

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: ACIDS, BASES AND SALTS	
S2 Chemistry	**Unit 6:** Preparation of salts and identification of ions.		**Number of periods:** 28
Key unit competency: To be able to prepare a salt from suitable starting materials and identify cations and anions in a solution.			

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define solubility. – Describe factors that affect solubility. – Explain the concept of unsaturated, saturated and supersaturated solutions. – Explain the solubility curves of different salt solutions. – Describe different methods of preparing	– Prepare different soluble and insoluble salts using suitable chemicals. – Interpret solubility curves of different solutions. – Carry out experiments to show the effect of temperature on the solubility of different salts. – Use solubility curves to	– Develop a team spirit and sense of responsibility during experiments. – Appreciate the uses of salts in daily life such as sodium chloride as a table salt.	– Definition of: o Solubility. o Unsaturated. o Saturated. o Super saturated solutions. – Factors influencing solubility of different salts e.g temperature. – Solubility curves and calculations of solubility. – Different ways of preparing normal salts from reaction of: o Acid with active metals. o Acids with carbonates and hydrogen carbonates. o Acids with metal oxides. o Acids with bases. o Precipitation and neutralisation reactions. o Metal oxides with non-metal oxides and a base and non-	– Perform exercises on the solubility of different salts (g/100g of water) and make presentations of the results. – In groups, discuss and make presentations on the differences between unsaturated, saturated and super saturated solutions, giving examples in each case. – Carry out experiments to show the effect of temperature on solubility of different salts. E.g. o Solubility of lead(II) chloride in cold and hot solutions, potassium nitrate, potassium chloride, calcium hydroxide, and calcium carbonate. – Interpret solubility curves to calculate the solubility of different solutions at different

soluble and insoluble salts. – Name the sources and uses of salts in daily life.	determine the solubility of different salt solutions at different temperatures. – Perform tests to identify cations and anions.		metal oxides. – Uses and sources of salts. – Identification of cations and anions. E.g.: Ca^{2+}, NH_4^+, Al^{3+}, Zn^{2+}, Mg^{2+}, Fe^{2+}, Cl^- , CO_3^{2-}, SO_4^{2-} , Fe^{3+}, NO_3^-, Cu^{2+}, SO_3^{2-}	temperatures. Make a scientific report. – Carry out experiments to: ○ Prepare zinc sulphate crystals from zinc metal and diluted sulphuric acid. ○ Prepare copper(II) sulphate from copper(II) oxide and dilute sulphuric acid. ○ Prepare calcium chloride from calcium carbonate and hydrochloric acid. ○ Prepare sodium chloride from sodium hydrogencarbonate and hydrochloric acid. ○ Prepares lead carbonate from lead nitrate and sodium carbonate. Prepares sodium sulphate crystals from sodium hydroxide and sulphuric acid. ○ Report the results obtained. – Research and make presentation on the sources and uses of salts. – Perform different experiments to identify cations and anions. Discuss the results obtained after each experiment to make conclusions with supporting theory (solubility, colour of ions).
Links to other subjects: *Biology: mineral salts. Geography: geology.*				

Assessment criteria: *Can prepare a salt from suitable starting materials and identify cations and anions in a sample of solution.*
Materials/ equipment: *Appropriate chemicals and apparatus.*

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: STOICHIOMETRY		
S2 Chemistry	**Unit 7: The mole concept and gas laws.**			**Number of periods:** 18
Key unit competency: To be able to determine the composition of compounds by mass, volume and number of moles.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the mole concept. – Explain the concepts of: relative atomic mass, relative formula mass, relative molecular mass, molar mass, limiting reactant, empirical and molecular formulae. – State the gas laws: Gay-Lussac, Charles' law, Boyle's law and the ideal gas law, Grahams' law of diffusion.	– Experimentally determine the mass composition of a compound using magnesium oxide as an example. – Calculate the molar masses of various substances and weigh out 1 mole of each. – Perform calculations involving empirical and molecular formulae. – Apply the gas laws to calculate the volume, temperature and pressure of gases,	– Develop a teamwork approach in research, group activities and exercises. – Respect procedures while performing experiments. – Appreciate the work done by different personalities in the formulation of gas laws e.g. Gay-Lussac, Charles, Boyle, and Graham.	– Avogadro number and the mole concept. – Calculation of the number of moles. – Definition of relative atomic mass. – Definition and calculation of relative molecular mass. – Definition and calculation of relative formula mass. – Calculation of molar mass. – Relationship between numbers of moles, mass and molar mass. – Calculation of mass percentage composition of an element in a	– In groups, discuss the concept of moles as a way of expressing the amount of substance and make a presentation. – Carry out an experiment of burning magnesium ribbon in air in order to determine the percent composition of magnesium in magnesium oxide, and write a report of the findings. – Do examples and exercises of calculations on: ○ Empirical formula given the percentage composition by mass. ○ Molecular formula given the empirical formulas and the relative

