REPUBLIC OF RWANDA

MINISTRY OF EDUCATION

CHEMISTRY SYLLABUS FOR TTCs

OPTIONS: SCIENCE AND MATHEMATICS EDUCATION (SME)

Kigali, January 2019

REPUBLIC OF RWANDA

MINISTRY OF EDUCATION

CHEMISTRY SYLLABUS FOR TTCs

Option: Science and Mathematics Education (SME)

Year 2 & 3

Kigali, 2019

FOREWORD

Rwanda Education Board is honored to avail the Chemistry Syllabus for Teacher Training Colleges (TTCs). This document serves as official guide to competence-based teaching and learning of Chemistry in TTCs. The document ensures consistency and coherence in the delivery of quality education in TTCs, Pre-primary and Primary education.

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

The ambition to develop a knowledge based society and the growth of regional and global competition in the labour market, has necessitated the shift from knowledge to competence based curriculum in TTCs. The TTC curriculum was revised to align it to the competence based curriculum for basic education to prepare teachers who are competent and confident to implement CBC in pre-primary and primary education. The rationale for the changes in the curriculum is to ensure that TTC leavers are qualified for job opportunities and further studies in Higher Education in different programs under education career advancement.

I wish to sincerely express my appreciation to the people who contributed towards the development of this syllabus, particularly, Consultants, REB staff, UR-CE Lecturers, TTC Tutors, Teachers from general education and experts from Local and International Organizations for their technical support. A word of gratitude goes to the Head Teachers and TTC principals who availed their staff for various revision activities.

Special appreciation goes to the Development Partners such as UNICEF, USAID/Soma Umenye, Save the Children and Right To Play for their financial support.

Dr. NDAYAMBAJE Irénée,
Director General REB.

ACKNOWLEDGEMENT

I wish to sincerely express my special appreciation to the people who played a major role in development of Chemistry syllabus. It would not have been successful without the support from different education stakeholders. My thanks first go to the leadership of UR-CE who started the review of the TTC curriculum in 2015.

I wish also to thank Rwanda Education Board (REB) leadership who took over and supervised the curriculum review process. I wish to extend my appreciation to Consultants, REB staff, Lecturers from UR-CE, TTC principals, TTC Directors of Studies, Deputy Principals, Tutors and Teachers from secondary general education and whose efforts during the revision process were much valuable.

I owe gratitude to different Education Partners more especially UNICEF, USAID/Soma Umenye, which funded TTC curriculum revision, Flemish Association for Development Cooperation and Technical Assistance (VVOB), Right to Play, Help a Child, Save the Children, Aegis Trust, Humanity and Inclusion, Teach Rwanda, Educate! and IEE for their technical support.

Joan Murungi,

Head of Curriculum, Teaching and Learning Resources Department (CTLRD)

TABLE OF CONTENT

1. GENERAL INTRODUCTION

1.1 Rwanda Education Sector Objectives

The Education Sector objectives are the reference point for the inclusion of education issues into other Rwandan policy documents. These objectives are aligned with those recommended in the Eastern African Curriculum Framework proposals. The Government of Rwanda through law number 36/2018 of 29th June, 2018, determining the organization of education, revised the objectives of the sector. They are to:

1. Provide Rwandans with adequate skills at all levels of general education, professional as well as technical and vocational education;
2. Offer quality courses and education at all levels;
3. Promote science, technology and research in order to equip many Rwandans with capacity to speed up national development;
4. Promote the culture of peace, tolerance, justice, respect for human rights, solidarity, democracy and that of avoiding any form of discrimination or favouritism;
5. Provide each Rwandan with an integrated education based on ethical values, science and social welfare and directed towards building a nation to ensure its sustainable development.
6. Instil into Rwandans the love of a job well done, the value of hard work, punctuality and promotion of competence.
7. Train the Rwandan to have freedom of thought, be innovative, have abilities to acquire and be analytical towards other people's opinions and to communicate his or her own ideas, to be patriotic and encourage him or her to be updated on the situation prevailing elsewhere;
8. Eliminate all grounds and obstacles that hinder the development of girls and women education as well as of any other groups that need special attention.

These objectives and associated strategies are the backbone for developments in education including the curriculum and assessment policy and the curriculum framework.

1.2. Level Competences of Primary Teacher Education in the Republic of Rwanda

As stated earlier, Primary Teacher Education is under the responsibility of Rwanda Education Board. The following are the competences of Teacher Education. By the time a student teacher is exiting the college after three years he or she should:

- be a qualified teacher who can compete not only locally but regionally and internationally;
- have professional ethics and develop an inquiring mind for innovative education;
- be prepared adequately for efficiency in education, administration, management, evaluation and measurement;
- be competent, reliable, honest and responsible;
- be equipped with potentials that enable him/her to explore the learners' abilities and interests;
- be able to develop the child's ability in critical thinking, free expression and ideas.

1.3. Background to Curriculum Review

The Chemistry syllabus is developed for TTC student teachers in the option of Science and Mathematics Education.

The motive of reviewing the syllabus was to ensure that the syllabus is responsive to the needs of the student teacher and to shift from objective and knowledge based learning to competence based learning. Another reason was to align the TTC curriculum to the CBC in general education. Emphasis in the review was put more on skills and competences as well as the coherence within the existing content by drawing on the previous syllabus and benchmarking with syllabi elsewhere with best practices.

The Chemistry syllabus guides the interaction between the tutor and student teachers in the learning processes and highlights the competences a student teacher should acquire during and at the end of each unit of learning. Student teachers will have the opportunity to apply Chemistry in different contexts, and see its importance in daily life. Tutors should help the student teachers appreciate the relevance and benefits for studying Chemistry.

The learning of the student teacher is influenced by many factors such as curriculum relevance, necessary and sufficient pedagogical approach by tutors, assessment strategies and sufficient instructional materials. With review of the Chemistry syllabus, these factors have been aligned with the competence based curriculum for general education. This will lead to having qualified and competent teachers who are ready to implement the competence based curriculum for pre and primary education. This implies equipping student teachers with relevant knowledge, skills, attitude and values necessary to make them competitive on local, regional and global job market. This revised syllabus will allow future teachers to contribute to the development of equity and quality education at pre/primary levels and then it will enable student teachers to go for further studies.

1.4. Rationale of teaching and learning Chemistry

Chemistry, one of the natural science subjects is an important discipline that has contributed significantly to the global socio economic transformation through discoveries on the part of chemists. This has led to new technologies in the production of small scale and industrial products that are beneficial to People and the environment. Chemistry is a worthwhile subject because it prepares students for the real world of work through career path ways like medicine, agriculture, pharmacy, chemical engineering, food science, teaching , environmental studies and many others. It also provides skills that guide the construction of theories, hypotheses and laws that help to explain natural phenomenon and manage People and the environment.

1.4.1. Chemistry and Society

Chemistry plays an important role in society through observation, manipulation, calculation, measurement, classifying, systematic study of matter and its transformation. It is also used in natural sciences, engineering and medicine. It also provides a wide area in many different career opportunities related to sciences. In addition, some crosscutting issues such as environmental sustainability awareness and peace education are incorporated into some of the Chemistry units to improve social and economic welfare of Rwandan society.

Chemistry is a key to the Rwandan education ambition of developing a knowledge based and technology-led economy since it provides to student teachers all required knowledge and skills to be used in different learning areas. Therefore, it is an important subject as it supports other

subjects like Biology and Physics. This TTC Chemistry syllabus is intended to address gaps in the current syllabus which lacks adequate and appropriate knowledge, skills, attitude and values.

1.4.2. Chemistry and Student Teachers

Student teacher needs enough basic chemistry competences to be effective members of Rwandan society including the ability to observe, analyse, interpret data, read the commonly used Chemistry abbreviations (formulae) of different compounds.

Therefore, Chemistry equips student teachers with knowledge, skills and attitudes necessary to enable them to succeed in an era of rapid technological growth and socio-economic development. Mastery of basic Chemistry ideas in observation, calculations, analysing and interpretation of different concepts in Chemistry makes student teachers being confident in problem solving. It enables the student teachers to be systematic, creative and self-confident in using chemistry language and techniques to reason; think critically; develop imagination, initiative and flexibility of mind. In this regard, learning of Chemistry needs to include practical problem solving activities with opportunities for student teachers to plan their own investigations in order to develop their Chemistry competence and confidence.

As new technologies have had a dramatic impact on all subjects of life, wherever possible in Chemistry, student teachers should gain experience of a range of ICT equipment and applications.

1.5. Professional Standards and Competences

1.5.1. Competences

Competence is defined as the ability to perform a particular task successfully, resulting from having gained an appropriate combination of knowledge, skills, attitudes and values. The present syllabus gives the opportunity to student teachers to develop different basic competences as well as the generic competences.

Broad subject competences are highlighted and broken into key competences for each year, these are further broken into key unit competences which are finally split into learning objectives (knowledge, skills, attitudes and values) in every learning unit.

Taking into account the rationale behind the overall TTC curriculum review as well as the parameters and constraints of the local context, student teachers will be equiped with professional standards and generic competences.

For student teachers, professional standards are acquired through generic competences and professional practices that are emphasized and reflected in the learning process. The tutors will ensure that student teachers are exposed to tasks that help them acquire these competences.

1.5.2. Teaching Professional Standards

These refer to the characteristics that all tutors globally should have. All teachers in Rwanda should have the six characteristics listed below:

- **The teacher has knowledge of CBC and how to implement it.**

The tutor has understanding of CBC and how it works. He/she has knowledge of basic and generic competences and is able to integrate the cross cutting issues within and across subject area.

- **The teacher as an educator**

The professional teacher enhances and stimulates cognitive, social-emotional, physical and moral development of the children. She/he therefore has a thorough understanding of the child's background, interests, motivations and problems and can adjust her/his actions and the learning environment to the different needs of the students. A competent educator is a role model, showing desired behaviour and values. She/he guides and coaches the students to become social, self-confident, independent, responsible, open-minded and innovative people. In order to be educator, the student teacher should be *supported to develop* cooperation, inter personal and lifelong learning skills.

- **The teacher as a subject expert**

The professional teacher stimulates the student's critical thinking, problem solving and creativity. She/he uses teaching and learning methods and techniques that are appropriate to pre-primary and primary education; she/he applies relevant content, plan lessons integrating play-based strategies in teaching and learning. The teacher in pre-primary and primary education has a thorough subject knowledge that enables him/her to develop teaching and learning materials and in lesson planning so as to effectively to deliver the lesson and connect with daily life activities in pre-primary and primary education using the language of instruction correctly. The teacher as subject expert in upper primary education stimulates English in the teaching/learning process by considering the transition from Kinyarwanda to English as medium of Instruction in upper primary.

The teacher as subject expert knows and uses appropriate methods/techniques to assess students and give constructive feedback to the whole class. The teacher is able to link the content of his/her subject specialisation with other subjects and connect it with real life situations.

- **The teacher as a communicator**

The professional teacher displays a good example in expressing him/herself, stimulates and enhances positive and clear communication between him/herself and the student teachers, between the students, college community and the wider society. A good communicator is open-minded and respects diversity within and around the college. This requires students to communicate in official languages.

- **The teacher as a guide and an organizer**

The professional teacher facilitates the holistic development of all students, taking into account the differences between them. S/he ensures that the learning environment (class or playground) is well maintained and conducive for expected learning outcomes. This requires the teacher to be equipped with managerial skills.

- **The teacher as an innovator, researcher and reflective practitioner**

The professional teacher looks for ways to improve his/her teaching and the wellbeing and results of the students. S/he is a reflective practitioner and knows how to perform small-scale reflective action.
The acquisition of such skills will require teachers to update knowledge and skills with minimum external support and to cope with evolution of knowledge advances for personal fulfilment in areas that need improvement and development, thus becoming lifelong learners.

