THE REPUBLIC OF UGANDA

Lower Secondary Curriculum

CHEMISTRY SYLLABUS

NCDC
NATIONAL CURRICULUM DEVELOPMENT CENTRE

CONTENTS

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FOREWORD

This four-year Syllabus for Chemistry is for one of the 20 subjects of the Lower Secondary School Curriculum. The Syllabus builds upon concepts, skills, attitudes, and values developed at primary school level, which provide a firm foundation for further learning of Chemistry. The Learning Outcomes of the syllabus are structured to provide the learner with opportunities to develop understanding of Chemistry within the different topics, across the four-years.

Chemistry provides a foundation for a knowledgeable, skilled, and responsive workforce, which is crucial for the development of the country's economy, thus contributing to the livelihoods of all. It can also be the basis for entrepreneurial development. The study of Chemistry contributes to the development of independent critical thinking, creativity, invention, and innovation which helps the learner to use evidence to evaluate the way Science can be applied in everyday life. Applied Chemistry has the potential to make a beneficial impact on how technology can enhance traditional agricultural practices and medicine. In this way, scientific knowledge, skills, and attitudes contribute purposefully towards the improvement of the health and material wellbeing of individuals, and our society as a whole.

Indigenous Science is our livelihood; therefore, this Syllabus has complemented the inherited indigenous knowledge and skills about the way people live and interact with the natural environment. The intention of this Chemistry syllabus, therefore, is to positively affect everyday life, by improving understanding of the natural phenomena.

The specific needs of the higher-achieving minority learners who will proceed to study Chemistry at a higher level are presented in this syllabus. The teachers of Chemistry are required to shape the learning experiences to cater for the needs and interests of all.

I, therefore, endorse this Syllabus as the official document for the teaching and learning of Chemistry at the Lower Secondary School level throughout the country.

Hon. Janet K. Museveni
The First Lady and Minister for Education and Sports

ACKNOWLEDGEMENT

National Curriculum Development Centre (NCDC) would like to express its appreciation to all those who worked tirelessly towards the production of this Lower Secondary Syllabus.

Our gratitude goes to the Ministry of Education and Sports (MoES), for overseeing the development of the syllabus and taking timely decisions whenever necessary. They worked as a team with NCDC to produce this syllabus. Their decisions have been invaluable in getting this work completed as required. Our thanks also go to our partners in education who provided the necessary guidance.

We would also like to thank the members of the public who made helpful contribution towards shaping this syllabus. Their efforts are instrumental towards having this syllabus implemented in the schools and for improved quality of education in Uganda.

The Centre is indebted to the learners, teachers and consultants from Cambridge Education and Curriculum Foundation UK, who worked with NCDC specialists. Great thanks go to members of Chemistry Working Group who worked tirelessly to put together the necessary facts and guidance in producing this Syllabus.

Furthermore, NCDC would like to thank the World Bank for the initial technical and the Government of Uganda for the financial support towards the Lower Secondary Curriculum Review.

Last but not least, NCDC would like to acknowledge all those behind the scenes who formed part of the team that worked hard to finalise the work on this Syllabus.

NCDC takes responsibility for any shortcomings that might be identified in this publication and welcomes suggestions for effectively addressing the inadequacies. Such comments and suggestions may be communicated to NCDC through P.O. Box 7002 Kampala or email *admin@ncdc.go.ug* or through our *Contact Us* page on our website at *www.ncdc.go.ug*.

Grace K. Baguma
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INTRODUCTION

The Uganda Vision 2040 aims to transform Uganda into a modern and prosperous country; however, the National Development Plan recognises the existing weaknesses in education, including the low efficiency and variable quality at the secondary level. The Sustainable Development Goal 4 advocates for equitable and quality education, while the NDP II focuses on enhancement of human capital, development, strengthening mechanisms for quality, effective, and efficient service delivery and improvement of quality and relevance of skills development. The NRM Manifesto (2016-2021), emphasises continuous assessment of examination systems and strengthening soft skills, which promote self-esteem, conscientiousness, and a generally positive attitude to work, promoting e-learning, and computer literacy in order to enhance learning outcomes. All these are lacking and where they exist it is at a minimum level.

In line with the above, the Education and Sports Sector Strategic plan (2017/20) advocates for delivery of equitable, relevant, and quality education for all. The current secondary school curriculum of Uganda, although highly regarded, is focused on the needs of a minority academically oriented elite, yet the needs of the majority of learners need to be the focus. The Ministry of Education and Sports (MoES) through the National Curriculum Development Centre (NCDC) therefore, undertook a review of the Lower Secondary Curriculum, aimed at providing a learning environment, opportunities, interactions, tasks, and instructions that foster deep learning by putting the learner at the centre of the learning experience. This is in line with the aims of secondary education in Uganda, as for provided in the Government White Paper on education (1992) as outlined below:

The aims of secondary education in Uganda are:

- Instilling and promoting national unity, an understanding of the social and civic responsibilities;
- Promoting an appreciation and understanding of the cultural heritage of Uganda including its languages;
- Imparting and promoting a sense of self discipline, ethical, and spiritual values, personal and collective responsibility and initiative;
- Enabling individuals to acquire and develop knowledge and an understanding of the emerging needs of the society and economy;
- Providing update and comprehensive knowledge in theoretical and practical aspects of innovative production and modern management methods in the field of commerce and industry and their application in the context of socio-economic development of Uganda;
- Enabling individuals to develop basic scientific, technological, technical, agricultural, and commercial skills required for self-employment;
- Enabling individuals to develop personal skills of problem solving, information gathering, and interpretation, independent reading and writing, as well as self-improvement through learning and development of social, physical, and leadership skills such as are obtained through games and sports, societies, and clubs;
- Laying the foundation for further education;
- Enabling the individual to apply acquired skills in solving problems of the community, and
- Instilling positive attitudes towards productive work.

BACKGROUND TO THE NEW CURRICULUM

The review was based on the Education Sector Strategic Plan (ESSP), 2009 – 2018) which set out strategies to improve the quality and relevance of secondary education. The ESSP's sub objective 2.2 was to ensure that "Post-primary students [are] prepared to enter the workforce and higher education". This is also in line with the current strategic plan of 2017-2020. To achieve this objective, one of the Ministry's strategies was to revise the curriculum and improve instruction and assessment by eliminating the short comings in the current curriculum.

The review focused on: producing a secondary school graduate who has the competences that are required in the 21st century; promoting values and attitudes, and effective learning and acquisition of skills in order to reduce unemployment among school graduates.

The review also aimed at reducing the content overload and contact hours in the classroom so as to create time for: research and project work, talent development and creativity; allowing for emerging fields of knowledge across all subjects, and doing away with obsolete information. There was a need to address the social and economic needs of the country like the mining sector, tourism, services provision, science and technology development, and to ensure rigorous career guidance programme to expose learners to the related subjects. This will enable learners to make informed choices as they transit and to equip them with knowledge and skills that will enhance their competitiveness in the global value chain.

To meet these requirements, the reforms are based on:

- The development of a holistic education for personal and national development based on clear shared values.
- A commitment to higher standards, deeper understanding, and greater opportunities for learners to succeed.
- A focus on the key skills that are essential to work, learning, and life, and which will promote lifelong learning.
- An integrated approach that will develop the ability to apply learning in practical situations.

The ESSP further outlines what the reforms imply:

"This reform will necessitate a sweeping revision of the general secondary curriculum, away from strictly academic learning objectives that are thought to prepare students for erudite higher education and towards a set of competencies that serve both those who continue their education after S4 and those who choose to enter the workforce. The new curriculum will enable learners to acquire specific vocational skills that they can use once they enter the world of work. The new curriculum will help learners make informed decisions as citizens and family members, and it will give those who continue with their education, either immediately in S5 or later in life, the learning skills they need to think critically and study efficiently."