	and molecular weight of gases.		compound. – Empirical and molecular formulae. – Stoichiometric calculations. – Limiting reactants. – Gas laws (Gay-Lussac, Charles' law, Boyle's law and the ideal gas law, Grahams' law of diffusion) and perform simple calculations on gas laws. – Calculation of molar gas volume under standard conditions.	molecular masses ○ The calculation of limiting reactants using stoichiometric equations and molar gas volumes.
Links to other subjects: *Mathematics: number operations and units. Physics: gas laws and measurements.*				
Assessment criteria: *Learners can determine the composition of compounds by mass, volume and number of moles.*				
Materials: *Computers.*				

TOPIC AREA: CHEMICAL REACTION		**SUB-TOPIC AREA: OXYGEN AND OXIDES**
S2 Chemistry	**Unit 8:** Preparation and classification of oxides.	**Number of periods:** 18
Key unit competency: To be able to prepare oxides and classify them based on their properties.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Categorise different oxides. – Explain how different oxides are formed. – State the uses of different oxides. – Describe the reaction of oxides with other substances. – Describe the process of producing slaked lime.	– Experimentally prepare different oxides from elements and compounds – Test the properties of oxides prepared in the laboratory. – Classify oxides into alkaline, acidic, amphoteric and neutral.	– Develop a team approach and a sense of responsibility in group activities. – Respect for the procedures while performing experiments. – Care about harmful oxides like sulphur dioxide and nitrogen dioxide, during experiments	– Preparation of oxides from: o Direct combination of an element with oxygen. o Thermal decomposition of hydroxides, carbonates and nitrates. – Reactions of oxides with water, acids and bases – Classification of oxides as acidic, basic, neutral and amphoteric oxides. – Uses and production of slaked lime (ishwagara).	– Carry out an experiment to show the products obtained from the reaction of oxygen with non-metals and metal, thermal decomposition of hydroxides, carbonates, and nitrates. Report on the findings. – Using a table, discuss the classification of oxides as alkaline, amphoteric, acidic, and neutral. – Carry out the experiments to show the properties of oxides.

Links to other subjects: *Geography: rocks. Biology: respiration. Agriculture: change of soil pH.*
Assessment criteria: *Can prepare and classify oxides based on their properties.*
Materials/equipment: *Appropriate chemicals and apparatus, computers, and projectors.*

TOPIC AREA: CHEMICAL REACTIONS		**SUB-TOPIC AREA: ELECTROLYSIS**
S2 Chemistry	**Unit 9:** Electrolytes and non- electrolytes.	**Number of periods:** 8

Key unit competency: To be able to distinguish between non-electrolytes, weak electrolytes and strong electrolytes.

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define an electrolyte and a non-electrolyte. – Give examples of weak and strong electrolytes and non-electrolytes. – State applications of electrolytes in daily life.	– Carry out experiment to distinguish between electrolytes and non-electrolytes. – Carry out experiments to classify solutions as strong electrolytes, weak electrolytes or non-electrolytes.	– Develop an awareness of safety issues when carrying out experiments. – Appreciate the importance of electrolytes in daily life like sulphuric acid in a car battery.	– Definition of electrolyte and non-electrolyte. – Definition of electrolysis. – Strong and weak electrolyte and examples (e.g. mineral acids and organic acids respectively). – Conductivity of electricity by electrolytes. – Applications of electrolytes in daily life e.g. Leclanché cell (dry cell) and car batteries.	– Carry out experiments to classify solutions as strong electrolytes, weak electrolytes or non- electrolytes using ethanoic acid, hydrochloric acid, and sugar solution. Report on the findings. – Carry out experiments to distinguish between electrolytes and non-electrolytes using sugar solution and hydrochloric acid solution. Make an appropriate report. – Research and make presentations about the applications of electrolytes in daily life.

Links to other subjects: *Physics electricity.*

Assessment criteria: *Can distinguish and give examples of non-electrolytes, weak electrolytes and strong electrolytes.*

Materials/equipment: *Appropriate chemicals and apparatus, computer, and projector*