1.5.3. Broad chemistry competences

At the end of three years the student teacher should be able to:

- Work in systematic way to develop clear, logical, coherent and creative reasoning and imagination;
- Express clearly, comprehensibly, correctly and precisely in verbal and/or in written form all the reasons and calculations leading to the required result whenever finding a solution to any given exercise;

- Apply chemistry concepts, principles and processes in real life situations/ experiences or problem solving;
- Use ICT tools (such as calculators and chemistry software) in teaching and learning Chemistry in sense of research, curiosity and creativity to explore Chemistry concepts and facts;
- Use the acquired Chemistry knowledge and skills to teach at Primary Education or pursue further studies;
- Describe, explain, present, analyse, interpret, draw logical conclusions and make predictions and decisions on scientific data;
- Apply Chemistry knowledge to other subjects.

1.5.4 Chemistry and Developing Competences

The national policy documents based on national aspirations identify some 'basic competences' alongside the 'generic competences'' that will develop higher order thinking skills and help student teachers learn subject content and promote application of acquired knowledge and skills.

The student teacher will not only develop deductive and inductive skills but also acquire cooperation, communication, critical thinking and problem solving skills. This will be realized when student teachers make presentations leading to inferences and conclusions at the end of learning unit. This will be achieved through group work and cooperative learning which in turn will promote interpersonal relations and teamwork.

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

2. PEDAGOGICAL APPROACH

The change to a competence based curriculum is about transforming learning, ensuring that learning is deep, enjoyable and habit-forming.

2.1. Role of the Student Teacher

In the competence-based syllabus, the student teacher is the principal actor of his/her education. He/she is not an empty bottle to fill. Taking into account the initial capacities and abilities of the student teacher, the syllabus suggests under each unit, some activities of the student teacher and they all reflect active participation in the learning process.

The teaching and learning processes will be tailored towards creating a student's friendly environment basing on the capabilities, needs, experience and interests.

The following are some of the roles or the expectations from the student teachers:

- Student teachers construct the knowledge either individually or in groups in an active way.
- Student teachers work on one competence at a time to form concrete units with specific learning objectives (knowledge, skills and attitude).
- Student teachers will be encouraged to do research and present their findings through group work activities.
- A student teacher is cooperative: they work in heterogeneous groups to increase tolerance and understanding.
- Student teachers are responsible for their own participation and ensure the effectiveness of their work.

2.2 .Role of the Tutor

In the competence based syllabus, the tutor is a facilitator, organiser, advisor, a conflict solver.

The specific duties of the tutor in a competence based approach include the following, Tutor is:

- A facilitator, his/her role is to provide opportunities for student teachers to meet problems that interest and challenge them and that, with appropriate effort, they can solve. This requires an elaborated preparation to plan the activities, the place they will be carried, the required assistance;
- An organizer: his/her role is to organize the student teachers in the classroom or outside and engage them through participatory and interactive methods through the learning processes as individuals, in pairs or in groups. To ensure that the learning is personalized, active and participative, co-operative the teacher/tutor must identify the needs of the student teachers, the nature of the learning to be done, and the means to shape learning experiences accordingly;
- An advisor: he/she provides counselling and guidance for student teachers in need. He/she comforts and encourages student teachers by valuing their contributions in the class activities;
- A conflict-solver: most of the activities are performed in groups. The members of a group may have problems such as attribution of tasks; they should find useful and constructive the intervention of the teacher as a unifying element.
- asked for help only when the whole group agrees to ask a question
- ethical and preaches by examples by being impartial, by being a role-model, by caring for individual needs, especially for slow student teachers and those with physical impairments, through a special assistance by providing remedial activities or reinforcement activities.

2.3.Special Needs and Inclusive Education 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 student teachers 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.

These student teachers equally have the right to benefit from the free and compulsory basic education in the nearby ordinary/mainstream colleges. Therefore, the college's role is to enroll them and also set strategies to provide relevant education to them. The tutor therefore is

requested to consider each student teacher's needs during teaching and learning process. Assessment strategies and conditions should also be standardized to the needs of these student teachers. Detailed guidance for each category of student teachers with special education needs is provided for in the guidance for teachers. The Chemistry tutor is advised to work closely with the tutor of special need education to provide appropriate support to any identified student teacher's needs.

2.4 Skills Laboratory Pedagogy (Skills Lab)

Student teachers should have time to research, experiment and practice what has been taught in small groups in order to enhance the acquisition of competences. This is called "Skills Laboratory" or "Skills Lab. No special facilities or equipment is required for Skills Lab. In order for the students to learn programs focused on developing transferable 21st century skills, the pedagogical structure of skills lab is provided in the learning activities.

Skills lab is when student teachers are required to complete learning activities working in small groups. The skills labs is an easy method to change teacher's pedagogy from theory-based to competence-based instruction. Skills lab ensures teachers are accountable to completing all the learning activities and projects as outlined in the syllabus.

The basic characteristics of Skills Lab are:

- Students work in small groups (manageable teams)
- Assessment takes place through portfolio activities
- Students talk more than teachers (10% tutor talk time and the rest is for the students)
- Students receive constructive feedback on their work (Tutor gives quality feedback on student presentations).
- Skills lab consists of three components: build, practice and present.

Skills lab is the time when lesson combines the competences acquired during the unit and previous units to make learning more practical. Thus, in the learning activities of every unit, this syllabus provides /suggest skills lab pedagogy lesson to ensure practical application of the competences acquired.

3. ASSESSMENT APPROACH

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

3.1. Types of Assessment

The assessment should reflect the three domains of learning, namely cognitive, social affective and psychomotor:

- Knowledge and understanding: Does the student teacher demonstrate an understanding of the Chemistry concept? Has the student teacher mastered the Chemistry concepts? Indicators: correctness of answers, coherence of ideas, logical reasoning, use correctly mathematical symbols and concepts, etc.
- Practical skills: How does the student teacher perform on aptitude and practical tests? Indicators: accuracy, using appropriate methods, quality product, speed and efficiency, coherence.
- Attitude and values: How does the student teacher respond to a task or a situation? What is the student teacher's behaviour? How the student teacher persists on solving a given problem?

3.1.1 Formative Assessment

Formative assessment helps to check the efficiency of the process of learning. It is done within the teaching/learning process.

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

3.1.2 Summative Assessment

When assessment is used to record a judgment of a competence development or performance of the student teacher, it serves a summative purpose. Summative assessment gives a picture of a student teacher's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether competences have been achieved and to use the results for ranking or grading of student teachers, 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 competences. It can be internal College based assessment or external assessment in the form of national examinations. College based summative assessment should take place once at the end of each term and once at the end of the year. School summative assessment average scores for the subjects which are examined at the national level will be weighted and included in the final national examinations grade. For the subjects which are not examined externally the grade should be part of the continuous assessment reflected in the student's transport.

.

3.2 Record Keeping

This is gathering facts and evidence from assessment instruments and using them to judge the student's performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used generate data in the form of scores which will be carefully be recorded and stored in a portfolio. The latter is used in deciding remedial actions, alternative instructional strategy and as well as feed back to the student teacher. The records also are important to parents to check the learning progress and to advice accordingly. Finally, the records are very essential to the final assessment of professional practice of the student teacher at the end of the college.

This portfolio is a folder (or binder or even a digital collection) containing the student teacher's work as well as the student teacher's evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as papers and assignments), but also it is a record of the activities undertaken over time as part of student learning. Besides, it will serve as a verification tool for each student teacher that he/she attended all the learning sessions before undertaking the summative assessment for the subject.

3.3 Item Writing in Summative Assessment

Before developing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on, the number of questions in each level of revised 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 topic areas to be tested on from the subject syllabus.
- Outline subject-matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.
- Prepare a table of specifications.
- Ensure that the verbs used in the formulation of questions do not require memorization or recall answers only but also testing broad, subject and generic competences as stated in the syllabus.

4. RESOURCES

4.1. Materials Needed for Implementation

The following list shows the main materials/equipment needed in the learning and teaching process:

- Materials to encourage group work activities and presentations: Computers (Desktops & laptops) and projectors; Manila papers and markers, textbooks and handouts.

- Materials for drawing and ICT tools such as chemDraw, Microsoft student ENCARTA and any other relevant materials.

- Materials for enhancing research skills: Textbooks and internet (the list of the textbooks to consult is given in the reference at the end of the syllabus and those books can be found in printed or digital copies).

- Materials to encourage the development of chemistry models, scientific calculators, chemDraw, Software, different chemistry mobile applications etc.

-The technology used in teaching and learning of Chemistry has to be regarded as tools to enhance the teaching and learning process and not to replace tutors.

4.2. Human resource

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

The following are some of the skills required for the teacher: engage the students in a variety of learning activities; use multiple teaching and assessment methods; adjust instructions to the level of the learner; creativity and innovation; make connections/relations with other subjects; should have a high level of knowledge of the content; effective discipline skills; good classroom management skills; good communicator; a guide and a counsellor and have passion for children in teaching and learning.

In addition, 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 the learners as well as the development of the country.

5. SYLLABUS UNITS

5.1 Chemistry Syllabus Units of Year two

5.1.1 Key competences for end of year two

- Compare and contrast the chemical properties of the Group 13 elements and their compounds in relation to their position in the Periodic Table.
- Describe the trends in chemical properties of s bloc elements and their compounds.
- Compare the chemical properties of the Group 14 elements and their compounds in relation to their position in the Periodic Table.
- Explain the chemical properties of group 17 and their compounds.

- Explain the variation of Period 3 elements and their compounds in relation to their positions in the Periodic Table.
- Explain the properties and uses of transition metals.
- Apply IUPAC rules to name organic compounds and explain their types of isomers.
- Relate the chemical properties of alkanes to their reactivity and uses and explain their physical properties.
- Relate the chemical properties of alkenes and alkynes to their reactivity and uses and explain their physical properties
- Relate the physical and chemical properties of halogenoalkanes to their reactivity and uses.
- Compare the physical and chemical properties of alcohols and ethers and explain their preparation methods, reactivity and uses.
- Compare the chemical nature of carbonyl compounds to their reactivity and uses.
- Compare the chemical nature of carboxylic acids and acid halides to their reactivity.
- Relate the functional groups of esters, acid anhydrides, amides and nitrites to their reactivity, and uses, and describe their preparation methods
- Relate the chemical nature of amines and amino acids to their properties, uses and reactivity.
- Deduce how concentration, pressure, catalyst and temperature affect chemical processes in industry.
- Write expressions of equilibrium constant Kc and Kp, calculate interpret their values in relation to the yield of the products in reversible reactions.
- Explain the acid-base theories (Arrhenius, Bronsted–Lowry, Lewis).
- Explain the concept of energy changes and energy profile diagrams for exothermic and endothermic reactions.