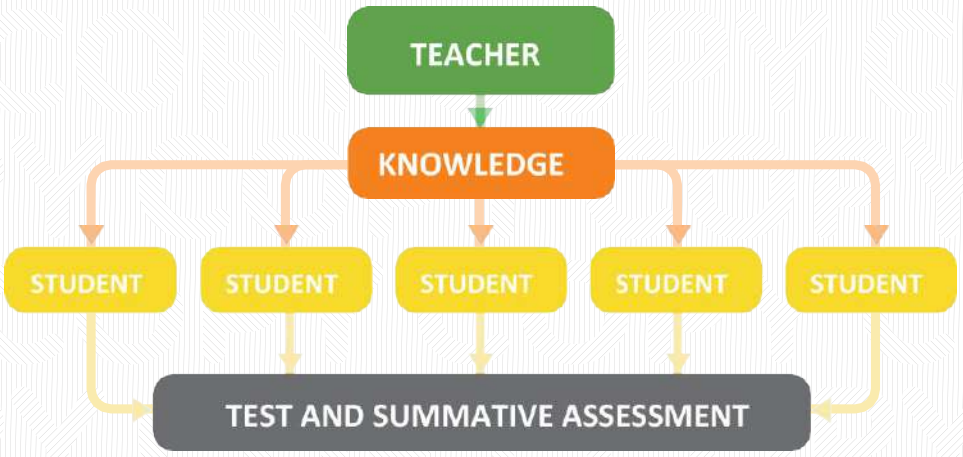
KEY CHANGES IN THE NEW CURRICULUM

The key change in the new curriculum is a move from a knowledge-based curriculum to a competence and skill-based curriculum. It is no longer sufficient to accumulate large amounts of knowledge. Young people need to develop the ability to apply their learning with confidence in a range of situations. They need to be able to use knowledge creatively. A level of competence is the ability to use knowledge rather than just to acquire it. This requires an active, learner-centred rather than passive, teacher-centred approach.

This approach to teaching and learning is in support of the Sustainable Development Goals (SDG's), otherwise known as the Global Goals. These are a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity. The key changes in the curriculum will ensure that Uganda is making good progress towards SDG 4 in particular which aims to ensure equitable quality education and promote lifelong learning opportunities for all.

The change can be summarised in the following diagrams.

THE KNOWLEDGE-BASED CURRICULUM



Knowledge-based teaching was based on transferring knowledge from the teacher to the students. The teacher had knowledge and transferred this knowledge to the students by lecturing, talking, and asking them to read the text book or writing notes on the board for the students to copy and learn. Students acquired the knowledge, often without fully understanding it, and were tested at the end of a unit, term or school course to see if they had remembered it. The knowledge was based mainly on the knowledge in the subjects traditionally taught at University, and little attempt was made to make it relevant to young people's own lives. The whole education system was seen by many people as a preparation for University, but the vast majority of learners never reach university. The new curriculum will cater for this majority as well as those who later on go to University.

THE NEW COMPETENCE BASED CURRICULUM

In the new competence-based approach, the "student" becomes a "learner". The new Learning Outcomes can only be achieved through active engagement in the learning process rather than simply absorbing knowledge given by the teacher.

The teacher needs to build on the learners' own knowledge and experience and create Learning Activities through which learners can explore the meaning of what is being learned and understand how it is applied in practical situations.

Teaching and learning becomes a two-way process of dialogue between the Teacher and Learners. Learners also learn from each other through discussion. Assessment also becomes a two-way process of formative and summative assessment; not just to give grades but to find out problems the learners may be having and help to solve them.

THE NEW CURRICULUM

The new curriculum focuses on four "Key Learning Outcomes" of: self – assured individuals, responsible and patriotic citizens, lifelong learners, and positive contributors to society.
The curriculum emphasises knowledge, application, and behavioural change. It is based on a clear set of values which must be imparted to learners during the learning process.

At the heart of every subject, there are generic skills that allow development into lifelong learners. Besides, there are also cross cutting challenges that are embedded across subjects to enable learners understand the connections between the subjects and complexities of life.

Key Learning Outcomes

The new curriculum sets out 'Key Learning Outcomes' that sum up the expectations of the curriculum as a whole, and sets out clearly the qualities that young people will develop.

By the end of the educational process, young people will become:

Self-assured individuals who:

- Demonstrate self- motivation, self-management, and self-esteem.
- Know their preferences, strengths, and limitations.
- Adjust their behaviour and language appropriately to different social situations.
- Relate well to a range of personality types.

Responsible and patriotic citizens who:

- Cherish the values promoted in the curriculum.
- Promote the development of indigenous cultures and languages, and appreciate diversity, equity, and equality.
- Apply environmental and health awareness when making decisions for themselves and their community.
- Are positive in their identity as individuals and global citizens.
- Are motivated to contribute to the wellbeing of themselves, their community and the nation.

Lifelong learners who:

- Can plan, reflect, and direct their learning
- Actively seek lifelong learning opportunities for personal and professional development

Positive contributors to society who:

- Have acquired and can apply the Generic Skills.
- Demonstrate knowledge and understanding of the emerging needs of the society and economy.
- Understand how to design, make, and critically evaluate products and processes to address needs.
- Appreciate the physical, biological, and technological world; make informed decisions about sustainable development and its impact on people and the environment.

Values

The new curriculum is based on a clear set of values. These values underpin the whole curriculum and the work of schools. They are also the values on which learners need to base their lives as citizens of Uganda. The values are derived from The Uganda National Ethics and Values Policy of 2013. They are:

- Respect for humanity and environment
- Honesty; uphold and defend the truth at all times
- Justice and fairness in dealing with others
- Hard work for self-reliance
- Integrity; moral uprightness and sound character
- Creativity and innovativeness
- Social Responsibility
- Social Harmony
- National Unity
- National Consciousness and patriotism

These values are not taught directly in lessons, nor will they be assessed, but they will inform and shape all teaching and learning.

Generic Skills

The generic skills lie at the heart of every Subject. They are the skills that enable the learner to access and deepen learning across the whole curriculum. They are the same skills that are sought by employers and which will unlock the world of work. They allow young people to develop into lifelong learners who can adapt to change and cope with the challenges of life in the 21st Century.

Young people need to be able to think critically and solve problems, both at school and work. They need to be creative and innovative in their approach to learning and life. They must be able to communicate well in all forms, co- operate with others and also work independently. They must also be able to use functional mathematics and ICT effectively. The details of the generic skills are:

Critical thinking and problem-solving

- Plan and carry out investigations
- Sort and analyse information
- Identify problems and ways forward
- Predict outcomes and make reasonable decisions
- Evaluate different solutions

Creativity and innovation

- Use imaginations to explore possibilities
- Work with others to generate ideas
- Suggest and develop new solutions
- Try out innovative alternatives
- Look for patterns and make generalisations

Communication

- Listen attentively and with comprehension
- Talk confidently and explain ideas/opinions clearly
- Read accurately and fluently
- Write and present coherently
- Use a range of media to communicate ideas

Co-operation and Self-directed Learning

- Work effectively in diverse teams
- Interact effectively with others
- Take responsibility for own learning
- Work independently with persistence
- Manage goals and time