TOPIC AREA: ORGANIC CHEMISTRY			SUB-TOPIC AREA: INTRODUCTION TO ORGANIC CHEMISTRY	
S2 Chemistry	**Unit 10:** Properties of organic compounds and uses of alkanes.			**Number of periods:** 18
Key unit competency: To be able to compare the properties of organic and inorganic compounds and explain the uses of alkanes in daily life.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Identify organic compounds and their origin. – Describe the physical and chemical properties of alkanes (methane). – State the uses of methane and some other alkanes. – Explain structural isomerism.	– Use simple experiments to classify compounds into organic and inorganic. – Prepare methane gas in the laboratory. – Apply IUPAC rules to the nomenclature of alkanes.	– Develop a team approach and sense of responsibility in group discussions and experiments. – Appreciate the economic importance of alkanes in daily life such as fuels.	– Definition of organic chemistry. – Differences between organic and inorganic chemistry. – Occurrence of organic compounds. – Homologous series. – General formulae and nomenclature of alkanes (from C_1-C_{10}). – Structural isomerism up to C_4. – Physical properties of alkanes. – Chemical properties (reaction with halogens, combustion and thermal cracking). – Laboratory preparation of methane. – Uses of alkanes (methane) in daily activities.	– Carry out experiments to distinguish organic from inorganic compounds in terms of flammability, volatility and in water. Report your observations. – Perform exercises naming alkanes from C_1-C_{10} according to IUPAC. – Discuss the physical and chemical properties of alkanes include the use of alkanes as a source of heat energy in Rwanda. – Carry out research and make a presentation on how methane gas is naturally formed. (A field visit may be necessary to a biogas plant). – Carry out an experiment to prepare methane in the laboratory.
Links to other subjects:				

Assessment criteria: *Can compare the properties of organic and inorganic compounds and state the uses of alkanes in daily life. Can name alkanes using IUPAC rules and draw their structures.*
Materials/equipment: *Appropriate chemicals and apparatus, computer, and projector.*

5.4 Senior three

5.4.1. Key competencies at the end of senior three

- Determine the concentration of solutions from data obtained by simple acid- base titration.
- Relate the properties of carbon, nitrogen, sulphur, chlorine and their compounds to their uses. Show how some of their compounds are prepared.
- Show the environmental impact of industrial preparation of some compounds of carbon, nitrogen, sulphur and chlorine.
- Examine the effect of different conditions in relation to the speed of reactions.
- Prepare acids and bases and react them with other substances.
- Perform electrolysis of different electrolytes and explain their real- life applications.
- Relate the properties of alkenes and alcohols to their functional groups.
- Explain properties of carboxylic acids and relate artificial polymers to products e.g. crude oil.

5.4.2. Senior three units

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: PERIODIC TABLE**
S3 Chemistry	**Unit 1:** Carbon and its inorganic compounds.	**Number of periods:** 15
Key unit competency: To be able to relate the properties of carbon and its compounds to its uses. Describe how some of its compounds are prepared.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Name the allotropic forms of carbon and relate its properties to its uses. – Explain the properties of carbon and its compounds. – Explain the impact of carbon compounds on the environment.	– Prepare, collect and test for CO2. – Prepare, collect and test the carbonates of different metals.	– Appreciate the importance of natural resources. – Develop self-confidence during presentations. – Develop a culture of working together in groups.	– Define allotropy. – Allotropic forms of carbon and their physical properties. – Uses of allotropes of carbon. – Chemical properties of carbon: reaction with oxygen, carbon dioxide, iron(III) oxide, concentrated nitric acid, and concentrated sulphuric acid. – Compounds of carbon: carbon oxides, carbonates and hydrogen carbonates. – Properties, preparation, and testing for carbon dioxide, carbonates and hydrogen carbonates and their uses	– With the help of examples, discuss in groups the concept of allotropes e.g. graphite from dry cells, charcoal, and soot. Deliver a presentation. – Discuss the properties and uses of carbon as a source of fuel (burning charcoal in air) and carbon (coke) in extraction of iron. – Carry out experiments to prepare carbon dioxide through the reaction of dilute hydrochloric acid and a carbonate (emphasise the test of carbon dioxide). Write a report. – Carry out experiment to prepare

– Explain the carbon cycle and relate it to food chains. – Explain the causes of hard water.			– Environmental issues of carbon monoxide and carbon dioxide. – Hard water: soft and hard water, types of hardness of water, and softening hard water. – Advantages and disadvantages of hard water. – The carbon cycle.	one or two carbonates e.g. calcium carbonate, magnesium carbonate, lead carbonate or zinc carbonate. – Research and present on the uses of carbon compounds (e.g. carbon dioxide in fire extinguishers, or calcium carbonate in manufacture of cement) and their environmental issues (e.g. toxicity of carbon monoxide, greenhouse effect and global warming by carbon dioxide). – Research and make presentations on the causes, types and uses of hard water.
Links to other subjects: *Biology: respiration, photosynthesis, and ecology. Geography: physical geography.*				
Assessment criteria: *Can relate the properties of carbon and its compounds to its uses and show how some of its compounds are prepared.*				
Materials: *Computer, projector, source of heat, charcoal and other appropriate chemicals and apparatus.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: PERIODIC TABLE**
S3 Chemistry	**Unit 2:** Nitrogen and its inorganic compounds.	**Number of periods:** 15

Key unit competency: To be able to relate the properties of nitrogen and its compounds to their uses. Describe how some of compounds of nitrogen are prepared and discuss the related environmental issues.