5.1.2. Chemistry units for Year Two

<table>
<tr><td colspan="3">SUBJECT: CHEMISTRY</td><td>YEAR : 2</td><td>OPTION: SME</td></tr>
<tr><td colspan="2">TOPIC AREA:THE ATOMISTICS</td><td colspan="3">SUB TOPIC: PERIODIC TABLE</td></tr>
<tr><td colspan="3">Unit 1: Trends of chemical properties of Group 13 elements and their compounds</td><td colspan="2">No. of periods:8</td></tr>
<tr><td colspan="5">Key Unit competence: The learner should be able to compare and contrast the chemical properties of the Group 13 elements and their compounds in relation to their position in the Periodic Table.</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>-State the physical properties of Group13 elements.
- Explain the reactivity of Group 13 elements with oxygen, water, halogens, dilute acids and sodium hydroxide.</td><td>Compare and contrast the reactivity of Group 13 elements with oxygen, water, halogens, dilute acids and sodium hydroxide.
- Perform experiments to show the solubility of Group 13 compounds.
- Practically illustrate the</td><td>-Develop attitude of orderliness when performing experiments.
- Develop a team approach and respect diverse opinions during group discussions and practical activities.</td><td>- Physical properties of Group 13 elements (physical state, metallic character, physical appearance).
- Reactions of group 13 elements with oxygen, water, halogens, dilute acids and sodium hydroxide.
- Amphoteric character of aluminium and gallium oxides and hydroxides.
- Anomalous properties of boron</td><td>Make a group discussion on the physical properties of Group 13 elements and present the results.
- Carry out experiment of the reaction between aluminium with different acids and sodium hydroxide and report observations made.
- Perform experiments on the reaction of aluminium oxide and</td></tr>
</table>

- Describe the properties of oxides, hydroxides and chlorides of Group 13 elements. - State the uses of Group 13 elements and their compounds.	amphoteric properties of aluminium oxides and hydroxides. - Identify the anomalous properties of boron and its compounds. - Perform chemical tests for the presence of aluminium ion in the solution.	- Appreciate the uses of Group 13 elements in daily life.	and its compounds - Identification of Al^{3+} ion in aqueous solution. - Uses of Group 13 elements and their compounds: Boron: making electronic devices. Aluminium: electric cables, kitchen utensils, construction, packaging.	hydroxide with acids and bases and report the conclusion. - Carry out chemical test for the presence of Al^{3+} ion in the solutions. - Research work on the uses of Group 13 elements and their compounds and make presentation of the findings
Assessment criteria:The learners can compare and contrast the chemical properties of Group 13 elements and their compounds in relation to their position in the Periodic Table				
Skills lab: Learners discuss into groups, perform experiments and present their findings.				
Link to other subjects: Physics (electricity).				
Resources: Periodic table, computer, projector, internet access				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:THE ATOMISTICS			**SUB TOPIC: PERIODIC TABLE**	
Unit 2: **Chemical properties of s block elements**			**No. of periods:** 5	
Key Unit competence: The student teacher should be able to describe the trends in chemical properties of s bloc elements and their compounds				
Learning Objectives				
Knowledge and understanding	**Skills**	**Attitudes and values**	**Content**	**Learning Activities**
-Describe and explain the reactivity of the Group 1 and 2elements with oxygen, water and the halogens. -State and explain the properties of Group 1 and 2 oxides and hydroxides. -Explain the trends in the solubility of Group 1 and 2 compounds. -State the uses of Group 1 and 2elements and their compounds.	-Compare the reactivity of Group 1 and 2 elements. -Interpret the trends in the thermal decomposition of Group 1 and 2carbonates and nitrates -Perform experiments to test the alkalinity of Group 1 and 2 hydroxides.	-Develop care when dealing with extremely reactive Group 1 and 2elements. -Appreciate the uses of Group 1 and 2 elements and their compounds in our daily life.	-Reactivity of Group 1 and 2 elements with: oxygen, water and the halogens. -Properties of Group 1 and 2 oxides and hydroxides. -Effect of heat on Group 1 and 2 carbonates and nitrates. -Solubility of Group 1 and 2 compounds. -Uses of Group1 and 2 elements and their compounds	-Carry out an experiment to compare the reactivity of sodium and potassium with water and report the observations. Or watch a video clips on reactions of Group 1 and 2 elements with water and explain the trend in their reactivity down the group. -Experiments to show the alkaline character of sodium oxide and the alkalinity of Group 1 and 2 hydroxides and take note of the observations made. -Heat Group 1 and 2 carbonates and nitrates and Identify the products formed using appropriate reagents -Carry out experiments on the solubility of Group 1 and 2 compounds. -Research and make presentation on the uses of Group 1 and 2 elements and their compounds.
Assessment criteria: Can compare and contrast the properties of Group 1 elements and their compounds in relation to their position in the				

Periodic Table
Skills lab: Learners carry out experiments, do research and make presentations
Link to other subjects: physics, biology (transmission of impulses in nervous system)
Resources: Weighing balance, appropriate chemicals and apparatus, computer, projector

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: THE ATOMISTICS			SUB TOPIC AREA: PERIODIC TABLE OF THE ELEMENTS	
Unit 3: Trends in chemical properties of Group 14 elements and their compounds			No. of periods: 10	
Key Unit competence: The student teacher should be able to compare the chemical properties of the Group 14 elements and their compounds in relation to their position in the Periodic Table				
Learning Objectives			Content	Learning Activities
Knowledge and understanding	Skills	Attitudes and values		
-State physical properties of Group 14 elements. -State the chemical properties of Group 14 elements. -Distinguish between the chemical reactions of the oxides and chlorides of Group 14 elements. -Explain the trends in thermal stability of the oxide, halides and hydrides of Group 14 elements. -Explain the variation in stability of oxidation state of +2 and +4 down the –Group 14 elements. Mention the uses of Group 14 elements.	-Compare and contrast the physical properties of Group 14 elements. -Compare the relative stabilities of the higher and lower oxidation states in oxides. -Illustrate practically the reactivity of Group14 oxides and chlorides.	-Respect of procedures during experiments. -Develop a team approach and respect of diverse opinions during group discussions and practical activities. -Appreciate the uses of Group 14 elements in daily life	-Comparative study of physical properties of the Group 14 elements: physical state, metallic character, electrical conductivity. -Reactions of C, Sn, Pb, Si with oxygen, hydrogen, chlorine, dilute acids/concentrated acids and hydroxides. -Comparative study of compounds of Group 14 elements: - Reaction of oxides, chlorides with water, acids and strong alkaline solutions.	-Students do research and make presentation on the physical properties of Group 14 elements. -Carry out experiments of the reaction of carbon, tin, lead with oxygen, dilute acids/concentrated acids and hydroxides and interpret results. -Perform experiments to explain the reactions of Group 14 oxides and chlorides with water, acids and bases and analyse the results with appropriate report. -Learners will research and make a report about the extraction process of tin metal from its oxide.

			- Thermal stability of oxides, halides and hydroxides. -Trends in stability of oxidation states: +2 and +4 as a result of inert pair effect. -Uses of Group 14 elements.	
Assessment criteria:Learners can compare and contrast the chemical properties of Group 14 elements and their compounds in relation to their position in the Periodic Table				
Skills lab:				
Link to other subjects: Biology (respiration, blood circulation)				
Resources: Appropriate chemicals and apparatus, computer, projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: THE ATOM			SUB TOPIC AREA: PERIODIC TABLE OF THE ELEMENTS	
Unit 4: Trends in chemical properties of Group 17 elements and their compounds			No. of periods: 8	
Key Unit competence: The student teacher should be able to explain the chemical properties of group 17 and their compounds.				
Learning Objectives			Content	Learning Activities
Knowledge and understanding	Skills	Attitudes and values		
-Describe the trends in strength acidity, volatility and reducing power of halogen hydrides. -State the uses of halogens and their compounds.	-Compare the reactions of the halogens with cold dilute sodium hydroxide and hot concentrated sodium hydroxide solutions.	-Develop carefulness in handling harmful halogen gases -Appreciate the uses of halogens in manufacture of insecticides and bleaching reagents and organic solvents. -Develop the culture of protecting environment from harmful halogen compounds.	-Comparative study of chemical properties of halogens: - Reactions with oxygen, water, sodium hydroxide (both dilute and cold or hot concentrated). - Tends in oxidizing power down the group (displacement reactions). - Reaction with metals and non-metals. -Preparation and behaviour of hydrides of halogens with regard to: acid strength, volatility and their reducing power. -Uses and hazards of halogens and their compounds.	-Experiment to show the displacement of the iodide ion by chlorine and bromine, and the bromide ion by chlorine and make appropriate report. -Carry out reaction of chloride, bromide and iodide ions with concentrated sulphuric acid and make appropriate report. -Discuss in groups the reaction of halogens with sodium hydroxides and make a presentation. -Research work: in groups research and make presentation about the trends in acid strength, volatility and reducing power of hydrogen halides. -Research work: in groups research and make presentations on the uses of halogens and their derivatives.

Assessment criteria: Learners can compare and contrast the chemical properties of Group 17 elements and their compounds in relation to their position in the Periodic Table
Skills lab: Learners present their fing
Link to other subjects: Biology (respiration, blood circulation)
Resources: Appropriate chemicals and apparatus, computer, projector

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: ATOMISTICS			**SUB TOPIC AREA: PERIODIC TABLE OF THE ELEMENTS**	
Unit 5: Trends in chemical properties of Period 3 elements and their compounds			**No. of periods**: 10	
Key Unit competence: The student teacher should be able to explain the variation of Period 3 elements and their compounds in relation to their positions in the Periodic Table.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Compare the physical properties of Period 3 elements. -Describe the nature of the oxides of Period 3 elements and the type of bonding in their chlorides, oxides and hydrides.	-Relate the physical properties of Period 3 elements to their position in Periodic Table. -Relate the physical properties of compounds of the Period 3 elements to their nature of bonds across the period.	-Develop the sense of analysis while comparing the properties of elements and compounds across the period. -Develop the culture a team work during discussion sessions and presentation.	Properties of period III elements: - Physical properties e.g. melting and boiling points, atomic radius, physical state, polarisability, ionization energy, conductivity, electronegativity and metallic character. - Chemical properties: reaction with hydrogen, trends in oxidizing/reducing power across the period' -Properties of Period 3 compounds: alkalinity and acidity of oxides. - Ionic and covalent character of compounds (chlorides, hydrides and oxides).	-Group work: Discuss the variation of physical properties across Period 3 and suggest convincing explanations. - Discuss and make presentation about the reducing/oxidizing power, alkalinity and acidity of their oxides and bonding in halides of Period 3 elements. - Discuss the influence of nature of bonding on physical properties of compounds of Period 3 elements and make presentation.
Assessment criteria:Learners can compare and contrast the chemical properties of Period 3 elements and their compounds in relation to their positions in the Periodic Table				

Link to other subjects: Biology (respiration, blood circulation)
Resources: Appropriate chemicals and apparatus, computer, projector

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: ATOMISTICS		SUB TOPIC AREA: PERIODIC TABLE OF THE ELEMENTS		
Unit 6: Properties and uses of Transition metals			No. of periods: 5	
Key Unit competence: The student teacher should be able to explain the properties and uses of transition metals				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Discuss qualitatively the properties of transition elements when compared to those of calcium as a typicals-block metal.	-Relate the electronic configurations to special properties of transition metals. -Relate the electronic configuration to the definition of a transition metal/element as d block elements. -Compare the physical properties of transition metals to those of s-block and p-block elements. -Explain why scandium and zinc are not considered as true transition metals. -Observe and distinguish the colours of transition metal solutions. -Perform the confirmatory tests for transition metal ions.	-Show respect for other's opinion during group discussion. -Develop team work in group discussion. -Respect procedure in experiments. -Appreciate the use of transition metals in biological processes.	-Definition of transition metal. -Electronic configuration of transition metals (1st series). -Physical and special Properties of the transition metals. -The anomalous properties of Zn and Sc.	-Do exercises in groups and exchange work sheets for marking about writing the electronic configuration of elements from scandium to zinc -Discuss in groups the properties of transition metals and make presentation. -Carry out experiments in groups for the preliminary and confirmatory tests for transition metal ions (Ni^{2+}, Fe^{2+}, Fe^{3+}, $Mn^{2+,}$ Cr^{3+}, Zn^{2+}, Co^{2+}, Cu^{2+}) and write an appropriate report.
Assessment criteria:Can explain the properties and uses of transition metal				

Link to other subjects: Biology (respiration, blood circulation)
Resources: Appropriate chemicals and apparatus, computer, projector