Mathematical Computation and ICT Proficiency

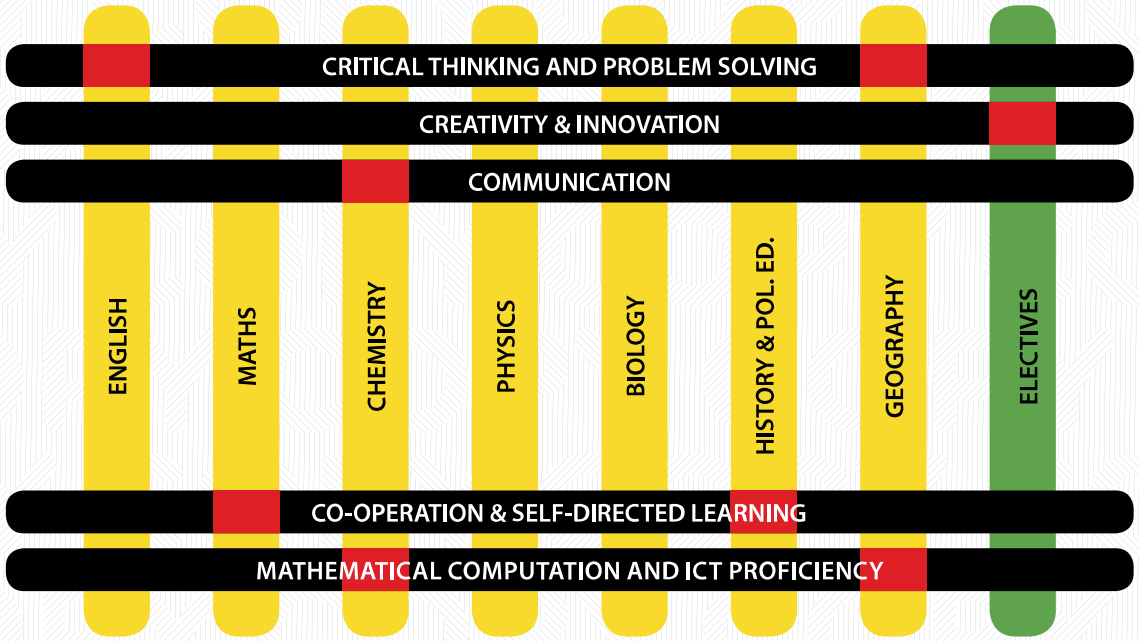
- Use numbers and measurements accurately
- Interpret and interrogate mathematical data
- Use mathematics to justify and support decisions
- Use technology to create, manipulate, and process information
- Use technology to collaborate, communicate, and refine their work

GENERIC SKILLS WITHIN CHEMISTRY

These skills are not separate subjects in themselves; they are developed within the subjects of the curriculum. They also help learning within those subjects. It is when these generic skills are deployed that learning is most effective.

The generic skills are a key part of the new curriculum. They have been built into the syllabuses for each of the subjects which provide the context for the skills development. Chemistry provides a rich context for learners to communicate, co-operate, and think critically about how the world works, and to understand the world from a scientific point of view.

The subjects also provide the contexts for progression within the skills. The same skills definitions apply to all year groups, and skills progression is provided by the increasing complexity of the subject matter within each subject. For example, within 'critical thinking', learners begin thinking critically about the relatively simple subject matter in Senior 1 and then progress to thinking about the much more complex matters in Senior 4. Thus, the progression is in the increasing complexity of the matters being thought about.



Cross-cutting Issues

There are some issues that young people need to learn about, but which are not confined to one subject . These are the 'Cross-cutting Issues' and they need to be studied across the subjects . These issues develop learners' understanding of the connections between the subjects and the complexities of life.

The Cross-cutting issues identified in the curriculum are:

- Environmental awareness
- Health awareness
- Mixed abilities and involvement
- Life skills
- Socio-economic challenges
- Citizenship and patriotism

(For details on cross-cutting issues, refer to the Curriculum Framework document, page 11).

These have been built into the syllabuses of each Subject. The way in which they operate within the subject is very similar to the generic skills. Chemistry provides a very good context for considering environmental and health awareness, and to understand the complex and diverse world in which we live.

ICT Integration

ICT is embedded as a learning/teaching tool. ICT integration framework is given below and cuts across all the subjects on the curriculum.

CATEGORY OF A TASK IN THE SYLLABUS	ICT APPLICATION (HOW ICT WILL BE INTEGRATED FOR THE TASK CATEGORY)
Field works	Use of cameras to take photos and record videos
Presentations in class	Use presentation application
Key words and meanings	Use online dictionary or search online
Drawing/graphics	Use publishing software, Word processor
Role play, narrations	Use audio and video recordings
Demonstrations	Use audio and video recordings and simulations
Locating and putting marks on an area	Use digital/online mapping
Present findings in graphic and written format	Use desktop publishing software or word processor
Showing data charts	Use spreadsheet software
Group discussions	Mind-mapping software
Search for extra reading materials	Download files on Internet or by sharing
Writing equations and formulas	Use equation editors
Carrying out academic research	Using the Internet and other academic applications like "Encarta", "Britannica", etc.
Sharing or learning with people across the world	Forming learning networks, formation of blogs, social media, emails, etc.

THE CHEMISTRY SYLLABUS

Chemistry is a compulsory subject from Senior 1 to Senior 4.

Time allocation

CHEMISTRY	S1 & S2	S3 & S4
	3 periods a week	4 periods a week

Rationale

The application of scientific principles and the conduct of relevant research are of significant importance in identifying, assessing, and realising the potential of the resources of Uganda. A good foundation in the sciences will help citizens of Uganda to respond to the challenges of a rapidly changing world using the scientific approach.

Chemistry is concerned with the physical and chemical properties of substances and the interaction of energy and matter. The study of Chemistry involves an investigation into chemical reactions and processes. The discipline seeks to explain and predict events at the atomic and molecular level. Through the principles of Chemistry, learners will understand everyday life, nature and technology, and the significance of the wellbeing of man and the environment.

The Ugandan Chemistry Syllabus is redesigned to allow learners to work individually and with others in practical, field, and interactive activities that are related to theoretical concepts in the course. It is expected that learners will apply investigative and problem-solving skills, effectively communicate scientific information, and appreciate the contribution the study of chemistry makes to their understanding of the world.

The syllabus places greater emphasis on the understanding and application of chemical concepts and principles and different learning styles and needs, so that learners will develop skills that will be of long- term value in an increasingly technological world, rather than focusing on large quantities of factual information. In addition, it encourages the use of various teaching and learning strategies while at the same time catering for multiple intelligences.

It contributes to the development of the ideal Ugandan citizen as articulated by the Education White Paper of 1992 in the following areas: respect for human life, awareness of the importance of living in harmony with the environment; demonstrates multiple literacies, independent and critical thinking and the innovative application of science and technology to problem solving. In keeping with the UNESCO Pillars of Learning, on completion of this course of study, learners will learn to do, to be and transform themselves and society.

This syllabus aims to:

- appreciate and understand natural phenomena and the ways in which materials behave,
- be aware of the power, impact, and influence which Chemistry has in a modern scientific world and to emphasise that there is a responsibility that Chemistry be used for the good of the society and for the preservation of the environment,
- appreciate, understand, and use methods of science,
- see the relevance of Chemistry to everyday life,
- appreciate and understand the role of Chemistry in enabling materials to be used in the service of mankind, in Uganda and elsewhere,
- understand basic chemical concepts in sufficient depth to provide an adequate foundation for specialisation,
- develop the spirit of inquiry and to continue the search for new ways in which materials may be used in the service of mankind,
- appreciate the inter-relationships among Chemistry, Biology, Physics, Mathematics and other subjects,
- make use of chemical data, concepts, principles, and terminology in communicating chemical information,
- develop the ability to work independently and collaboratively with others when necessary,
- appreciate the significance and limitations of science in relation to social and economic development,
- integrate Information and Communication Technology (ICT) tools and skills into the teaching and learning of chemical concepts,

Teaching and Learning: Chemistry

The thrust of the new syllabuses is experiential and towards deeper understanding. The focus in Chemistry is on the development of understanding through scientific enquiry and rational thought.

The new syllabuses provide learners with a wide range of contexts in which to develop this understanding. These contexts are designed to engage the interest of the learner and to provide opportunities to build life-related knowledge, experience, and skills. Teachers are encouraged to go beyond the textbooks and provide as many meaningful contexts as possible. The generic skills have been integrated throughout the curriculum and can only be acquired through active approaches.