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe the physical and chemical properties of nitrogen and its uses. – Describe the impact of nitrogen compounds on the environment. – Describe the industrial preparation of nitric acid. – State the uses of nitric acid,	– Interpret the effect of ammonia solution on different cations. – Develop observation skills during the experiments on the addition of ammonia solution on different cations. – Prepare and collect ammonia gas.	– Protect natural resources. – Develop self-confidence during presentations. – Develop a culture of working in a team. – Respect of the procedures in all experiments. – Appreciate the dangers caused by nitrogen compounds to the	– Industrial isolation of nitrogen. – Properties and uses of nitrogen. – Preparation, uses and properties of nitrogen compounds: nitrogen dioxide, ammonia, nitric acid and nitrates. – Reaction of ammonia with acids (nitric acid, sulphuric acid, hydrochloric acid), with oxygen – Reaction of nitric acid with metals, bases, non-metals. – Tests for ammonia and nitrates. – Environmental issues with nitrogen dioxide and nitrate fertilisers.	– In groups, discuss the industrial isolation of nitrogen gas (fractional distillation of liquid air) and make a presentation. – In groups carry out an experiment to prepare ammonia gas in the laboratory, test it and write a report. – Research in groups: discuss the industrial preparation of ammonia (Haber process) and nitric acid and make a presentation. – Research and make a presentation about the uses of compounds of nitrogen.

ammonia and some nitrates.	– Research skills in relation to the protection of the environment.	environment.		
Links to other subjects: *Biology: ecology. Geography: relationship between people and the environment.*				
Assessment criteria: *Can relate the properties of nitrogen and its compounds to their uses. State how some of its compounds are prepared and discuss related environmental issues.*				
Materials: *Flow charts, computer, projector, source of heat and other appropriate chemicals/apparatus.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		SUB-TOPIC AREA: PERIODIC TABLE
S3 Chemistry	**Unit 3:** Sulphur and its inorganic compounds.	**Number of periods:** 15

Key unit competency: To be able to relate the properties of sulphur and its compounds to their uses. Describe how its compounds are prepared and discuss related environmental issues.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall the occurrence, extraction, properties and uses of sulphur. – Explain the impact of sulphur oxides on the environment. – Describe the preparation of sulphuric acid (contact process). – State the properties and uses of	– Develop skills in observation in preparing sulphur dioxide gas and testing for the presence of sulphates and sulphites. – Prepare, test and collect sulphur dioxide gas. – Test for the presence of sulphates and sulphites in given solutions.	– Protect natural resources. – Develop self-confidence in discussions and presentation of research findings. – Develop a culture of working in a team during research and discussions. – Respect of procedures during experiments.	– Occurrence, extraction, properties and uses of sulphur (medicines, matches, vulcanization of rubber, manufacture of sulphuric acid). – Laboratory preparation of sulphur dioxide, chemical reactions with the water bleaching action of sulphur dioxide and alkalis and their uses. – Preparation of sulphuric acid, sulphates). Properties of concentrated and diluted sulphuric acid and their uses. – Reaction of sulphuric acid with metals and bases. – Tests for sulphates, sulphites and sulphur dioxide. – Environmental issues related to	– Research and discuss the extraction of sulphur and its uses. Make a presentation. Focus on sulphur obtained as a byproduct of crude oil refining and metal sulphide ore refining. – Carry out experiments to prepare sulphur dioxide in the laboratory and make appropriate presentations of results. – Research and make presentations on the industrial preparation of sulphuric acid (contact process). – Carry out an experiment to show the dehydration of sugar, pieces of fabric, paper, wood, hydrated copper(II) sulphate by concentrated sulphuric acid. Write

sulphuric acid and sulphur compounds e.g. sulphur dioxide.			sulphur oxides.	a report. – Carry out experiments to show the reaction of sulphuric acid with metals (magnesium and copper). Write an appropriate report. – Research and deliver presentations on the uses of sulphur and its compounds (e.g. sulphuric acid in car batteries, the manufacture of fertilisers, explosives, etc.) and the associated environmental issues (e.g. acid rain by sulphur oxides). – Carry out an experiment to verify the presence of sulphur dioxide, sulphites and sulphates in a given solution. Write an appropriate report. – In groups, research and discuss the environmental effects of sulphur oxides and deliver a presentation.
Links to other subjects: *Biology: ecology. Geography: relationship between people and the environment.*				
Assessment criteria: *Can relate the properties of sulphur and its compounds to their uses. Can state how its compounds are prepared and explain related environmental issues.*				
Materials: *Flow charts, computer, and projector.*				

TOPIC AREA: ATOMIC STRUCTURE AND THE PERIODIC TABLE		**SUB-TOPIC AREA: PERIODIC TABLE**
S3 Chemistry	**Unit 4:** Chlorine and its inorganic compounds.	**Number of periods:** 15

Key unit competency: To be able to relate the properties of chlorine and its compounds to its uses. Describe how its compounds are prepared and discuss related environmental issues.