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			**SUB TOPIC AREA:ALPHATIC COMPOUNDS**	
Unit 7:Introduction to organic chemistry and isomerism in organic compounds			**No. of periods:** 12	
Key Unit competence: The student teacher should be able to apply IUPAC rules to name organic compounds and explain their types of isomers.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Name organic compounds. -Describe the isomers of organic compounds	-Use IUPAC rules to name different organic compounds. -Classify organic compounds as aliphatic, alicyclic and aromatic. -Determine different formula for given organic compounds by calculation method. -Write the structures of different isomers of organic compounds	.- Develop a sense team approach and self-confidence in group discussions and presentations of the findings	-Classification of organic compounds as aliphatic, alicyclic and aromatic. -Types of formulae for organic compounds (empirical, molecular, structural, displayed and skeletal formulae). -General rules of nomenclature of organic compounds according to IUPAC. -Isomerism in organic compounds (structural isomers, stereoisomers) -Functional group and homologous series.	-Make a group discussion to classify compounds as aliphatic, alicyclic or aromatic) and make presentation. -Do exercises to determine different formula of organic compounds. -Do exercises in groups to name some organic compounds using IUPAC rules and make presentation. -Research, discuss and present about different types of isomerism and write the isomers of different compounds.
Assessment criteria:Can relate the physical and chemical properties of alkanes to preparation methods, uses and isomerism in organic compounds.				
Link to other subjects: Biology (chemicals of life)				
Resources: Atomic models, computer and projector.				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS		**SUB TOPIC AREA:ALPHATIC COMPOUNDS**		
Unit 8: Alkanes			**No. of periods:** 12	
Key Unit competence: The student teacher should be able to relate the chemical properties of alkanes to their reactivity and uses and explain their physical properties.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Name straight chain alkanes up to carbon 20. -Define homologous series. -Be aware of the dangers associated with combustion reactions of alkanes. -Describe and explain the trend in physical properties of homologous series of alkanes. -Describe a photo-chemical reaction and free radical mechanism -Describe the preparation methods of alkanes. -State the physical properties and uses of alkanes. -State the chemical properties of alkanes	-Write the structural formula of alkanes. Scientific report: writing skills in the practical experiments. -Prepare, collect and test methane gas. -Write reaction mechanisms for a photochemical reaction. -Use IUPAC system to name straight and branched alkanes -Develop practical skills and interpreting results in making appropriate deductions.	-Appreciate the importance of alkanes in daily life. -Appreciate the dangers caused by alkanes to the environments as major sources of air contaminants. -Develop orderliness and confidence in presentation. -Respect of procedure in experiment to carry out preparation of methane or propane.	-Nomenclature of straight chain hydrocarbon alkanes (up to carbon 20) and branched hydrocarbons using IUPAC system. -Definition of homologous series. -Homologous series of alkanes. -Physical properties of straight and branched alkanes. -Laboratory preparation of alkanes by decarboxylation and other general methods. -Uses of alkanes -Chemical properties of alkanes (e.g. combustion, halogenations (photochemical reaction).	-Exercise in groups to name straight chain alkanes up to carbon 20 and make presentation. -Do exercises in groups to name some branched alkanes using IUPAC system and make presentation. -Carry out experiment to prepare alkanes (methane gas or ethane gas), interpret a make an appropriate scientific report. -Make a research and presentation on properties of alkanes both physical and chemical

Assessment criteria: Can relate the physical and chemical properties of alkanes to preparation methods, uses and isomerism.
Link to other subjects: Biology (chemicals of life)
Resources: Atomic models, flip charts, computer and projector.

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			SUB TOPIC AREA:ALPHATIC COMPOUNDS	
Unit 9 : Alkenes and alkynes			No. of periods: 12	
Key Unit competence: The student teacher should be able to relate the chemical properties of alkenes and alkynes to their reactivity and uses and explain their physical properties				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain the reactivity of alkenes in comparison to alkanes. -Explain the existence of geometrical isomerism in alkenes. -Describe the industrial process of preparing alkenes and alkynes.	-Apply IUPAC rules to name alkenes and alkynes. -Carry out an experiment to prepare and test ethene gas. -Propose the mechanisms for electrophilic addition reactions for alkenes and alkynes. -Write the structural formulae of straight chain alkenes and alkynes. -Apply	-Appreciate the combustion reaction as source of fuels. -Appreciate the uses and dangers of addition polymers (polythene used for polythene bags, polypropene for plastic bottles etc.). -Develop a team approach and	-Definition of alkenes and homologous series. -Nomenclature and structure of alkenes: Straight and branched (C_5- C_{10}). -Structural and geometrical isomerism in alkenes. -Preparation methods of alkenes. -Laboratory preparation of ethene. -Testing for unsaturation in hydrocarbons. -Physical properties and uses of alkenes -Chemical reactions of alkenes (addition reactions, combustion reaction, oxidation of alkenes, ozonolysis in alkenes, hydroformylation, addition polymerization). - Definition of alkynes and homologous series. -Structure and nomenclature of straight and branched chain alkynes (C_5- C_{10}). -Physical properties and uses of alkynes. -Industrial preparation method of alkynes. -Chemical properties of alkynes (electrophilic addition reactions and reactions of terminal and non-terminal alkynes with metals or metal salts)	-Make a group discussion and do exercise on writing the structural formulae of isomers of alkenes and their names. Exchange work sheets for marking. -Carry out an experiment to prepare and test ethene gas from dehydration of ethanol and make a report. -Research in groups and make presentation about physical properties of alkenes and alkynes their uses. -Research in groups and make presentation about the reactions of alkenes and alkynes. -Propose their reaction mechanisms. -Research in groups and make presentation about industrial preparation process of alkenes and

	Markovnikov's rule to predict the product of hydrohalogenation of alkenes. -Classify alkynes as terminal and non-terminal alkynes using their different structures.	confidence in group activities and presentations.		alkynes and their uses. -Do exercises in groups to identify whether the alkyne is terminal or non- terminal and exchange work sheets for marking
Assessment criteria:Can relate the physical and chemical properties of alkenes and alkynes to their reactivity and uses.				
Link to other subjects: Biology (endocrinology, chemicals of life)				
Resources: Appropriate chemicals and apparatus, computer and projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			**SUB TOPIC AREA:ALPHATIC COMPOUNDS**	
Unit 10: Halogenoalkanes (alkyl halides)			**No. of periods:** 15	
Key Unit competence: The student teacher should be able to relate the physical and chemical properties of halogenoalkanes to their reactivity and uses.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define halogenoalkanes and homologous series. -Explain the reactivity of halogenoalkanes. -Explain the physical properties of halogenoalkanes. -Describe preparation methods for halogenoalkanes. -Explain different mechanisms in halogenoalkanes. -Explain the uses	- Draw displayed structural formulae of halogenoalkanes and give names using IUPAC system. -Classify halogenoalkanes according to developed formula as primary, secondary and tertiary. -Write reaction mechanisms of halogenoalkanes as SN_1, SN_2, E_1 and E_2.	-Appreciate the uses and dangers of halogenoalkanes in everyday life. -Develop the awareness in protecting the environment. -Develop team work approach and confidence in group activities and presentation sessions.	-Definition of halogenoalkane and homologous series -Nomenclature of halogenoalkanes, Isomerism and classification. -Physical properties of halogenoalkanes -Preparation of halogenoalkanes. -Chemical reactions of halogenoalkanes (substitution reactions and elimination reactions). -Uses of halogenoalkanes (e.g. chlorofluorocarbons (CFCs) in fluids in refrigerator and aerosol sprays, as solvents for organic substances, as fire extinguishers). -Dangers associated with CFC on destruction of ozone layer and	-Make a group discussion and presentation on nomenclature, classification, physical properties and reactivity of halogenoalkanes. -Do exercises on writing and naming halogenoalkanes. -Make a group discussion on preparations of halogenoalkanes and test for their presence using silver nitrate solution in ethanol. Write appropriate report. -Discuss in groups and make presentations the structural isomers in halogenoalkanes. -Discuss in groups the SN_1 and SN_2, E_1 and E_2 mechanisms for primary, secondary and tertiary halogenoalkanes and factors considered for a particular compound to undergo SN_1 and SN_2, E_1 and E_2 mechanisms and make presentation. -Research and make presentations on the uses and dangers of halogenoalkanes and their derivatives (put emphasis on

and dangers associated with halogenoalkanes	-Test for the presence halogenoalkanes in a given sample organic compound.		increasing the global warming.	chlorofluorocarbons on environmental pollution).
Assessment criteria:Can relate the physical and chemical properties of halogenoalkanes to their reactivity and uses				
Link to other subjects: Biology (ecology), Geography (people and the environment), General studies (environment).				
Resources: Appropriate chemicals and apparatus, computer and a projector				

SUBJECT: CHEMISTRY			YEAR 2	OPTION SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			SUB TOPIC AREA:ALPHATIC COMPOUNDS	
Unit 11 : Alcohols and ethers			Number of period: 14	
Key Unit competence: The student teacher should be able to compare the physical and chemical properties of alcohols and ethers and explain their preparation methods, reactivity and uses				
Learning Objectives			Content	Learning Activities
Knowledge and understanding	Skills	Attitudes and values		
-Explain isomers in alcohols from C-4 to C-6. -Describe the physical properties and uses of alcohols. -Explain the mechanism of dehydration of alcohols and that reaction with hydrogen chloride. -Recall the steps involved in fermentation process. -Describe the physical, chemical properties and preparation	-Write and name alcohols according to IUPAC system. -Classify alcohols as primary, secondary and tertiary. -Carry out an experiment to compare the oxidation reactions of primary, secondary and tertiary alcohol. -Perform iodoform test to distinguish between the methyl and non- methyl alcohols. -Carry out experiments to distinguish between primary, secondary and tertiary alcohols -Prepare ethanol at school.	-Appreciate the uses and dangers of alcohols to the society. -Develop a culture of working as a team during group activities. -Appreciate the uses ethers as non-polar solvents	-Definition of alcohols and homologous series. -Nomenclature, isomerism and classification of alcohols. -Physical properties of alcohols -Uses of alcohols as drinks, solvents and motor fuels. -Preparations of alcohols (e.g. ethanol). -Local preparation of ethanol by fermentation (urwagwa. ikigage). -Chemical properties of alcohols (e.g. oxidation,	-Make group discussion to do exercises of naming and writing isomers for different alcohols. Exchange work sheets for marking. -Make group discussion to explain the physical properties of alcohols and make a presentation. -Carry out an experiment to compare the oxidation reactions of primary, secondary and tertiary alcohols and write appropriate report. -Do more exercises on writing and naming alcohols and ethers. -Visit breweries to assess industrial production of alcohol by fermentation and make appropriate field report. -Carry out experiments to distinguish between primary, secondary and tertiary alcohols. (Lucas test) and write an appropriate report.

methods of ethers. -State the uses of ethers -Describe the local process of making alcohol. -Explain the effect of oxidation on urwagwa when it overstays. (Urwagwa rushaje).			esterification, reaction with sodium metal, reaction with sodium hydroxide, reaction with concentrated sulphuric acid at different temperatures …). -Nomenclature, physical properties, isomers and uses of ethers as non-polar solvents -Preparation reactions and chemical properties of ethers	-Perform an experiment to distinguish between the methyl and non- methyl alcohols (iodoform test) and write an appropriate report. -Debate the uses of alcohols and dangers associated with unsafe use of different types of alcohols on our health, family and society. -Carry out a research and make presentations on physical properties, chemical properties, uses and preparation reactions of ethers.
Assessment criteria: Can deduce the physical and chemical properties of alcohols and ethers to their preparation methods, reactivity and uses.				
Link to other subjects: Biology (chemicals of life)				
Resources: Appropriate chemicals and apparatus, computer, projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			**SUB TOPIC AREA:ALPHATIC COMPOUNDS**	
Unit12 : Carbonyl compounds			**No. of periods:** 14	
Key Unit competence: The student teacher should be able to compare the chemical nature of carbonyl compounds to their reactivity and uses.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Describe the reactivity of carbonyl compounds. -State the physical properties of aldehydes and ketones. -Describe the preparation reactions of ketones and aldehydes. -Explain the mechanisms of nucleophilic	-Prepare ketones from secondary alcohols by oxidation reaction. -Compare aldehydes and ketones by using Fehling's solution and Tollens' reagent. -Write and name carbonyl compounds and isomers of ketones and aldehydes. -Write equations for the reactions of carbonyl compounds with other substances. -Compare the physical properties of carbonyl compounds to those of alcohols and alkenes.	-Appreciate the importance and dangers associated with carbonyl compounds in daily life. -Develop a culture of working in group self-confidence in presentation. -Respect of procedure in performing experiment on	-Nomenclature and isomerism in carbonyl compounds. -Physical properties of aldehydes and ketones (volatility, solubility and boiling point). -Uses of carbonyl compounds. -Preparation methods of ketones and aldehydes. -Chemical reactions of carbonyl compounds (nucleophilic addition, oxidation, iodoform reactions, and chemical test).	-Group discussion and presentation about the physical properties and uses of aldehydes and ketones. -Carry out experiment to distinguish between carbonyl compounds and other organic compounds by using 2, 4dinitrophyneylhydrazine and write appropriate report. -Carry out an experiment to prepare ethanal and acetone by oxidizing ethanol and propan-2-ol under controlled conditions and report the findings. -Carry out experiment to distinguish between ketones and aldehydes using Fehling's solution and Tollens' reagent and write appropriate report.