The role of the teacher is to build on learners' existing knowledge and experience through posing problems to the learners. This makes them think about their own ideas and experiences as well as adding new knowledge and skills to it.

Learners need to interact with real situations inside and outside the classroom. They need to look at pictures or diagrams, examine statistics, or read texts from a range of sources. They need to find out knowledge and ideas for themselves. They should then be expected to express these in their own words, not those of the teacher, and so demonstrate that they have understood what they have learnt.

In this approach, learners are encouraged to:

- be responsible for their learning.
- think for themselves and form their ideas and opinions.
- become critical thinkers, ready to face new challenges and situations for themselves.

THE CHEMISTRY PROGRAMME PLANNER

SENIOR 1	THEME	TOPIC	DURATION (NUMBER OF PERIODS)
Term 1	Introduction to Chemistry and Experimental Techniques	Chemistry and Society	6
		Experimental Chemistry	12
	Particle Nature of Matter	States and changes of states of matter	9
		Using materials	9
Term 2	Temporary and Permanent Changes to Materials	Temporary and permanent changes	16
		Mixtures, Elements, and compounds	20
Term 3	Air and environment	Air	10
		Water	14
	Earth and Space	Rocks and Minerals	12
		Total	**108**

SENIOR 2	THEME	TOPIC	DURATION (NUMBER OF PERIODS)
Term 1	Acids and Alkalis	Acids and alkalis	12
		Salts	12
	The Periodic Table	The Periodic Table	12
Term 2	Carbon in the Environment	Carbon in the Environment	36
Term 3	Order of Reactivity of Metals	The Reactivity Series	36
		Total	**108**

SENIOR 3	THEME	TOPIC	DURATION (NUMBER OF PERIODS)
Term 1	Carbon in Life	Carbon in Life	30
	Structures and Bonds	Structures and Bonds	18
Term 2	Using Equations in Chemistry	Formulae, Stoichiometry and mole concept	30
	Structures of Substances	Properties and Structures of Substances	18
Term 3	Fuels and Energy	Fossil Fuels	20
	Reactants and Products	Chemical reactions	28
		Total	**144**

SENIOR 4	THEME	TOPIC	DURATION (NUMBER OF PERIODS)
Term 1	REDOX Reactions	Oxidation and Reduction Reactions	18
		Industrial Processes	30
Term 2	Periodicity	Trends in the Periodic Table	20
	Thermochemistry	Energy Changes during Chemical Reactions	28
Term 3	Consumable Chemicals	Chemical for Consumers	20
		Nuclear Processes	12
		Total	**128**

The syllabus details for all subjects are set out in three columns:

LEARNING OUTCOMES	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT ACTIVITIES
The knowledge, understanding or skills expected to be learned by the end of the topic.	The sorts of learning activities which include the generic skills that will help learners achieve the Learning Outcomes.	Opportunities for assessment within the learning

Teachers should base their lesson plans on the Learning Outcomes using the Suggested Learning Activities as a guide. These are not the only possible learning activities; therefore, teachers are encouraged to extend these and devise their own that are appropriate to the needs of their class.

DETAILED SYLLABUS FOR CHEMISTRY

SENIOR 1: TERM 1

Theme: Introduction to chemistry and experimental techniques

TOPIC 1.1: CHEMISTRY AND SOCIETY — 6 PERIODS

Competency: The learner assesses the application of chemistry in our everyday life and its contribution to our economy.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. know appropriate activities to explain the discrete nature of chemistry (k, u) b. understand why chemistry is studied and how it overlaps with other subjects such as biology, physics, mathematics, and geology (k, u) c. understand the importance of chemistry and relate knowledge of chemistry to relevant careers (u) d. know the contribution of chemistry to the Ugandan economy (k)	• In groups, learners discuss what they already know about chemistry and common chemicals in pharmaceutics and cosmetics, plastics, food and beverages, soaps and detergents, water treatment, and indigenous chemistry in local environments. They produce a mind-map to show their conclusions. • In groups, learners brainstorm why we study chemistry and careers related to knowledge of chemistry; areas such as human and animal medicine, pharmacy, chemical engineering, teaching, etc. Learners produce a table to present their ideas. • Learners research how chemistry contributes to the economy of Uganda: medicines, industries, transport, and agriculture. • In groups, learners make a field visit and carry out research to explore the common industrial products in our country and relate their uses to the importance of chemistry. Groups write a report on their research and give a presentation in class. • Individuals write reports of visits to show knowledge of the importance of chemistry to the Ugandan society.	• Observe group interactions and engagement in field study and research, offering guidance to ensure all are participating and learning. • Listen to learners discussing common chemicals, the reasons for studying chemistry and brainstorming on the careers related to chemistry. Intervene by asking questions to help them achieve learning outcomes. • Gauge learners' progress towards achieving learning outcomes by assessment of their products: common chemical mind-maps; tables of reasons for studying chemistry and chemistry careers; group reports and presentations on chemistry in Uganda, and individual reports.

SENIOR 1: TERM 1

Theme: Introduction to chemistry and experimental techniques

TOPIC 1.2: EXPERIMENTAL CHEMISTRY 12 PERIODS

Competency: The learner **u**nderstands that chemistry is a process of evidence-based enquiry involving the collection of evidence about the natural world, the identification of trends and patterns in the evidence and the development of theories that help us explain the evidence.

LEARNING OUTCOMES The learner should be able to:	**SUGGESTED LEARNING ACTIVITIES**	**SAMPLE ASSESSMENT STRATEGY**

a. know laboratory rules and regulations and understand the importance of risk assessment in order to work safely. Know action required in the event of an accident (k)
b. know and use laboratory equipment (such as burettes, pipettes, measuring cylinders, thermometers, the Bunsen burner, and balance) appropriately for measuring time, temperature, mass, and volume (s, k)
c. understand the scientific method to carry out investigations and the importance of risk assessment to keep self and others safe (u)
e. know how to purify a mixture, given information about the substances involved (s, k)
f. know how to identify substances and their purity by using their melting and boiling points (k, s)
	• In groups, learners a) examine a list of laboratory rules and produce a table or diagram showing the reasons for each rule; b) observe a demonstration of how to deal with a fire and how a fire extinguisher is used, and produce a set of guidelines
	• In groups, learners plan and carry out an investigation using measuring cylinders, separating funnel, a thermometer, Bunsen burner and balance to mix 5g of sand and 200 cm3 water, separating them and recording detailed observations and measurements. Learners should:
	  • plan by selecting techniques, apparatus and materials
	  • make predictions based on prior knowledge and propose a hypothesis
	  • record observations and measurements in a table
	  • interpret observations and report results
	  • compare observations and results with other groups
	  • discuss and develop explanations
	• In groups, learners plan and carry out investigations, using the scientific method to purify named impure substances and formally write up investigations individually. Techniques:
	  • physical separation e.g. Sulphur and iron filings
	  • dissolving, filtration, and crystallization, e.g. salt and sand
	  • distillation of a solution and fractional distillation, with particular references to the fractional distillation of crude oil, liquid air and fermented liquor
	• Ingroups, learners carry out chromatography using some common dyes/inks and then:
	• interpret chromatograms
	• develop and apply knowledge of paper chromatography in explaining results
	• research and use locating agents in chromatography of colourless compounds
	Groups discuss, research and agree on explanations of their observations. Individuals record results and conclusions.
		• Observe the learners in the laboratory when taking part in practical experiments and offer guidance to ensure safe practice and effective use of techniques so that learning outcomes are achieved
		• Listen to group discussions and:
		  • guide learners as necessary on the use of different apparatus and correct techniques for using them safely
		  • intervene to ensure knowledge, understanding, and skills are developing appropriately
		• Gauge learners developing knowledge, understanding, and skills through assessment of products: reasons for laboratory rules and fire guidelines, observations and results of re- boiling water, experiment reports on separating mixtures, including chromatography, and purity of substances.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• In groups, learners investigate the melting and boiling points of substances, comparing their results with those of pure substances and drawing conclusions about the purity of their samples. Groups produce tables comparing their actual results with theoretical results and show conclusions and possible experimental errors.	