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe the physical properties of chlorine and its compounds. – Describe the chemical properties of chlorine and its compounds. – Recall the preparation of chlorine gas. – Describe the toxicity of chlorine and its impact on the	– Observe the colour formed in the preparation of chlorine. – Research skills in the protection of the environment. – Prepare chlorine in the laboratory. – Test chlorine in the laboratory. – Prepare hydrogen	– Protect natural resources. – Develop self-confidence in the presentation of research, work and group discussions. – Develop a culture of working in groups – Appreciate the impacts of CFCs on the environment.	**Chlorine:** – Preparation and test for chlorine. – Physical properties of chlorine. – Chemical properties of chlorine with: metals, hydrogen, water, and strong alkalis. – Uses of chlorine: water treatment, making bleaches, and manufacture of hydrochloric acid. **Chlorine compounds (sodium chloride, hydrogen chloride):** – Preparation and properties of hydrogen chloride gas and sodium chloride. – Reaction of hydrochloric acid with metals, bases, manganese(IV) oxide, and carbonates.	– Carry out experiments on the preparation of chlorine through a reaction between concentrated hydrochloric acid and manganese(IV) oxide or potassium manganite(IV). Test for chlorine gas produced and make a report (emphasis on the bleaching properties of chlorine). – Carry out an experiment to prepare hydrogen chloride from concentrated sulphuric acid and sodium chloride. Write an appropriate report. – Carry out an experiment to test for hydrogen chloride gas in the laboratory and write a scientific

environment.	chloride in the laboratory. – Test for the presence of chlorides and other halides in solutions.	– Respect for the procedures in experiments.	– Uses of hydrochloric acid and sodium chloride. **Environmental issues of chlorine and its compounds (CFCs, and toxicity of chlorine gas).**	report. – Carry out an experiment to show how hydrochloric acid reacts with metals like magnesium, zinc, etc. – Research and make presentations on the uses of chlorine and its compounds (e.g. sodium chloride, hydrochloric acid, hypochlorites and chlorates) and environmental issues (e.g. CFCs). – Carry out chemical tests for chloride and other halide ions (bromides and iodides) and write a report.
Links to other subjects: *Geography: relationship between people and the environment: Biology: digestion.*				
Assessment criteria: *Can relate the properties of chlorine and its compounds to its uses. Show how its compounds are prepared and the related environmental issues.*				
Materials: *Computer, projector and other appropriate chemicals/apparatus.*				

TOPIC AREA: CHEMICAL REACTIONS		SUB-TOPIC AREA: TYPES OF REACTIONS		
S3 Chemistry	**Unit 5:** Rate of reactions.			**Number of periods:** 12
Key unit competency: To be able to describe and explain the effect of different conditions on the speed of reactions.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define the rate of a reaction. – Describe the effects of different conditions on the speed of reactions.	– Observation skills in experiments that involve changes of colour. – Research and scientific reporting skills. – Interpret mass against time graphs for different reactions.	– Develop a culture of working in a team during discussions and research. – Appreciate that reactions in everyday life like burning and rusting happen at different rates. – Respect for the procedures in an experiment.	**Reaction rate/speed of reaction.** **Effect of different conditions on the speed of reaction:** – Temperature. – Concentration. – Pressure. – Catalysts. – Particle size. – Light.	– Perform an experiment to verify the effect of: o Temperature. o Catalyst (e.g. decomposition of hydrogen peroxide using manganese(IV) oxide). o Concentration (e.g. reaction between dilute hydrochloric acid and sodium thiosulphate solution to produce a yellow precipitate of sulphur). o Particle size (e.g. different forms of calcium carbonate + diluted hydrochloric acid). o Light on the speed of reaction (e.g. decomposition of silver bromide or silver chloride by light) o Write an appropriate report after each experiment.