addition reactions of carbonyl compounds.	-Differentiate methyl ketones from other ketones by using the iodoform test. -Carry out experiment to distinguish between carbonyl compounds and other organic compounds. -Carry out experiment to distinguish between ketones and aldehydes. -Carry out an experiment to prepare ethanal and propan-2-one.	distinguishing carbonyl compounds from other organic compounds.		-Carry out iodoform test to distinguish methyl ketones from aldehydes and other ketones and write an appropriate report.
Assessment criteria:Can deduce the chemical nature of carbonyl compounds to their reactivity and uses.				
Link to other subjects: Biology (chemicals of life)				
Resources: Appropriate chemicals and apparatus, computer and a projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			SUB TOPIC AREA:ALPHATIC COMPOUNDS	
Unit 13 :Carboxylic acids and acyl halides			No. of periods: 10	
Key Unit competence: The student teacher should be able to compare the chemical nature of carboxylic acids and acid halides to their reactivity.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain the physical properties and uses of carboxylic acids and acyl chlorides. -Describe the inductive effect on the acidity of carboxylic acids. -Explain the reactions of carboxylic acids and acyl chlorides	-Apply the IUPAC rules to name different carboxylic acids acyl chlorides. -Write the structural formula and isomers of carboxylic acids. -Distinguish between carboxylic acids from other organic compounds using appropriate chemical test. -Prepare carboxylic acids from oxidation of aldehydes or primary alcohols. -Compare the physical	-Develop a culture of working as a team group activities and self-confidence in presentation. -Appreciate the uses of carboxylic acids as the intermediate compounds in industrial processes	-Nomenclature and isomers. -Physical properties and uses of carboxylic acids. -Acidity of carboxylic acids. -Preparation methods carboxylic acids and acyl halides. - Reactions of carboxylic acids (with metals, sodium hydroxide, sodium carbonate/hydrogencarbonates, phosphorus pentachloride/ thionylchloride, esterification, reduction reactions, reaction with halogens).	-Make a group discussion on naming carboxylic acids, writing the structures and their isomers. Exchange work sheets for marking. -Do exercises of writing and naming, carbonyl compounds and make a report. -Research and make presentations on physical properties of carboxylic acids, acyl chlorides and their uses. -Discuss in groups the preparation reactions of carboxylic acids and acyl halides and make presentation. -Research and make

	properties of carboxylic acids to those of alcohols. -Outline the mechanisms of esterification and those of reaction of acyl chlorides with ammonia, amines and alcohols.	such as aspirin, vinegar and perfumes.	-Nomenclature and physical properties of acyl chlorides. -Reactions of acyl chlorides with water, strong base, Grignard reagents, alcohols, ammonia and amines, salts of carboxylic acid and reduction of acyl halides.	presentation on chemical reactions of carboxylic acids and acyl chlorides. -Carry out an experiment to distinguish carboxylic acids from other organic compounds using sodium carbonate/hydrogen carbonate and write an appropriate report. -Carry out experiment to prepare a carboxylic acid by oxidation of an aldehydes or a primary alcohol using acidified potassium manganite (VII) and write an appropriate report
Assessment criteria:Can deduce the chemical nature of carboxylic acids and acyl halides to their reactivity.				
Link to other subjects: Biology (chemicals of life)				
Resources: Appropriate chemical and apparatus, computer, projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS		**SUB TOPIC AREA:ALPHATIC COMPOUNDS**		
Unit 14: **Esters, acid anhydrides, amides and nitriles**			**No. of periods:**17	
Key Unit competence: The student teacher should be able to relate the functional groups of esters, acid anhydrides, amides and nitriles to their reactivity and uses, and describe their preparation methods				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Describe the chemical properties of esters, acid anhydrides, amides and nitriles. -Describe the process of urea manufacture and its uses. -Describe the formation of detergents.	-Apply IUPAC rules to name esters, acid anhydrides, amides and nitriles. -Compare the physical properties of esters to those of alcohols and carboxylic acids. -Make a soap and compare its	-Appreciate the importance of esters in manufacture of soap. -Appreciate the importance of esters and amides as intermediate compounds in manufacture of polyesters and polyamides such as Terylene and nylon in textile industries. -Appreciate the importance of acid anhydrides in manufacture of drugs such as	-Nomenclature and structure of esters. -Physical properties of esters and uses. -Chemical properties of esters. -Saponification and detergents. -Structure and nomenclature of acid anhydrides. -Preparations of acid anhydrides. -Chemical properties of acid anhydrides.	-Research and group discussions to write the structures and names of esters, acid anhydrides, amides and nitriles. -Exchange work sheets for marking. -Do exercises on wiring and naming esters, acid anhydrides, amides and nitriles. -Research in groups and discuss the properties of acid anhydrides, amides and nitriles. -In groups, discuss the chemical reactions of esters, acid

	properties with those of soapless detergents. -Compare the reactivity of acid anhydrides with those of acyl chlorides. -Prepare aspirin from appropriate reagents.	aspirin and paracetamol. -Appreciate the importance of urea as a fertiliser in agriculture -Appreciate the importance of detergents in comparison to soap.	-Uses of acid anhydrides. -Structure and nomenclature of amides. -Physical properties of amides. -Preparations of amides -Chemical properties of amides (reduction reaction, reaction with water /acid, Hoffman degradationreaction and reaction with nitrous acid, dehydration reaction and alcohols). -Uses of amides like urea in chemical industry, medicine, niche, agriculture etc -Structures and nomenclature of some nitriles. -Physical properties and preparation methods of nitriles. -Reactions of nitriles (hydrolysis and reduction).	anhydrides, amides and nitriles. -Make presentations. -Carry out a field study at nearby soap making and detergents factory to observe the process of saponification and write an appropriate report. -Carry out an experiment to make soap in the laboratory and write appropriate report. -Carry out an experiment to prepare aspirin using acetic anhydride and salicylic acid and write appropriate report. -Research in groups and make presentation about the industrial manufacture of urea and its uses.
Assessment criteria:Can relate the functional groups of esters, acid anhydrides, amides and nitriles to their reactivity, preparation methods and uses.				
Link to other subjects: Agriculture (fertilizers), Biology (homeostasis)				
Resources: Appropriate chemicals and apparatus, computer, projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA:ORGANIC COMPOUNDS AND MATERIALS			**SUB TOPIC AREA:ALPHATIC COMPOUNDS**	
Unit 15 :Amines and amino acids			**No. of periods:**10	
Key Unit competence: The student teacher should be able to relate the chemical nature (structure) of amines and amino acids to their properties, uses and reactivity.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain the zwitterion forms in solution of different pH. -Explain isoelectric point in amino acids. -Describe the physical properties uses of amines. -Describe the preparation methods of amines. -Describe the reactions of amino acids and amines with other substances.	-Apply IUPAC rules to name amines and amino acids. -Classify amines as primary, secondary and tertiary amines. -Write the optical isomers of zwitterion forms of amino acids. -Compare and contrast the physical properties of amino acids to those of carboxylic acids and amines. -Test the presence of amines and amino acid in solution.	-Appreciate the importance of amines as intermediate compounds in making polyamides in textile, drugs and dyes industries. -Appreciate the importance of amino acids as the building blocks for proteins in our bodies. -Develop a team approach and self-	-Name and classify amines. -Physical properties, natural occurrence and uses of amines. -Preparation reactions of amines (reduction of amides by Hoffman degradation reaction, reduction of nitriles, alkylation of ammonia, and reduction of nitro compounds). -Chemical reactions of amines (with: dilute acids, nitrous acid, derivatives of carboxylic acids, Grignard reagents, alkyl halides). -General structure of amino acids and some common examples. -Comparison of physical properties of amino acids to those of carboxylic	-Discuss in groups to classify amines as primary, secondary tertiary and name some amines. Then compare the classification of amines to that ofalcohols. -Do exercises on writing, naming and classifying amines. -In groups, discuss the physical properties of amines and those of amino acids then make the presentation. -Research and discuss on the natural occurrence, solubility of amines in water and behaviour as bases in comparison with ammonia. Make an appropriate report. -Make a group discussion and presentation to compare and contrast the physical properties of amino acids to those of carboxylic acids

		confidence in group activities and presentations.	acids and amines. -Chemical properties of amino acids (reaction with hydrochloric acid, nitrous acid, sodium hydroxide and sodium carbonate). -Optical isomers of amino acids. -Peptides and polypeptides: Formation and structure. -Uses of amino acids as building blocks of proteins.	and amines. -Research in groups and make a presentation about the preparation methods of amines and their chemical reactions with substances. -Carry out an experiment to test the presence of amines in a solution and write an appropriate report. -Carry out an experiment to test for the presence of amino acid in a solution and write appropriate report. -Make research, discuss in groups and make presentation on how amino acids react with: hydrochloric acid, sodium hydroxide and sodium carbonate. -Research in groups on the uses of amino acids and make a presentation.
Assessment criteria:Can deduce the chemical nature of amines and amino acids to their properties, uses and reactivity.				
Link to other subjects: Biology (nutrition in animals, cytology)				
Resources: Appropriate chemicals and apparatus, computer, projector				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: EQUILIBRIUM			SUB TOPIC AREA: CHEMICAL EQUILIBRIUM	
Unit 16:Factors that affect chemical equilibrium			No. of periods:5	
Key Unit competence: The student teacher should be able to deduce how concentration, pressure, catalyst and temperature affect chemical processes in industry.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Distinguish between complete and reversible reactions. -Explain dynamic equilibrium. -State characteristics of dynamic equilibrium. -Explain the factors that affect the position of equilibrium in a reversible reaction.	-Apply Le Chatelier's principle to explain the effects of changes in temperature, concentration and pressure on a system in equilibrium. -Compare and contrast theoretical and actual optimal conditions in industrial processes. -Relate the effect of concentration, temperature, pressure and catalyst to the amount of products in manufacturing	-Develop the culture of working as a team, mutual help and care in performing experiments. -Appreciate the importance of Le Chatelier's principle in Haber and Contact processes. -Respect of procedure in experiments.	-Difference between complete and reversible reactions. -The concept equilibrium (dynamic equilibrium). -Characteristics of a system in dynamic equilibrium. -Factors that affect equilibrium position (concentration, temperature, pressure and catalyst). Use Le Chatelier's principle. -Application of those factors on industrial processes (contact process and Haber process)	-Carry out experiments to show that some chemical reactions are reversible e.g. Addition of acid to chromate(IV)- solution (forward reaction) Warming cobalt(II) chloride solution (forward reaction), then cooling the solution favours the backward reaction. Addition of hydroxide to dichromate(VII) solution (backward reaction) and then presents the findings. -Discussing in groups and makes presentation about the effect of concentration, pressure, temperature and catalyst on equilibrium position. Include their applications to Haber and contact processes. - Research in groups and make presentation about the effect of different conditions on the yield of product in industries.