SENIOR 1: TERM 1 Theme: Particle nature of matter

TOPIC 1.3: STATES AND CHANGES OF STATES OF MATTER 9 PERIODS

Competency: The learner uses knowledge of the arrangement and motion of particles to explain the properties of solids, liquids, and gases.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand that matter is anything which occupies space and has mass and can exist in a solid, liquid, gas, and plasma form (u)
b. understand that solids, liquids, and gases have different properties including shape, pouring, and compressing (u, s)
c. know the kinetic theory of matter and use it to explain particle arrangement, inter-particle forces, movement of particles and the properties of solids, liquids, and gases (k, u)
d. understand that a change from one state to another involves either heat gain or heat loss (u, s)
e. appreciate the cooling effect of evaporation and how this contributes to maintaining constant body temperature (k, u, s)
	• Individually, learners research what is known about states of matter and kinetic theory, and in groups, they discuss where they are observed in everyday life.
	• In groups, learners use the results from Topic 1.2 and explain them in terms of how matter exists and kinetic theory.
	• In groups, learners plan and use the scientific method to investigate changes of state of matter and record observations in a table, e. g melting a candle wax, or ice, boiling water (observe the change of state with temperature), heating iodine or naphthalene.
	• In groups, learners investigate diffusion in a gas, liquid, and solid using the scientific method
	  • Ammonia, from concentrated ammonia solution and, concentrated hydrochloric acid to form ammonium chloride.
	  • Potassium manganate (VII) in water and in a hot gel solution.
	  • In groups, learners observe Brownian motion and use the particle theory to explain:
	  • the properties of solids, liquids and gases and phenomena such as gas pressure, clothes drying, rain formation, and making a cup of tea, and
	  • how diffusion takes place faster in a gas than in a liquid or a solid, and then explain why this is the case.
		• Observe how individuals use texts or the Internet and use it to contribute to group discussion about the kinetic theory, and then use the information to explain states of matter. Intervene to pose questions to clarify and deepen understanding.
		• Listen to gauge progress towards achieving an understanding of kinetic theory and states of matter as solid, liquid, gas, and plasma. Intervene to ensure knowledge and understanding is developing appropriately.
		• Evaluate learners' knowledge of the kinetic theory through their explanations of diffusion and pressure illustrated by common phenomena.
		• Listen to group discussion and the explanation of changes of state to:
		  • check understanding of kinetic theory
		  • evaluate understanding of changes in states of matter, heating, and cooling,
		  • intervene where misconceptions are identified,

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• In groups, learners use the scientific method to investigate the heat changes as ice melts and water is heated and cooled, and then produce diagrams to explain why heat is taken in during melting and boiling but given out during condensing and freezing. • In groups, learners use their knowledge of kinetic theory to discuss and explain the importance of evaporation in preventing the body from overheating on a hot day.	
ICT Support The learner can: • use Internet to download or view an appropriate simulation about particle nature of matter. • use data collection tools such as a temperature sensor to capture temperature-time data.		

SENIOR 1: TERM 1 Theme: Particle nature of matter

TOPIC 2.1: USING MATERIALS 9 PERIODS

Competency: The Learner explores how materials are used and relates these uses to their molecular structures.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. know that materials used in everyday life can be classified into natural and synthetic group, and how this affects their use in everyday life (s,k) b. understand how the physical properties of polymers determine uses in everyday life such as in building, as fabrics, fabricating utensils used in homes, etc. (k, u) c. know about the molecular structures of materials and relate this to their use (k, u) d. know that polymers are useful long chain molecules made by both natural and synthetic processes (k, u) e. understand how the physical properties of polymers determine uses in everyday life such as in building, as fabrics, fabricating utensils used in homes, etc. (k, u) f. know how common materials can pollute environment and which materials can be recycled(k)	• In groups, learners classify samples of natural and synthetic material (wood, paper, natural and synthetic fibres, plastics, cotton, sisal, silk, nylon, wood, polythene, polyester, protein, rubber, starch, wool, polystyrene, Glass polytetrafluoroethene) on the basis of physical properties such as tensile and compressive strength, flexibility, elasticity, ability to absorb water, etc. They tabulate the observations and identify patterns in their observations. • Individually, learners research and write a report on the molecular structure of materials and relate the structure of polymers to their use. • In groups, learners plan and use the scientific method to investigate: a) the tensile strengths of cement strips made with different proportions of sand and cement b) the insulating properties of common roofing materials such as tiles, corrugated iron and thatch • Individuals write reports to explain why the physical and molecular structure of some materials makes them suitable for building.	• Observe learners in discussion and how they come to a group judgement about an agreed standard for 'physical properties and their use'. • Listen and gauge learners' progress towards an understanding of: o how the physical and molecular structure of materials makes them suitable for use in building o how natural and artificial polymers determine their use • Observe how learners carry out the test on burning materials, pay due regard to safety, the accuracy of their observations, and whether they can identify patterns in the nature of changes. • Using products of activities, gauge learners' understanding that some materials are resistant to change, others change in form and colour, and may give off fumes, and some may be recycled and reused in the same or different form.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

g. understand that heating changes the structure and properties of some materials (u, s)	• In groups, learners classify materials in everyday use (wood, paper, natural and synthetic fibres, plastics, cotton, sisal, silk, nylon, polythene, polyester, protein, rubber, starch, wool, polystyrene, glass, polytetrafluoroethene), into those that can be recycled and those that are not Recyclable. Learners record result in a table, and use prior learning to label them according to a) their molecular structure and b) whether they are natural or synthetic
	• Individually, learners carry out research and write reports on ways to:
	  • dispose of materials using appropriate methods to guard against polluting the environment
	  • identify which of the following materials can be recycled: paper, ink cartridges, plastic plates, old TVs, clay pots, light bulbs, broken glass, fabrics/textiles/ clothing etc.	

SENIOR 1: TERM 2 Theme: Temporary and permanent changes to materials

TOPIC 2.2: TEMPORARY AND PERMANENT CHANGES 16 PERIODS

Competency: The learner recognises occurrence of temporary and permanent changes, and their importance in everyday life.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand that many substances undergo permanent changes when they are heated or burnt, forming new materials, while other substances change temporarily (u, s)
b. recognise temporary (reversible) and permanent (irreversible) changes to matter under different conditions (u)
	• In groups, learners draw on prior learning from Topic 2 and identify which materials underwent permanent change when heated.
	• In groups, learners plan and carry out a practical investigation to find out temporary and permanent changes, and record the results in a table about:
	  • boiling and condensing water
	  • heating and cooling candle wax
	  • sublimation of iodine
	  • breaking a wooden stick
	  • melting of ice
	  • boiling an egg
	  • dissolving salt in water
	  • rusting an iron nail
		• Observe group interaction and engagement in the practical investigation and gauge skill in making and recording observations. Intervene to help them understand temporary (reversible) and permanent (irreversible) changes to matter.
		• Listen to discussions and ask questions to deepen learning.
		• Evaluate how well learners apply their learning to explain which are permanent and which are temporary changes.

SENIOR 1: TERM 2 Theme: Temporary and permanent changes to materials

TOPIC 2.3: MIXTURES, ELEMENTS AND COMPOUNDS 20 PERIODS

Competency: The learner recognises the characteristics of mixtures and compounds.