Links to other subjects: *Biology: enzymes, photosynthesis.*
Assessment criteria: *Can describe and explain the effect of different conditions on the speed of reactions.*
Materials/ equipment: *Appropriate laboratory apparatus and chemicals.*

TOPIC AREA : CHEMICAL REACTIONS		SUB-TOPIC AREA: ACID, BASES AND SALTS
S3 Chemistry	**Unit 6:** Chemical properties of acids and bases.	**Number of periods:** 8

Key unit competency: To be able to prepare and carry out reactions of acids and bases with other substances.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe the chemical properties of acids and bases.	– Observation skills in experiments that involve changes of colour or evolution of gases. – Develop scientific reporting skills. – Prepare and handle acids and bases. – Predict the products of the reactions of acids and bases with other substances.	– Develop a culture of working in a team. – Develop orderliness especially when performing experiments. – Appreciate the potential dangers associated with strong acids and bases. – Appreciate the uses of acids on biological processes especially in	– Preparation of acids and bases from: o Displacing a volatile acid by a less volatile one (e.g. concentrated sulphuric acid and sodium chloride). o Addition of water to soluble metal oxide. – Reactions of acids and bases with: metals, metal oxides, carbonates and hydrogencarbonates – Reactions of acids and metal hydroxides (neutralisation). – Uses and dangers of acids and bases.	– Perform an experiment to show: o The reaction between concentrated sulphuric acid and sodium chloride. o The reaction between water and a metal e.g. sodium + water (test the gas produced is hydrogen). – Perform experiments to show the reaction of: o Diluted hydrochloric acid/sulphuric acid with magnesium metal. o Diluted hydrochloric acid and calcium carbonate and sodium hydrogencarbonate or any other carbonate. o Diluted hydrochloric acid/sulphuric acid with any metal oxide (e.g. magnesium oxide).

		digestion of proteins in human beings and other species. – Appreciate the uses of a base in balancing the pH of soil.		– Write a report. – Perform experiment to show a neutralisation reaction.
Links to other subjects: *Biology: digestion, transport of blood, proteins: Agriculture: determining acidity and alkalinity of soil.*				
Assessment criteria: *Can prepare and carry out reactions of acids and bases with other substances.*				
Materials/ equipment:				

TOPIC AREA: CHEMICAL REACTIONS	**SUB-TOPIC AREA: STOICHIOMETRY**	
S3 Chemistry	**Unit 7:** Concentration of solutions.	**Number of periods:** 15
Key unit competency: To be able to determine the concentrations of solutions from data obtained by simple acid-base titration.		

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the difference between end point and equivalence point. – Describe the process of titration.	– Carry out experiments in groups to prepare solutions of different concentrations. – Perform simple acid-base titrations. – Use data obtained from the titration of an acid and base to calculate the concentration of either acid or base.	– Develop a culture of working in a team. – Develop self-confidence during presentations and discussion in groups. – Appreciate the importance of accuracy in measurement. – Appreciate the importance of repeating procedures to obtain more accurate results.	– Concept of concentration. o Molarity. o Mass concentration. – Preparation of solutions. – Define end points and equivalence points. – Simple acid-base titration and procedures between sodium hydroxide and hydrochloric acid, and sodium carbonate and hydrochloric acid.	– Calculations in groups on number of moles, molarity and concentration in grams per litre and vice versa as well as volume and mass. – Carry out experiments in groups to prepare solutions of different concentrations e.g. o Oral rehydration salts (ORS). o Sodium hydroxide, sodium carbonate, and sodium chloride. o Write a report. – Carry out experiments on titrations e.g. hydrochloric acid by sodium hydroxide or the inverse. Make a report.

Links to other subjects: *Medicine: preparing ORS.*
Assessment criteria: *Can determine the concentrations of solutions from data obtained by simple acid-base titration.*
Materials:

TOPIC AREA: CHEMICAL REACTIONS		**SUB-TOPIC AREA: ELECTROLYSIS**
S3 Chemistry	**Unit 8:** Electrolysis and its applications.	**Number of periods:** 18

Key unit competency: To be able to examine and explain the electrolysis of different electrolytes and state their application in daily life.

Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the concept of electrolysis (ionic theory by Arrhenius 1880). – Describe the formation of gases and metals on cathode and anode electrodes. – Explain the applications of electrolysis. – Give products of electrolysis for different solutions or molten salts	– Predict the products of the electrolysis of: molten lead bromide, concentrated sodium chloride (brine), molten sodium chloride, and electrolysis of water (dilute sulphuric acid). – Carry out an experiment to investigate the electrolysis of copper(II) sulphate solution. – Write balanced	– Develop a culture of working in a team. – Develop orderliness especially during experiments and presentations. – Respect for the procedures of an experiment. – Appreciate the importance of electrolysis in daily life. – Develop self-confidence in handling	**Oxidation-reduction reactions in terms of:** – Loss and gain of electrons. – Addition of oxygen and removal of hydrogen (reduction as addition of hydrogen and removal of oxygen). – Increase and decrease of oxidation numbers. **Oxidising and reducing agents.** **Definition of: electrolysis, electrodes; cathode and anode.** **Electrolysis of:** – Molten lead bromide. – Water. – Molten sodium chloride. – Diluted and concentrated sodium chloride solution. – Copper (II) sulphate using platinum electrodes and copper electrodes.	– In groups perform exercises to write balanced equations to represent oxidation and reduction reactions and exchange work sheets for marking. – Carry out an experiment to investigate the electrolysis of: o Water/diluted sulphuric acid o Molten lead bromide o Concentrated sodium chloride solution o Diluted sodium chloride solution. o Copper (II) sulphate using platinum/graphite electrodes and again using copper electrodes. o Write an appropriate report every after experiment above. – Perform an experiment to electro-plate a silver coin using copper(II)