	industries.			
Assessment criteria:Can deduce how concentration, pressure, catalyst and temperature affect chemical processes in industry				
Link to other subjects: Economics (finance)				
Resources: Computers, projectors, appropriate chemicals and apparatus				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: EQUILIBRIUM		**SUB TOPIC AREA: CHEMICAL EQUILIBRIUM**		
Unit 17:Quantitative chemical equilibrium			**No. of periods:**5	
Key Unit competence: The student teacher should be able to write expressions of equilibrium constant Kc and Kp, calculate and interpret their values in relation to the yield of the products in reversible reactions.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain how the temperature affects the magnitude of equilibrium constant Kc. -Derive the relationship between Kc and Kp. -Write expression for Kc and Kp.	-Derive equilibrium constant Kc. Interpret the Kc values in relation to the yield of the reversible reactions. -Compare the Kc value with Qc value and predict if a reaction is at equilibrium or not. -Compare and interpret the values of Kc and Kp of different reactions. -Perform calculations involving equilibrium constants in terms of concentration, (Kc) and partial pressure, (Kp).	-Develop the culture of working in a team while discussing and presenting. -Appreciate the values of Kc in relation to the completion of different reactions	-Definition of equilibrium constant Kc -Deriving equilibrium constant Kc (from thermodynamic approach and kinetic approach). -Mass action law and equilibrium constant expression. -Definition of equilibrium constant in terms of partial pressures Kp -Derivation of the relationship between Kc and Kp -Calculations on Kc and Kp.	-In group discuss and derive the equilibrium constant expression Kc and make presentation. -Using examples do exercises of writing expressions for equilibrium constants in terms of concentrations and partial pressures of different reversible reactions and exchange work sheets for marking. -Learners do exercises to determine the relationship between Kc and Kp and exchange work sheets for corrections -Perform different exercises on calculations of equilibrium concentrations and equilibrium constant values and exchange work

				sheets for marking. -Learners do exercises to compare the values of Kc and Qc .exchange work sheets for correction.
Assessment criteria:Can write expressions and calculate the values of equilibrium constant, interpret the values of Kc in relation to the yield of products in the reversible reactions				
Link to other subjects: Mathematics (quadratic equations)				
Resources: Computers, projectors other relevant materials / apparatus				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: EQUILIBRIUM		**SUB TOPIC AREA: IONIC EQUILIBRIUM**		
Unit 18:Acids and bases			**No. of periods:**3	
Key Unit competence: The student teacher should be able to explain the acid-base theories (Arrhenius, Bronsted–Lowry, Lewis).				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain the acids and bases using different theories. -Explain the differences in behavior of strong and weak acids and bases, using Bronsted Lowry theory.	-Classify the acids and bases as strong and weak depending on their dissociation in aqueous solutions. -Distinguish between Lewis and Bronsted&Lowry theory of acids. -Write the dissociation of acids and bases and identify acid-base conjugate pairs.	-Develop the culture of team work; develop self-confidence during group discussion and presentation of the findings.	-Acids and bases (Arrhenius theory, Bronsted&Lowry and Lewis theory). -Differences between strong and weak acids and bases. -Explanation of acid-base conjugate pairs using Bronsted&Lowry theory.	-Research and make presentations on acid-base theories. Equations to support explanations are required. -Discussions and presentation of the findings about the dissociation of strong and weak acids and bases. Include the acid -base conjugate pairs.
Assessment criteria: Can prepare solutions and measure their pH, calculate the pH of acidic and alkaline solutions *- Can explain the concept of buffer solution, hydrolysis of salts and discuss its applications in manufacturing industry and biological processes*				
Link to other subjects: Mathematics (logarithm, operations), Biology (transport in animals), Agriculture (soil),				
Resources: Appropriate chemicals and apparatus, computers, projectors				

SUBJECT: CHEMISTRY			YEAR : 2	OPTION: SME
TOPIC AREA: CHEMICAL ENERGETICS			SUB TOPIC AREA: ENTHALPY CHANGE OF CHEMICAL REACTIONS	
Unit 19 :Energy changes and energy profile diagrams for chemical reactions			No. of periods:5	
Key Unit competence: The student teacher should be able to explain the concept of energy changes and energy profile diagrams for exothermic and endothermic reactions.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define the term thermochemistry. State the first law of thermodynamics. -Define standard enthalpy of reactions (formation, combustion, neutralization, and atomization). -Explain the differences between exothermic and endothermic reactions using energy profile diagrams.	-Interpret experimental results about energy changes during chemical reactions. -Relate the energy changes to the bond breaking and bond making.	-Carefully deal with reactions that can produce a lot of heat energy. -Appreciate the use of chemical energy in daily life like combustion of fuels. -Develop the culture of working in a team during experiments. -Respect of procedure during experiments.	-Definition of thermochemistry. -The concept of system. -Types of systems (open, closed and isolated systems). -Heat energy and temperature. -Internal energy of a chemical compound (kinetic + potential energy). -First law of thermodynamics. -Standard enthalpy change of chemical reactions (enthalpy of formation, combustion, neutralization, atomization ....). Exothermic and endothermic reactions. -Energy profile diagrams (for both	-Perform group discussions about the characteristics of different types of systems and heat transfer (examples of flask, calorimeter, boiling water in an open container and cooling water in closed container may be used). Present the findings. -Experiments to verify energy changes during a chemical reaction (e.g. -Displacement reaction using zinc and copper(II) sulphate solution. -Burning ethanol ...). Presentation of the observations is required. -Interpretation of energy profile diagrams for exothermic and endothermic reactions.

			exothermic and endothermic reactions	
Assessment criteria:Can predict the feasibility of chemical reactions				
Link to other subjects: Physics (thermodynamics), Mathematics (functions)				
Resources: Computer, projector, internet access				

5.2. Chemistry Syllabus Units for Year three

5.2.1 Key competences for the end of year 3

- Explain the importance and dangers of radioisotopes in everyday life.
- Relate the chemistry and uses of benzene to its nature and structure.
- Relate aromatic ketones, aldehydes, carboxylic acids and amines to their chemical activity.
- Relate the types of polymers to their structural properties and uses
- Prepare solutions, measure their pH and calculate the pH of acidic and alkaline solutions. Explain the concept of buffer solution, and discuss its applications in manufacturing industry and biological processes.
- Explain the concept of reduction and oxidation and balance equations for redox reactions.
- Calculate the solubility product constant of sparingly soluble salts and deduce the applications of common ion effect in industry.
- Explain the working and industrial applications of electrochemical and electrolytic cells
- Design an experimental procedure to verify the enthalpy changes in a chemical reaction.
- Explain the factors that affect the rate of chemical reaction

5.2.2. Chemistry Units for Year two

<table>
<tr><td colspan="3">SUBJECT: CHEMISTRY</td><td>YEAR : 3</td><td>OPTION: SME</td></tr>
<tr><td colspan="2">TOPIC AREA: THE ATOM</td><td colspan="3">SUB TOPIC AREA: RADIOACTIVITY</td></tr>
<tr><td colspan="3">Unit1:Importance and dangers of radioisotopes</td><td colspan="2">No. of periods:8</td></tr>
<tr><td colspan="5">Key Unit competence: The student teacher should be able to explain the importance and dangers of radioisotopes in everyday life.</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 concept of radioactivity.
-Explain the properties of alpha, Beta and Gamma rays
-Explain half-lives of radioactive radioisotopes.
-Explain the applications of radioisotopes in medicine, agriculture and industries</td><td>-Compare and contrast chemical and nuclear reactions.
-Write and balance nuclear reaction equations.</td><td>-Develop awareness of the dangers of radioactive substances and nuclear weapons.
-Appreciate the importance of radioactivity in electricity production, diagnosis and treatment of diseases.</td><td>-Define radioisotopes and radioactivity. -Emission of alpha, beta and gamma rays, their properties (relative mass, relative charge, speed, energy, penetrating power and their effect on photographic plate).
-Health hazards of radioactive substances.
-Nuclear equations and radioactive decay series.
-Fission and fusion and their applications (production of electricity, hydrogen and atomic bombs).
-Comparison between chemical and nuclear reactions.
-Uses of some radioisotopes e.g. ^{14}C,</td><td>-Research on historical background of the discovery of the radioactivity and types of radioactivity. Present the findings.
-Discuss the hazards of radioactive substances and suggest preventive measures.
-Do exercises to write the equations for the nuclear reactions. Exchange the worksheets for marking.
-Do research and make presentation on applications of radio isotopes.
-Research and make presentations on applications of nuclear fission and fusion. Also discuss the probable health and environmental hazards that they may cause.
-Discuss and make presentation about the differences and similarities between chemical and nuclear reactions.
-Determine the half-life of some elements by calculations and show how the calculated values can be used for the age determination of fossils.</td></tr>
</table>

			^{32}P, ^{60}Co, ^{131}I.	
Assessment criteria : Can explain the importance and dangers of radioisotopes in everyday life.				
Link to other subjects: Mathematics (logarithms), Physics (nuclear physics				
Resources: Materials: projector , computer , videos calculator				

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: ORGANIC CHEMISTRY		**SUB TOPIC AREA: AROMATIC COMPOUNDS**		
Unit2: Benzene			**No. of periods:**10	
Key Unit competence: The student teacher should be able to relate the chemistry and uses of benzene to its nature and structure.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-State the physical properties of benzene. -Describe the uses of benzene. Outline the preparations of benzene. -Describe the chemical properties of benzene (include mechanisms involved in electrophilic substitution reactions). -State the conditions required for different reactions.	Relate the conditions for reactions of benzene to its chemical stability. Illustrate the mechanism of electrophilic substitutions on benzene	-Appreciate the use of benzene in industries and in daily life. -Develop team work approach, self confidence in group activities and presentation. -Develop the carefulness while handling toxic chemicals like benzene	-Description of the structure of benzene. -Physical properties, uses and toxicity of benzene. -Preparation of benzene. Chemical stability of benzene: - π-bond delocalization in benzene ring. - Stabilization energy. -Reactions of benzene: .Combustion reaction, . Electrophilic addition reactions (addition of chlorine and hydrogenation). . Electrophilic substitution reactions and their mechanisms (chlorination, bromination, nitration, sulphonation, acylation and alkylation). - Nomenclature and positional isomerism in derivatives of benzene.	-Make a research and presentation about the structure, chemical stability and uses of benzene. -Discuss the mechanisms involved in electrophilic substitution reactions of benzene and name of the product formed in each case. -Group discussion to compare the electrophilic addition in benzene to electrophilic addition in unsaturated aliphatic compounds.
Assessment criteria: Can relate the chemistry and uses of benzene to its nature and structure.				

Link to other subjects:organic chemistry senior five
Resources: Iron (III) chloride solution, sodium hydroxide solutions

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: ORGANIC CHEMISTRY			**SUB TOPIC AREA: AROMATIC COMPOUND**	
Unit 3:Derivatives of benzene			**No. of periods:19**	
Key Unit competence: The student teacher should be able to compare and explain chemical reactivity of aromatic ketones, aldehydes, carboxylic acids and amines.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Explain the effects of substituent groups on the benzene ring. -Give systematic names of aromatic compounds. -Describe the preparation and reactions of phenol, benzoic acid, benzaldehyde, and phenylethanone and phenyl amine. -State the uses of phenols. -Describe the	-Test and compare the acidity of phenol with alcohols and carboxylic acids. Test for the presence of phenol in a given solution. -Compare and contrast the alkalinity of phenyl amines with aliphatic amines and ammonia. Test and compare the alkalinity of phenyl amine,	-Develop the team work approach and self-confidence in group discussions and presentations. -Appreciate the uses of phenols as analgesics, antiseptics, opium-based painkiller and in photography. -Appreciate the use of salts of aromatic carboxylic	Effect of substituent groups on the benzene ring: - Deactivating and activating substituent - Directing the incoming substituent at ortho, meta and para positions. Phenol: -Sources and preparations of phenol. -Reactions of phenols (breaking of O-H bond): Acidity of phenols compared to alcohols and carboxylic acids. - Reaction of phenol with sodium hydroxide, ethanoyl chloride, acid anhydrides and phosphorous pentachloride. -Reactions of phenol electrophilic substitutions: nitration, sulphonation, halogenation, reduction, ethylation and hydrogenation. -Test and uses of phenol (e.g. antiseptics, analgesics, some opium-based killers and photography). -Aromatic hydrocarbons, carbonyl compounds,	-Group discussions and presentations on why some substituent activate while others deactivate the benzene ring and why some direct at ortho/para while others direct at meta positions. -Group research work on the importance and sources of phenols. -Practical activity to test the acidity of phenol in comparison to alcohols and carboxylic acids Carry out an experiment to test for the presence of phenol in a given solution. State the observations made and make a report. -Experiments on the reactions of phenol with bromine, sodium hydroxide. -Research about uses of phenol

reaction of phenol, aromatic carbonyl compounds and carboxylic acids. -Describe the chemical properties of phenyl amines.	ammonia and aliphatic amines. -Perform experiments on the reactions of phenol and phenyl amine.	acids in food preservatives.	carboxylic acids and amines. -Structure and nomenclature of aromatic alkanes, alkenes, alcohols, ketones, aldehydes, carboxylic acids and amines. Reactions of alkyl benzene: - Oxidation of the side chain. Radical substitution on alkyl benzene (chlorination). -Preparations and reactions of aromatic carbonyl compounds and carboxylic acids. -Preparation methods of phenyl amine and uses of its derivatives. -Alkalinity of phenyl amine compared to aliphatic amines and ammonia. -Reactions of phenyl amine with water, hydrochloric acid, nitrous acid, ethanoyl chloride/ benzoyl chloride, phenol, halogenations and acid anhydrides.	and its derivatives and present the findings. -Exercises on naming aromatic hydrocarbons alcohols, ketones, aldehydes, carboxylic acids and amines. -Practical activity to test and compare alkalinity of phenyl amines, aliphatic amines and ammonia. -Experiments on reaction of phenyl amines with water, hydrochloric acid and phenol. Make appropriate report.
Assessment criteria: Can relate the structure of aromatic carbonyl compounds, carboxylic acids and amines to their chemical reactivity.				
Link to other subjects:Biology(cytology, genetics, chemicals of life)				
Resources: Phenyl amine, aliphatic amines, benzoic acid and other appropriate chemicals/apparatus.				