<table>
<tr><th>LEARNING OUTCOMES
The learner should be able to:</th><th>SUGGESTED LEARNING ACTIVITIES</th><th>SAMPLE ASSESSMENT STRATEGY</th></tr>
<tr>
<td>a. know the criteria for determining whether a substance is pure or not (k, s)
b. understand that substances are either elements, mixtures or compounds (u)
c. identify different mixtures and devise ways of separating pure substances from them (u, s)
d. know that, when added together, some liquids mix while others form two layers (k)</td>
<td>
• In groups, learners plan and carry out a practical investigation to find out whether 100g of crushed ice made from distilled water melts faster or slower than crushed ice made from tap water which contains salts. They record their results in a table and discuss.
• Individually, learners research and then discuss in groups examples of elements, compounds and mixtures and list their characteristics. These might include:
  • Elements: made from one type of atom
  • Compounds: a mixture of elements that can only be separated by chemical means
  • Mixtures: made up of two or more substances that can be separated by physical means
• In groups, learners research and then classify substances into compounds, mixtures or elements: e.g. carbon dioxide, hydrochloric acid, sugar, air, chlorine, gold, chlorophyll, oxygen, salt plus other examples
<table>
<tr><th>ELEMENT</th><th>COMPOUND</th><th>MIXTURE</th></tr>
<tr><td></td><td></td><td></td></tr>
</table>
• In groups, learners use a spatula to slowly add 10gms of sugar to 150cm3 distilled water and record their observations. Learners should discuss whether dissolving and disappearing are the same and explain their thinking. They should be introduced to the terms: solvent, solute and solution, and if necessary, revise their observations using these terms.
• Individually, learners research on the terms soluble and insoluble. Having been informed that rock salt is a mixture of rock which is insoluble in water and salt which is soluble in water. In groups, learners plan and implement a procedure to separate the rock from the salt. Learners use the following terms to explain their method: filtration, dissolve, soluble, solute, and solution.
• Learners use their experience of evaporation to plan a procedure to separate the solute from the solvent (water) and so recover the salt by crystallisation.
</td>
<td>
• Observe learners investigating, note their understanding of a fair test, and intervene to check their understanding that pure (distilled) water melts at a different rate from tap (impure) water which is a mixture.
• Listen to group discussion and intervene where appropriate to assist understanding. Encourage learners to add to their list of characteristics and share them, and check the correct use of definitions.
• Gauge learners' progress towards achieving learning outcomes.
• Listen to learners and encourage use of the terms: solvent, solute and solution and link their thinking to prior learning about mixtures.
• Listen to learners in the process of planning the separation of salt, and encourage them to use and record the process using the correct terms.
• Intervene where necessary to avoid misunderstandings and gauge learners' progress towards achieving learning outcomes through the product of activities.
</td>
</tr>
</table>

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• Learners discuss what will happen when palm oil is mixed with tap water, using the terms miscible and immiscible liquids, and how they might separate them.	
ICT Support The learner can: • use the Internet to research elements, compounds, and mixtures. • use a digital camera to take images to show the stages of separating rock and salt, and then purifying the salt by crystallisation.		

SENIOR 1: TERM 3 Theme: Air and environment

TOPIC 3.1: AIR 10 PERIODS

Competency: The learner appreciates that air is a mixture of gases in which oxygen is the active constituent, and he/she can describe processes that may affect air quality.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand that air is a mixture of different gases that can be separated and used (k, u)
b. understand how air pollution can affect the atmosphere (u)
c. Understand and appreciate that processes such as burning and rusting/corrosion use oxygen from the air to form oxides (k, u)
	• In pairs or individually, learners research on:
	  • the composition of air,
	  • the percentage of each chemical from a pie chart of the composition of air;
	  • what else might be in the air
	• In groups, learners examine a fractionating column and draw on research to discuss how different liquids have different boiling points, and how this is used to separate them into fractions.
	• In groups, learners research on and discuss how air pollution occurs when excessive quantities of gases and particles change the composition of air. They report on the causes and consequences.
	• Individuals or pairs research on and explain how oxygen and nitrogen can be separated from liquid air using a fractionating column, and then discuss in groups.
	• In groups, learners discuss what is necessary for wood to burn and understand that oxygen is the active ingredient in air that allows burning to take place and causes iron to rust.
		• Listen to discussions and gauge learners' understanding of why air is considered a mixture of gases rather than a compound, how the gases can be separated, how air pollution occurs, and its consequences. Intervene appropriately to clarify understanding about the composition of air and fractional distillation.
		• Evaluate how learners draw on prior knowledge of burning and rusting (and breathing) to develop the idea that there is an active ingredient (oxygen) in air.
		• Observe and listen to discussions about group planning and guide learners on the equipment required and the importance of controlling variables. Note the accuracy of their observations and whether their conclusions reflect their observations and predictions.
		• Listen to discussion about word equations and guide learners to understand that oxygen from the air combines with other element to form oxides.
		• Evaluate quality of learning through assessment of products: outcomes of investigation reports, and correct use of scientific notation.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

	• Groups plan an investigation of the factors that affect the rate of rusting of iron, using the scientific method. Steps include:
	  • selecting apparatus and materials
	  • making predictions based on prior knowledge and proposing a hypothesis
	  • recording observations and measurements
	  • interpreting observations and reporting results
	  • comparing observations and results with other groups
	  • discussing and developing
	explanations, conditions to include a clean nail placed:
	  • in air where water is removed with anhydrous CaCl2
	  • in normal air containing water vapour
	  • in tap water
	  • in boiled water (where air has been removed by boiling)
	• In groups, learners write word equations for the reaction between elements (metals and non-metals) and oxygen when they burn or corrode to form oxides	

ICT Support The learner can: • use a digital camera to take images to show how oxygen reacts with iron.		

SENIOR 1: TERM 3

Theme: Air and Environment

TOPIC 3.2 : WATER

14 PERIODS

Competency: The learner investigates evaporation and condensation as natural processes essential for replenishing supplies of fresh water in the water cycle.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand the occurrence of wateras a natural resource, its physical and chemical properties and importance in everyday life (u, s) b. appreciate how water is recycled by natural processes (u, v) c. understand the process of water and sewage treatment (u, k)	• In groups, learners draw on prior learning to brainstorm ideas about evaporation and condensation of water, ice, and steam as changes of state, and produce a chart of the water cycle to explain its physical and chemical properties and the role of the sun in providing energy to drive the cycle. • In groups, learners use their water cycle charts, and prior learning about the characteristics of water, to identify and report on where pollution might occur, its causes, impact, and possible ways to prevent it. • Learners visit a sewage treatment plant and find out how effluent is recycled into useable water. Individuals produce reports to explain the process of sewage treatment using their prior learning about the characteristics of water.	• Listen to group discussion and encourage learners to draw on and consolidate prior learning about changes of state, solvents and solutions, and then apply it to their understanding of the water cycle, the causes and prevention of water pollution, and the treatment of sewage. • Gauge learners' progress towards achieving the learning outcomes by assessing their understanding of the characteristics of water and the chemistry of water through their products of the activities.

ICT Support

The learner can:

- use mind-mapping/graphic or word processing software to draw a diagram of the water cycle.
- use a digital camera to take images showing different stages for water purification.

SENIOR 1: TERM 3

Theme: Earth and Space

TOPIC 4.1: ROCKS AND MINERALS

12 PERIODS

Competency: The learner appreciates that rocks are composed of different minerals and these determine the properties of the rocks.