(e.g. molten sodium chloride, concentrated sodium chloride solution, copper sulphate solution using platinum electrodes and using copper electrodes.).	equations to represent reactions that take place at each electrode during electrolysis. – Write balanced redox equations in terms of loss of oxygen or gain of hydrogen and vice-versa. – Loss and gain of electrons. – Perform an experiment to electro-plate a silver coin using copper(II) sulphate/nitrate solution.	electrical apparatus/ chemicals.	**Applications of electrolysis e.g.** – Electro-plating. – Extraction of some metals such as reactive metals from molten solutions e.g. aluminium. – Manufacture of some gases such as oxygen, hydrogen, chlorine and manufacture of sodium hydroxide.	sulphate/nitrate solution. – In groups, write equations to represent the reactions that take place at electrodes. – In groups, research and make presentations on the applications of electrolysis.
Links to other subjects: *Physics: Electricity.*				
Assessment criteria: *Can examine the electrolysis of different electrolytes.*				
Materials/ equipment:				

TOPIC AREA: ORGANIC CHEMISTRY		SUB-TOPIC AREA: INTRODUCTION TO ORGANIC CHEMISTRY
S3 Chemistry	**Unit 9:** Structure and properties of alkenes and alcohols.	**Number of periods:** 15
Key unit competency: To be able to relate the properties of alkenes and alcohols to their functional groups.		

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Describe the structures of alkenes, alcohols and their physical properties. – Name alkenes and alcohols using the IUPAC system of naming - up to C5. – State the chemical properties of alkenes and alcohols. – Describe the uses and misuse of	– Observation skills in testing for alkenes with bromine water that involves a change of colour. – Prepare alcohol by a fermentation process. – Draw the structure of alkenes and alcohols. – Carry out an experiment to confirm the presence of alkenes.	– Develop a culture of working in a team during discussions and experiments. – Develop orderliness in work to present results. – Respect for the procedures in an experiment. – Appreciate the social effects of the misuse alcohols. – Develop self-confidence in the	**Alkenes** – Structure of alkenes and nomenclature. – Sources of alkenes from dehydration of alcohols and cracking of higher alkanes. – Physical properties of alkenes. – Chemical properties of alkenes e.g. o Reaction with hydrogen. o Chlorine. o Bromine. o Hydrogen chloride. o Water. – Uses of alkenes. **Alcohols** – Name some alcohols up to carbon - 5. – Physical properties of alcohols. – Sources of alcohols (e.g. laboratory preparation from hydration of	– In groups write the structures and names of some alkenes up to carbon-5, exchange work sheets for marking. – In groups, discuss the sources (e.g. reaction with water and cracking of higher hydrocarbons), physical properties and existence of structural isomerism in alkenes. Make a presentation. – Carry out an experiment to confirm the presence of alkenes using bromine water, acidified potassium manganate(VII) or potassium dichromate solution. – In groups discuss the uses and chemical properties of alkenes and make a presentation. – In groups write and name alcohols up to carbon-6, exchange Carry out

alcohols and alkenes in daily life. – Describe the fermentation process. – Describe the hydration of alkenes as a method of preparing alcohols. – State the uses of alcohols as sources of fuel.		presentation of research work and discussions.	alkenes and fermentation on a large scale). – Chemical properties of alcohols (e.g. combustion, oxidation, reaction with concentrated H_2SO_4, reaction with carboxylic acids, reaction with alkali metals, and reaction with NaOH) – Uses and misuse of alcohols.	an experiment on fermentation of alcohols and the reaction with sodium metal. Present the results appropriately. – In groups research and discuss the sources, uses and misuse, physical and chemical properties of alcohols and make a presentation.
Links to other subjects: *Biology: chemicals of life.*				
Assessment criteria: *Can relate the properties of alkenes and alcohols to their functional groups.*				
Materials/ equipment:				

TOPIC AREA: ORGANIC CHEMISTRY		SUB-TOPIC AREA: INTRODUCTION TO ORGANIC CHEMISTRY
S3 Chemistry	**Unit 10:** Carboxylic acids.	**Number of periods:** 6