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: ORGANIC CHEMISTRY			SUB TOPIC AREA: POLYMERIZATION	
Unit4: Polymers and polymerization			No. of periods:5	
Key Unit competence: The student teacher should be able to relate the types of polymers to their structural properties and uses				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define the terms monomer, polymer and polymerization. -Describe the formation of polymers. -Describe addition and condensation polymerization. -Explain the terms thermosetting and thermo softening of plastics. -Discuss the advantages and disadvantages of both natural and synthetic polymers -Explain the biodegradability property of polymers based on their chemical structure	-Use equations to distinguish between condensation and addition polymerization. -Write equations to show how nylon-6, 6, polyester, -Dacron, Kevlar, natural rubber, PVC and Bakelite are formed. -Prepare phenol-methanol polymer (Bakelite). -Relate the structure and properties of polymers to their uses in plastic and textile industries. -Reduce polymer wastes by reusing, recycling and appropriate disposal.	-Develop the culture of working in groups. -Develop orderliness in presentation of research work. Respect others' opinions during debate, discussions and presentations. Appreciate the socioeconomic importance of polymers. -Develop the sense of responsibility to protect the environment against the	-Definition of monomer, polymer and polymerisation. -Types of polymerization: - Addition polymerization Condensation polymerization (Classes of polymers: - Natural polymers and Synthetic polymers -Types of polymers -Properties of polymers: - Thermosetting and thermo softening polymers - Biodegradable and non-biodegradable polymers -Importance of vulcanization in rubber processing. -Uses of polymers and their effect on the environment.	-Research and make the presentation about polymers, their properties and their uses in daily life. -Carry out an experiment to prepare phenolmethanal polymer (Bakelite) using (phenol, formalin 37% solution of methanal in water), concentrated ethanoic acid, aluminium foil, and concentrated sulphuric acid. -Learners debate on the use of plastics versus metals in daily life. -A field visit to any nearby plastic industries, textile industries and plastic recycling plant to study about the processes involved (e.g. Rwanda plastic industry, SONATUBE, recycling plant in Mageragere,

	-Develop observation, research and report writing skills during field visits and survey.	hazards of plastics.	-Management of old polymer materials (reuse, recycling and disposal).	Nyarugengedistrict). -Discussion on advantages and disadvantages of using natural and synthetic polymers.
Assessment criteria: Can relate the types of polymers to their properties and uses.				
Link to other subjects:Geography (environment), General studies (environment				
Resources: Flip charts, makers, computer, internet access				

SUBJECT: CHEMISTRY			Year : 3	Option: SME
TOPIC AREA:REACTION KINETICS		Sub Topic:RATE EQUATIONS, ORDERS AND MOLECULARITY		
Unit 5: Factors that affect the rate of reactions			No. of periods: 7	
Key Unit competence: The learner should be able to explain the factors that affect the rate of chemical reaction				
Learning Objectives:			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
- Explain the concept of reaction kinetics. - Explain the effect of different conditions on the rate of reaction.	- Carry out experiments to show how different factors affect the rate of chemical reactions. Predict the effect of changing conditions on the rate of reactions.	Appreciate the importance of reaction kinetics. - Appreciate the importance of different conditions on the reaction rates.	Concept of reaction kinetic - Factors that change the rates of reactions (temperature, concentration, surface area, catalyst, pressure and light). - Explanation of effect of change of factors on reaction rates.	Perform practical activities to show how different reactions have different rates (e.g. burning ethanol and rusting of iron). Then report the findings. - Carry out experiments to show how different factors (concentration, temperature, particle size and catalyst) affect the rate of chemical reactions. Write valid report.

Assessment criteria: The learners can explain the factors that affect the rate of chemical reaction and use Arrhenius equation to calculate the ratio of rate constant and activation energy with change in temperature.
Link to other subjects:
Resources: Periodic table, computer, projector, internet access

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: EQUILIBRIUM		SUB TOPIC AREA: IONIC EQUILIBRIUM		
Unit 6:pH of acidic and alkaline solutions			No. of periods:24	
Key Unit competence: The student teacher should be able to Prepare solutions, measure and calculate their pH, explain the concept of buffer solution, and its applications in manufacturing and biological processes.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define the degree of ionization (α). -Define the terms K_a, pH pK_a, K_b, pK_b and K_w. -Write equations for salt hydrolysis reactions and the expression for the hydrolysis constant. -Define the term buffer solution. -Explain how buffer solutions control pH. -Explain the buffer capacity in relation to buffer range. -Describe the applications of buffer solution in domains such as biological processes, agriculture, natural system (e.g. lakes) and industrial manufacture of cosmetics	-Perform calculations involving pH, K_a, pK_a, K_w, K_b and pK_b. -Interpret the values of K_a and K_b in relation to the strength of acids and bases. -Interpret results, draw valid conclusions and report about preparation of solutions with different pH. -Prepare different solutions and appropriately use pH-meter to measure their pH. -Compare the strength of acids and bases of the same concentration using the values of K_a and K_b.	-Develop a culture of working in a team, analysis and self-confidence while discussing exercises performing experiments and presenting the findings. -Care about corrosive chemicals like concentrated strong acids and alkalis. Respect the procedure in experiments. -Appreciate the achievements of Henderson and Hasselbalch in calculation of the pH of buffer solution. -Appreciate the importance of buffer	-Degree of ionization in relation to strength of acids and bases (α_a and α_b). -Explanation of acid and base dissociation constants (K_a and K_b). -The relationship between K_a and Kb. -Use K_a or pK_a and Kb or pK_b to explain the strength of the acids and bases. -Explanation of ionic product of water (K_w). -Definition and calculations of pH and pOH of acidic and alkaline solutions. -Explanation of buffer	-With help of examples do exercises on calculations of the degree of ionization. Use α-values to predict the strength of the acids and base. -Do calculations on acid and base dissociation constants and use the values to compare the strength of acids and bases. -Carry out experiments to prepare different solutions and measure their pH, present the report of the findings. -Discuss and make presentation on the pH scale in relation to the concentration in H+ and OH- ions.

and drugs.	Relate the values of pH and pOH. -Calculate the pH and hydrolysis constant of aqueous solutions of salts. Prepare buffer solutions of different pH values. -Derive Henderson – Hasselbalch relation and use it to calculate the pH of buffer solution.	solutions in pharmaceutical industries, agriculture and biological processes	solution. pH of buffer solution (include the derivation of Henderson-Hasselbalch's relation). -Preparation of buffer solutions of different pH. -Explanation of the working of buffer solutions. -explanation of buffer capacity and buffer range. -Applications of buffer solutions in biological processes, agriculture natural system (e.g. lakes) and in industrial manufacture of cosmetics and drugs.	-Do exercises on the calculations of pH of acidic and alkaline solutions. -Perform experiments to prepare and demonstrate the properties of a buffer solution. Then present the results. -In groups, do exercises on the calculations of pH for buffer solutions. Exchange worksheets for marking. -With the help of examples, discuss the working of a buffer solution when acids or bases are added and make conclusions. -Research in groups and make presentations about the applications of buffer solution.
Assessment criteria :- Can prepare solutions and measure their pH, calculate the pH of acidic and alkaline solutions *- Can explain the concept of buffer solution, hydrolysis of salts and discuss its applications in manufacturing industry and biological processes*				
Link to other subjects:Mathematics (logarithm, operations), Biology (transport in animals), Agriculture (soil),				
Resources: Appropriate chemicals and apparatus, computers, projectors				

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: SOLUTIONS AND SOLUBILITY			SUB TOPIC AREA: SOLUBILITY AND SOLUBILITY PRODUCT	
Unit 7: Solubility and solubility product for sparingly soluble salts			No. of periods:12	
Key Unit competence: The student teacher should be able to calculate the solubility product constant of sparingly soluble salts and deduce the applications of common ion effect in industry.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define the term solubility product K_{sp}. -State and explain the factors that affect solubility of sparingly soluble salts. -State and explain the applications of solubility product. -Explain common ion effect on solubility of sparingly soluble salts. -Explain the effect of pH on solubility of sparingly soluble salt. -Explain the relationship between kidney stone	-Perform a simple experiment to determine the solubility product of a sparingly soluble salt. -Write equations of dissociation and K_{sp} expression for sparingly soluble salts. -Calculate the molar concentration of ions and K_{sp} values for sparingly soluble salts. -Relate the solubility product principle to the selective precipitation of substances. -Use the values of K_{sp} and Qc to predict	-Develop a culture of working in a team and self-confidence while discussing in groups, performing practical activities and presentation of findings. -Appreciate the importance of solubility and solubility products in manufacturing industries and analysis of some ions in	-Definition of solubility and molar solubility. -Unsaturated, saturated and super saturated solutions. -Equations of the dissociation of sparingly soluble salts in water. -Definition of the solubility product K_{sp} and writing expressions for K_{sp}. -Relationship between solubility and solubility product K_{sp}. -Calculations involving solubility product. -Definition and calculation of ionic product (Qc). -Predicting precipitation reactions using Qc and K_{sp} values. -Separation of ions by fractional precipitation. -Common ion effects and solubility.	-Perform a simple experiment to determine the solubility product of a sparingly soluble salt (e.g. magnesium hydroxide) -In groups, do exercises of writing the equations of dissociation for sparingly soluble salts and do calculations involving solubility and solubility product K_{sp}. -Basing on calculations and predict whether the mixture of solutions leads to formation of a precipitate or not. -Practical activities to discuss the common ion, complex formation and pH change effect on the solubility of sparingly soluble salts. Then report the findings. -Research and make

formation and solubility and solubility product -Explain the applications of solubility product and common ion effect.	if a mixture of solutions will form a precipitate or not -Relate common ion effect to solubility of sparingly soluble salt.	solution	-pH change and solubility. -Complex ion formation and solubility. -Applications of solubility product (inorganic qualitative analysis, purification of sodium chloride, salting out the soap, manufacture of baking soda, quantitative analysis of salts kidney stone formation).	presentations about the applications of solubility product (inorganic qualitative analysis, purification of sodium chloride, salting out the soap, manufacture of baking soda, quantitative analysis of salts).
Assessment criteria: Student teacher Can carry out calculations related to solubility product; apply the knowledge of solubility and solubility product to other domain.				
Link to other subjects: Biology (physiology-urinary system)				
Resources: Computer, projector, appropriate chemicals and apparatus				