<table>
<tr><th>LEARNING OUTCOMES
The learner should be able to:</th><th>SUGGESTED LEARNING ACTIVITIES</th><th>SAMPLE ASSESSMENT STRATEGY</th></tr>
<tr>
<td>a. understand how igneous, sedimentary and metamorphic rocks are formed, that they are made up of minerals, and that some minerals are useful (k, u, s)
b. identify the physical properties of rocks and distinguish between the different types (s)
c. understand the process of weathering and how weathered rock particles form the basis of soil (u, s)</td>
<td>• In groups, learners examine and discuss the general appearance of igneous, sedimentary and metamorphic rocks and record characteristics such as colour, patterns, texture, and particle size in a chart. Individually, learners create a dichotomous key using the information from their observations.
• Individuals or pairs research and report on the minerals found in granite, sandstone and slate, and identify any patterns. Learners share their research with the class and discuss the use made of the minerals.
<table><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>
• Groups discuss the role that water (rain, ice, rivers) might play in extracting the minerals from the rocks, and how these minerals are deposited in the soil. Individually, learners write a report about their understanding of weathering.</td>
<td>• Observe group interaction and assess the accuracy of observations and words used to record the results. Gauge learner's ability to transfer this information to use it to create a dichotomous key; observe their progress towards the learning outcomes.
• Gauge learners' ability to access and summarise information from complex text and understand where minerals (chemicals) originate.
<table><tr><th>MINERALS IN GRANITE (IGNEOUS)</th><th>MINERALS IN SANDSTONE (SEDIMENTARY)</th><th></th></tr><tr><td>quartz
feldspar
mica</td><td>quartz
feldspar
calcium carbonate</td><td></td></tr></table>
• Listen to learners' discussions and presentations on weathering and where appropriate, make suggestions to improve clarity and understanding.
• Evaluate quality of learning through assessment of products: keys, tables, and reports.</td>
</tr>
<tr>
<td colspan="3">ICT Support
The learner can:
• use the Internet to research on useful minerals and present to the class.
• use any word processor to write the research report.</td>
</tr>
</table>

SENIOR 2: TERM 1

Theme: Acids and Alkalis

TOPIC 5 .1: ACIDS AND ALKALIS

12 PERIODS

Competency: The learner appreciates the properties and importance of acids, alkalis/bases and salts in everyday life.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. recognise that locally available materials and substances are either acidic or alkaline (k)
b. understand the concept of pH as a measure of the strength of acids and alkalis (u)
c. understand the reaction between acids and alkalis (u, s)
	• In groups, learners brainstorm what they know about acids and alkalis and, from personal experience, identify the characteristics of some familiar substances (e.g. the sharp taste of acids such as lemon juice and vinegar, the bitter taste of alkalis such as ash filtrate from banana peel, and the soapy feel of alkalis) and record information in a chart.
	• In groups, learners drop lemon juice into a solution made from red fruit (grapes, red cabbage) and universal indicator solution. Discuss and report on the colour change and how this provides an indicator of acidity.
	• In groups, learners use litmus paper to decide whether a range of solutions (e.g. lemon juice, vinegar, diluted bleach, diluted liquid soap, tea, cola, tap water, carbonated water) are acid or alkali, and record their results in a chart, making note of the final colour.
	• Individually, learners record the group results and write an explanation about the level of acidity in each solution.
	• In groups, learners review litmus colour charts and note that different shades have a numerical value of acidity and pH. They use this information to add a numerical value to their personal report and compare it with others. Learners agree on consistency or discuss where there is inconsistency.
	• In groups, learners discuss and record their thinking about the following:
	  • Where there is no change in colour this is the balance between acid and alkali (or a base) solution or neutral point.
	  • Our stomachs contain hydrochloric acid, and too much of this causes indigestion. Antacid tablets contain bases such as magnesium hydroxide and magnesium carbonate to neutralise the extra acid.
	  • Bee stings are acidic. They can be neutralised.
		• Observe learners engaged in activities, offering guidance to ensure all participate and make good progress in terms of their learning.
		• Listen to group discussions and where appropriate, warn about the dangers of tasting unknown chemicals, and therefore, the need to find a chemical test (or indicator) of acidity in the form of litmus paper. Ask probing questions to promote thinking.
		• Discuss with individuals and groups to check their progress towards the learning outcomes and if appropriate, offer guidance to understand the pH scale and the notion of the balance between an acid and alkali solution (a base) or neutral.
		• Evaluate learning through products: charts and reports.

SENIOR 2: TERM 1

Theme: Acids and Alkalis

TOPIC 5.2 : SALTS

12 PERIODS

Competency: The learner appreciates that acids and alkalis form salts.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. be familiar with, and be able to carry out neutralisation reactions to prepare salts (k, u, s) b. Know and appreciate the uses of common salts in everyday life (k, s)	• In groups, learners half-fill a plastic water bottle with vinegar and place a spatula of baking soda (sodium bicarbonate) into a balloon and fix it over the mouth of the bottle so that the baking soda mixes with the vinegar and they observe and report on the reaction they observe. • Individuals research the reaction between an acid and a base and explain what happens when hydrochloric acid and sodium hydroxide react. Then, they produce a word equation. • In groups, learners discuss the word equation and use symbolic representation to predict the outcome from the chemical reaction. • In groups, learners make magnesium sulphate by gently heating 50cm3 of diluted sulphuric acid in a beaker to 60C and adding magnesium oxide powder, stirring until a milky solution is formed. This is filtered, and the clear liquid or filtrate is magnesium sulphate solution. The water can be removed by gentle heating and evaporation. • Individually, learners make a record of the process based on careful observation in the form of a flow chart and create a word equation to explain the chemical reaction. Individually, learners research on the use of common salts and record their results in a table and discuss in a group. e.g. sodium chloride, sodium hydrogen carbonate (sodium bicarbonate), calcium carbonate, potassium nitrate, lead chloride, barium sulphate, potassium carbonate, sodium phosphate, ammonium chloride. • Groups use prior learning to suggest the chemical formulae of these salts: sodium chloride, calcium carbonate, potassium nitrate and potassium carbonate. Learners discuss how to write a simple equation to explain how they might have been made. • Groups plan an investigation to find out the solubility of some of the following salts in water, and record the results in a table and assess solubility: sodium nitrate, barium sulphate, copper sulphate, potassium carbonate, sodium chloride, lead chloride.	• Listen to group discussions and where appropriate, intervene to ensure complete understanding of the reaction between an acid and a base to form a salt and water and how this can be represented using symbols. • Observe groups preparing magnesium sulphate and listen to the discussion to check that: there is understanding of the process; risk assessment has taken place; flow charts show that the sequence of action and chemical terms are used correctly; word equation shows an understanding of neutralisation and formation of a salt. If appropriate, guide learners to use correct terms such as filtrate, residue, evaporation, crystallisation, solubility, soluble, insoluble and precipitation. • Listen to the discussion about the use of common salts and how learners draw on prior learning and research to suggest chemical formulae. Where appropriate, guide learners toward using the correct symbols. • Evaluate quality of learning through assessment of investigations. Where appropriate, help learners to understand the importance of establishing a consistent approach, or fair tests, which may involve observation or timing of changes so that results can be compared.

SENIOR 2: TERM 1 Theme: The Periodic Table

TOPIC 6: THE PERIODIC TABLE 12 PERIODS

Competency: The learner investigates the diversity of the elements in the Periodic Table.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand that elements can be grouped into metals and non- metals and relate the physical properties of metals and non-metals to their uses (k, u, s)
b. know that the Periodic Table is a classification of elements according to their atomic or proton number (k)
c. relate the arrangement of electrons in the first 20 elements to their positions in the Periodic Table (u, s)
d. understand the relationship between the position of elements in groups and the charge on the ions that they form (u)
	• In groups, learners use prior learning and research to discuss how:
	  • they might identify a metal and a non- metal and present to other groups.
	  • to arrange elements into a table according to whether they are metals or non-metals: e.g. iron, sulphur, copper, hydrogen, silver, aluminium, oxygen, chlorine, argon, sodium, magnesium, calcium, iodine, nitrogen, zinc
	Learners present conclusions to other groups
	• Individuals carry out research to find the chemical symbol and physical properties of each element and record their results in a chart.
	• In pairs, learners study the Periodic Table and carry out research and complete reports, explaining:
	  • the work of Mendeleev and others in classifying the elements
	  • the meanings of the terms: proton/atomic number and mass number
	  • the relationship between the proton (atomic) number of an element and the number of electrons.
	• In groups, learners discuss their findings and use a card activity and research to give each of the 13 most abundant elements in Earth's crust, listed from most to least abundant, its symbol, proton number, atomic mass, electron configuration, and element classification
	  • oxygen
	  • silicon
	  • aluminum
	  • iron
	  • calcium
	  • sodium
	  • magnesium
	  • potassium
	  • titanium
	  • hydrogen
	  • phosphorus
	  • sulphur
	  • carbon
		• Observe group interaction and assess the accuracy of observations and words used to record the results. Gauge learners' ability to transfer this information to use it to create a dichotomous key; observe their progress towards the learning outcomes.
		• Gauge learners' ability to access and summarise information from complex text and understand where minerals (chemicals) originate.
		• Listen to learners' discussions and presentations on weathering and where appropriate, make suggestions to improve clarity and understanding
		• Evaluate quality of learning through assessment of products: keys, tables, and reports.