Key unit competency: To be able to explain the properties of carboxylic acids.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define a carboxylic acid. – Name and write the structures of some carboxylic acids up to C5. – Explain the preparation of carboxylic acids from oxidation of alcohols. – State the physical properties of some carboxylic acids. – Explain the chemical reactions of	– Observation skills. – Manipulation of equipment. – Research and presentation skills. – Write the structures of different carboxylic acids and equations. – Carry out experiments to show how carboxylic acids react with other substances.	– Develop culture of entrepreneurship. – Develop a culture of working in a team. – Develop orderliness in presentations and experiments. – Respect for the procedures of an experiment.	– Definition of a carboxylic acid – Naming and writing structure formulae of carboxylic acids up to carbon-5 using the general equation ($C_nH_{2n+1}COOH$). – Preparation of carboxylic acids by oxidation of alcohols. – Physical properties of carboxylic acids. – Chemical properties of carboxylic acids e.g. reaction with sodium hydroxide, reaction with sodium metal, reaction with alcohols, reaction with sodium carbonate). – Reduction of carboxylic acids to alcohols.	– Do exercise to write and name carboxylic acids up to carbon -5. – Carry out experiment to show how carboxylic acids react with sodium carbonate, sodium hydroxide (saponification), reaction with alcohols (esterification), and sodium metal. Present results appropriately. – Visit to production unit of soap / soap manufacturing industry and make appropriate report.

carboxylic acids. – Explain the reduction of carboxylic acids as a method of preparing alcohols on small scale.				
Links to other subjects: *Biology: chemicals of life.*				
Assessment criteria*: Can explain properties of carboxylic acids.*				
Materials/ equipment: *Heating mantle.*				

TOPIC AREA: ORGANIC CHEMISTRY		SUB-TOPIC AREA: INTRODUCTION TO ORGANIC CHEMISTRY
S3 Chemistry	**Unit 11:** Petroleum products and polymerisation.	**Number of periods:** 10

Key unit competency: To be able to explain the origin of petroleum products and application of polymers.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– State the origin of crude oil. – Describe the process of fractional distillation of crude oil. – Define polymerisation and give examples of synthetic and natural polymers. – Describe uses of polymers in daily life.	– Observation skills. – Manipulation of equipment. – Research and presentation skills. – Classify polymers as natural or synthetic polymers.	– Develop culture of entrepreneurship. – Develop a culture of working in a team. – Develop orderliness in presentation and experiment. – Respect for the procedures of an experiment. – Appreciate the uses and dangers associated with polymers in daily life – Develop Self-confidence in presentations and discussions.	– Origin of crude oil. – Production of petroleum products by fractional distillation of crude oil and their uses. – Definition of polymerisation and identification of types as synthetic or natural polymers. – Examples of natural and synthetic polymers (starch, glycogen, proteins, cellulose and polythene, polypropene, polyester, and PVC). – Use of polymers in daily life. – Dangers associated with polymers and hydrocarbons to the environment.	– In groups, research and discuss the origin of crude oil and make a report. – In groups, discuss the process of fractional distillation of crude oil and the uses of the products. Present the results. – Field visit to any nearby plastic industry, or to the methane gas production at Lake Kivu and write a field report. – Hold a group discussion on polymerisation and classify polymers as synthetic or natural and deliver a presentation. – Hold a group discussion about the uses and dangers associated with polymers and hydrocarbons to the environment and a deliver a presentation.

		– Appreciate the uses of petroleum products as sources of raw materials for the chemical industry.		
Links to other subjects: *Geography: environment. General studies: environment.*				
***Assessment criteria**: Can explain the origin of petroleum products and the application of polymers.*				
Materials/ equipment:				

6. REFERENCES

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7. APPENDICES

Lower Secondary Subjects and weekly time allocation

Core subjects	**Weight (%)**	**Number of Periods (1 period = 40 min.)**		
		S1	S2	S3
1. English	11	5	5	5
2. Kinyarwanda	7	3	3	3
3. Mathematics	13	6	6	6
4. Physics	9	4	4	4
5. Chemistry	9	4	4	4
6. Biology and Health Sciences	9	4	4	4
7. ICT	4	2	2	2
8. History and Citizenship	7	3	3	3
9. Geography and Environment	7	3	3	3
10. Entrepreneurship	4	2	2	2
11. French	4	2	2	2
12. Kiswahili	4	2	2	2

13. Literature in English	2	1	1	1
Sub Total		**41 periods**	**41 periods**	**41 periods**
II. Elective subjects: Schools can choose 1 subject				
Religion and Ethics	4	2	2	2
Music, Dance and Drama	4	2	2	2
Fine arts and Crafts	4	2	2	2
Home Sciences	4	2	2	2
Farming (Agriculture and Animal husbandry)	4	2	2	2
III. Co-curricular activities (Compulsory)				
Physical Education and Sports	2	1	1	1
Library and Clubs	2	1	1	1
Total number of periods per week	**100**	**45**	**45**	**45**
Total number of contact hours per week		**30**	**30**	**30**
Total number of hours per year (39 weeks)		**1170**	**1170**	**1170**