SUBJECT: CHEMISTRY			Year : 3	Option: SME
TOPIC AREA:ELECTROCHEMISTRY		Sub Topic:ELECTROLYSIS AND ELECTROCHEMICAL CELLS		
Unit 8: Reduction and oxidation reactions			No. of periods: 15	
Key Unit competence: The learner should be able to explain the concept of reduction and oxidation and balance equations for redox reactions.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
Explain the redox reactions in terms of electron transfer and changes in oxidation state (number). - Explain the concept of disproportionation. - Differentiate the reducing agent from the oxidising agent in a redox reaction.	Work out the oxidation numbers of elements in the compounds. - Perform simple displacement reactions to order elements in terms of oxidising or reducing ability. - Apply half-reaction method to balance redox reactions. - Deduce balanced equations for redox	- Develop the culture of inquiring in order to continue the search for new concepts of redox reactions. - Respect of procedure during the experiment. - Appreciate the reactivity of elements in daily lives in terms of chemical phenomenon.	Definition of electrochemistry. - Relationship between electrochemistry and redox reactions. - Definitions of reduction and oxidation reactions. - Rules used to determine oxidation number of elements. - Determination of the oxidation numbers of elements in the compounds. - Oxidation -reduction reactions (reduction half reaction and oxidation half reaction).	- Group activities to work out the oxidation numbers of element in the compounds and balancing various oxidationreduction reactions and make a presentation. - Experiments to show that oxidation-reduction reactions have taken place and they are followed by change in oxidation numbers (e.g.: reduction of

	reactions from relevant half equations.		- Explanation of oxidising and reducing agents. Disproportionation reactions. - Balancing oxidation reduction reactions. - Reactivity series of metals	acidified potassium dichromate (VII) and potassium magnate (VII) by sulphur dioxide or ethanol), addition of zinc metal to a solution of copper (II) sulphate). Write an appropriate report. - Practical activities that will help the learners to arrange elements in order of oxidising and reducing ability (e.g.: displacement reactions of halogens, different metals and acids).
Assessment criteria:Can compare and contrast the properties of Group 1 elements and their compounds in relation to their position in the Periodic Table				
Link to other subjects: Physics, Biology (transmission of impulses in nervous system)				
Resources: Weighing balance, appropriate chemicals and apparatus, computer, a projector				

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: ELECTROCHEMISTRY		SUB TOPIC AREA: ELECTROLYSIS AND ELECTROCHEMICAL SERIES		
Unit 9: Electrochemical cell and applications			**No. of periods:**10	
Key Unit competence: The student teacher should be able to explain the working of electrochemical cells and their industrial applications.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-Define the term electrochemical. -Describe the standard hydrogen electrode. -Explain the working of galvanic cells using the fully labeled diagram. -Describe industrial applications of electrochemical cells.	Construct a simple galvanic cell. -Use the e.m.f. of the galvanic cell to predict if the cell will generate current or not. Record the results of a measurement accurately using a voltmeter. -Calculate standard cell potentials from standard electrode potentials of two half cells. -Properly use electrolytic cell to carry out electroplating of graphite by copper. -Use standard electrode potentials of cells to determine the direction of electron flow and feasibility of a reaction. -Apply the principles of redox processes to energy storage devices. -Compare electrochemical cell	-Develop a culture of team work, sense of responsibility in group activities and experiments. -Appreciate contributions of electrochemistry to the social and economic development of the society.	- Definition of electrochemistry. -Definition of electrochemical cell. -Description of standard hydrogen electrode as used to determine standard electrode potentials. -Description of electrochemical cells. Include the cell reactions and e.m.f. of the galvanic cells. -Explanation of corrosion and its effects on metallic objects. -Applications of electrochemical cell: batteries (dry cells, storage batteries Comparison between electrochemical cell and electrolytic cell.	-Carry out practical activities to discuss the working of the galvanic cell (e.g.: with copper and zinc electrodes) and make presentation. - In groups, do exercises involving calculations about galvanic cells (e.g.: using standard electrode potentials and Nernst equation). Report the information obtained Research in groups and make presentations about the applications of electrochemistry (e.g. observe dry cells, car battery, telephone batteries...).

	with electrolytic cell.			
Assessment criteria: Student teacher Can construct and explain the working of galvanic cells, appreciate the applications of electrochemistry				
Link to other subjects: Physics (electricity), Mathematics (operations and logarithmic functions)				
Resources: Computer, projector, internet access, appropriate chemicals and apparatus				

SUBJECT: CHEMISTRY			YEAR : 3	OPTION: SME
TOPIC AREA: CHEMICAL ENERGETICS		SUB TOPIC AREA: ENTHALPY CHANGE OF CHEMICAL REACTION		
Unit 10:Enthalpy change of reactions			No. of periods:10	
Key Unit competence: The student teacher should be able to design an experimental procedure to verify the enthalpy changes in a chemical reaction				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
-explain the differences between exothermic and endothermic reactions using profile energy diagrams. Derive the relationship between heat energy and temperature. -Define heat of reaction, standard enthalpy change of combustion, enthalpy of neutralization, enthalpy of solution, enthalpy of hydration and lattice enthalpy. -Describe an experimental procedure in determination of heat of combustion.	-Develop practical experimental skills about enthalpy changes of reactions, interpreting results and drawing valid conclusions. -Carry out practical activities to determine enthalpy change of reactions (enthalpy change of combustion of ethanol, enthalpy change of neutralization). -Calculate the enthalpy change of combustion, neutralization and dissolution from experimental data	-Develop team approach and sense of responsibility in performing experiments. -Have confidence in handling chemicals and apparatus during practical activities. -Respect of procedure during experiments of combustion and neutralization. Respect of other's opinion during group discussions.	- types of systems (open, closed and isolated) - heat energy and temperature - energy profile diagrams of different chemical reactions -Definition of standard enthalpy of reaction (enthalpy change of combustion, enthalpy change of neutralization, enthalpy change of solution, enthalpy of hydration and lattice enthalpy. -Experimental methods for finding the standard enthalpy of reaction (enthalpy change of combustion, enthalpy change of neutralization, enthalpy change	-Carry out practical activities to determine enthalpy change of reactions (Enthalpy change of combustion of ethanol, enthalpy change of neutralization of hydrochloric acid with sodium hydroxide solution and enthalpy of dissolution of sodium hydroxide in water). Presentation of the observations is required.

			of dissolution).	
Assessment criteria:Can design an experimental procedure to verify the enthalpy changes in a chemical reactions				
Link to other subjects: Physics (thermodynamics), Mathematics (vectors				
Resources: Appropriate chemicals and apparatus				

6. REFERENCES

Addison- wesley chemistry. (2000). *chemistryFifith edition*. Prentice Hall,inc, New York, USA

Arthur Atikson at al. (2004). *New chemistry s_1 s_2 s_3*. Longman.

Brown L. Theodore, at al. (2009). Chemistry *The central science. Upper sandle* river: Pearson Education.

Cambridge International Examinations. (2013). Syllabus Cambridge As /A level 9701 *chemistry for examination in 2015*, England: Cambridge International Examinations

Daniel Iyamuremye and MutumoyRiziki. (2013). *Senior secondary certificate chemistry for Rwanda.* Nairobi: East African educational publishers Ltd.

Jim Clark and Ray Oliver. (2007). *Longman chemistry for IDCSE.*: Pearson Education Limited,England

Martin, S. S. (2003). *Chemistry The moleculas nature and change Third edition*. New York: McGraw-Hill Higher Education.

Mathews, P. (2003). *Advanced chemistry*. Cambridge University.

Peter Cann and Peter Hughes. (2002). *Chemistry for advanced level. Manchester: Film setting Ltd*.

Ramsden, E. (2000). *A- Level chemistry fourtth edition*. Delta Place: Nelthonethornes.

Rwanda Education Eoard. (2015). *Advanced level chemistry syllabus S4-S6*, Kigali: CurriculumandPedagogical Materials Department (CPMD).

ANNEXES

1. TTC Subjects and time allocations

Table 7: Science and Mathematics Education (SME)

SN	SUBJECT	PERIODS PER WEEK		
		Y1	Y2	Y3
1	Foundations of Education *	6	5	5
2	Mathematics*	6	6	6
3	Integrated Sciences	11	0	0
4	Chemistry*	0	5	5
5	Biology*	0	5	5
6	Physics*	0	5	5
7	English*	5	4	4
8	Kinyarwanda*	2	2	2
9	Creative Performance (Music & Fine arts)	2	2	2
10	Physical Education	1	1	1
11	French	2	2	2
12	Entrepreneurship*	2	2	2
13	ICT	2	2	2
14	Teaching Methods and Practice (TMP)*	6	4	4
15	Special Needs Education (SNE)	2	2	2
16	Religious education	1	1	1
17	Kiswahili	1	1	1
18	Social studies	2	2	2
19	Co- Curricular	1	1	1
	Individual Study	8	8	8
	School Attachment			1stTerm
	TOTAL	**60**	**60**	**60**

At the end of year three, students in this option will take national exams in nine subjects: Common subjects (Foundations of Education, Teaching Methods and Practice, English, Kinyarwanda and Entrepreneurship), Mathematics, Physics, Chemistry and Biology.

2. Chemistry overview

TOPIC AREAS	SUB-TOPIC AREA	COMPETENCES		
		YEAR 1	YEAR 2	YEAR 3
		INTEGRATED SCIENCE	CHEMISTRY	CHEMISTRY
1. ATOMISTICS	1.1.Periodic table	Use atomic structure and electronic configuration to demonstrate the trends in the physical properties of elements and how the nature of the bonding is related to their properties	Compare the chemical properties of the Group 13 elements and their compounds in relation to their position in the Periodic Table	
		Compare the physical properties of elements and their compounds in relation to their position in the Periodic Table	Describe the trends in chemical properties of s block elements and their compounds	
			Compare the chemical properties of the Group 14 elements and their compounds in relation to their position in the Periodic Table	
			Explain the chemical properties of group 17 and their compounds	

			Explain the variation of Period 3 elements and their compounds in relation to their positions in the Periodic Table.	
		Describe and Demonstrate how the nature of the bonding is related to the properties of covalent compounds and molecular structures. .		
		Describe and demonstrate how properties of ionic compounds and metals are related to the nature of their bonding	Explain the properties and uses of transition metals	
	1.2.Radioactivity			Explain the importance and dangers of radioisotopes in everyday life
2. Organic compounds and materials	**2.1. Aliphatic compounds**		Apply IUPAC rules to name organic compounds and explain the types of their isomers	
			Relate the chemical properties of alkanes to their reactivity and uses and explain their physical properties.	

			Relate the chemical properties of alkenes and alkynes to their reactivity and uses and explain their physical properties	
			Relate the physical and chemical properties of halogenoalkanes to their reactivity and uses.	
			Compare the physical and chemical properties of alcohols and ethers and explain their preparation methods, reactivity and uses.	
			Compare the chemical nature of carbonyl compounds to their reactivity and uses.	
			Compare the chemical nature of carboxylic acids and acid halides to their reactivity.	
			Relate the functional groups of esters, acid anhydrides, amides and nitriles to their reactivity and uses, and describe their preparation methods	
			Relate the chemical nature (structure) of amines and amino acids to their properties, uses and reactivity.	
	2.2.Aromatic compounds			Relate the chemistry and uses of benzene to its nature and structure.

				Compare and explain chemical reactivity of aromatic ketones, aldehydes, carboxylic acids and amines.
	2.3Polymerization			Relate the types of polymers to their structures, properties and uses.
3. Reaction kinetics	**3.1. Factors that affect the rate of reactions**			Explain the factors that affect the rate of reactions.
4. Equilibrium	**4.1. Chemical equilibrium**		Deduce how concentration, pressure, catalyst and temperature affect chemical processes in industry.	
			Write expressions of equilibrium constant Kc and Kp, calculate and interpret their values in relation to the yield of the products in reversible reactions.	
	4.2. Ionic equilibrium		Explain the acid-base theories (Arrhenius, Bronsted–Lowry, Lewis)	Prepare solutions, measure and calculate their pH, explain the concept of buffer solution, and its applications in manufacturing and biological processes.

5. Solution and solubility	5.1. **Determination of concentration of solutions**	Prepare standard solutions and use them to determine concentration of other solutions by titration		
				Calculate the solubility product constant of sparingly soluble salts and deduce the applications of common ion effect in industry.
6. Electrochemistry	6.1. **Electrolysis and electrochemical cells**			Explain the concept of reduction and oxidation and balance equations for redox reactions.
				Explain the working of electrochemical cells and their industrial applications.
7. Chemical energetics	**7.1. Enthalpy change of chemical reaction**		Explain the concept of energy changes and energy profile diagrams for exothermic and endothermic reactions.	Design an experimental procedure to verify the enthalpy changes in a chemical reaction
Total number of periods		**396**	**180**	**120**