ICT Support

The learner can:

- use Internet to research on useful minerals and present to the class.
- use any word processor to write the research report.

SENIOR 2: TERM 2 Theme: Carbon in the Environment

TOPIC 7 : CARBON IN THE ENVIRONMENT 36 PERIODS

Competency: The learner investigates the diversity of carbon compounds in the environment.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand how and why carbon compounds are used as fuels (k, u) b. know and appreciate the difference between renewable and non-renewable fuels and understand that non-renewable fuels are not sustainable (k, u) c. know and appreciate the impact of burning carbon- based fuels on the environment (k, u) d. understand the processes of making charcoal, but recognise that the use of charcoal as a fuel is cheap, efficient , and sustainable only if it is made from wood that can be regrown easily (u, s) e. know and appreciate the physical properties and uses of carbon dioxide (k, u) f. understand how the increase in carbon dioxide in the air can cause the atmosphere and the oceans to get warmer (u) g. understand what greenhouse gases are, where they come from, and how they are affecting climate (u) h. understand the origin of hard water in limestone areas and investigate how it can be softened (u, s)	• In groups, learners draw on their experience and research to discuss the main uses of common carbon-based fuels in Uganda: charcoal, paraffin, petrol, firewood and diesel. • Individually, learners use prior learning to write a word equation to show the reaction when carbon-based fuels burn in oxygen. • In groups, learners discuss and report on the meaning of the terms 'renewable' and 'non-renewable' as applied to fuels, and then use data to estimate how long the world's coal, oil and natural gas reserves are likely to last at the current rates of usage. • Individually, learners research on the idea of 'sustainability' and write a report on how the use of fuel in their locality can be made more sustainable. • In groups, learners discuss and produce posters to explain why air pollution is a global problem and why it can only be properly controlled if all the countries of the world agree to collaborate. • Individuals research on the making of charcoal from waste organic material, and energy- saving charcoal stoves, and then explain the chemistry of what happens when organic material burns in a limited supply of oxygen. • Groups draw on prior learning to make carbon dioxide by reacting limestone with dilute hydrochloric acid; use apparatus to collect the gas, and then explain the chemical reaction and the property when tested with a lighted splint.	• Listen to learners' conversations and ask probing questions to help them draw on prior learning and use it to build on new learning. • Observe learners carrying out activities and intervene to ensure all participate and develop knowledge, skills, and understanding. • Evaluate quality of learning through assessment of products: how learners present their ideas to the wider group and their progress towards the learning outcomes. • Listen to group discussions and intervene appropriately, especially where learners misunderstand. Encourage discussion about the outcomes from personal and group research such as posters and models.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
j. understand how the properties and uses of the allotropes of carbon relate to their structures (u)	• In pairs, learners research and report on how an increase in carbon dioxide in the air can cause the atmosphere and the oceans to get warmer; what does this tells us about the nature of carbon dioxide?. Then, learners compare their findings with other learners to explain the effect of carbon dioxide on climate. • In pairs, learners research on how rainwater becomes hard as it soaks through limestone, and how it affects soap. • In groups, learners discuss, research and explain on a poster how adding washing soda (sodium carbonate) results in reducing the 'hardness'. • Groups research and make models to explain the structures of diamonds and graphite, and explain how the properties determine the uses of carbon structures such as carbon fibres and grapheme.	

ICT Support

The learner can:

- use any word processor to write the required equations and investigation report.
- use a spreadsheet to record and calculate the longevity of natural gas reserves.
- search the web for digital models of the structure of diamond and graphite.

SENIOR 2: TERM 3 Theme: Order of Reactivity of Metals

TOPIC 8: THE REACTIVITY SERIES 36 PERIODS

Competency: The learner evaluates data on reactivity in order to arrange metallic elements according to their reactivity.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. appreciate that metals vary in their chemical reactivity and can be arranged in a reactivity series (k, u, s)
b. understand that alloys are mixtures of a metal with other metals and/ or non-metals and compare the properties of common metals with their alloys (u, s)
	• Groups design and carry out an investigation, using the scientific method, to compare the reactivity of calcium, copper, iron, magnesium and zinc placed in cold water and dilute hydrochloric acid. Learners should discuss how they will measure and record the level of 'reactivity' and evaluate the limitations of the investigation.
	• Individually, learners research on how the reactivity of an element depends on its electronic structure, and they draw structure diagrams of calcium, copper, iron, magnesium and zinc to explain their level of reactivity and how this determines their uses.
	• In small groups, learners use a charcoal block and blowpipe to extract copper from copper oxide, explaining their observations and writing a word equation for the process. They should research and discuss with the wider group why the more reactive metals (e.g. groups I and II metals and aluminium) cannot be extracted on a charcoal block, and how gold is an uncombined metal at the bottom of the reactivity series that can be recovered in pure form from alluvial deposits.
	• Groups examine a collection of objects made from or containing alloys. They should research and report on the difference in chemical composition and properties, and then explain on a poster how this determines their use.
		• Observe and listen to group discussions to check:
		  • whether their investigation is valid and reflects the scientific method, and
		  • whether the recording of results is accurate and informs their learning about the reactivity series,
		  • understanding of how reactivity is related to the electronic structure of the element,
		• Listen to learners' conversations about the extraction of copper from copper oxide, and how the level of reactivity of alloys and unreactive elements are related to their use.
		• Evaluate quality of learning through assessment of products to determine the progress of learners towards achieving the learning outcomes.

ICT Support

The learner can:

- use web-based animations to illustrate key aspects of metal reactivity and displacement reactions.
- use Internet to research and get support information about chemical properties, composition, and reactivity.

SENIOR 3: TERM 1

Theme: Carbon in Life

TOPIC 9: CARBON IN LIFE

30 PERIODS

Competency: The learner appreciates the diversity of organic carbon compounds including the alkanes, alkenes, alcohols, and fatty acids.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. recognise that there is a diversity of carbon compounds in living things and materials derived from living things, and that these may be classified into groups (u, s) b. understand that crude oil is a mixture of different alkanes which can be separated by fractional distillation; that these products are used in fuels and to make other useful products (k, u) c. know and appreciate that natural gas deposits are found worldwide, that their main constituent is methane and that gas deposits are useful source of fuels and chemical feedstock (k, u) d. appreciate that biogas is a carbon-based fuel useful for cooking and lighting (u, s) e. know some common synthetic and natural polymers and how their properties relate to their uses (u, s) f. understand and appreciate that alcohols form a group of compounds of which ethanol is a typical member and has many uses (u, s) g. understand how ethanol is made naturally by fermentation of sugars and other organic substances, and be aware of the dangers of abuse of ethanol (u, s) h. know the process of making soapy detergents from natural fats and oils and appreciate that soaps are effective in removing oily stains (u, s)	• Individually, learners research and report on the uses of some common organic compounds derived from living things, such as ethanol, sucrose and ethanoic acid. • In groups, learners research on and explain the characteristics of alkanes, alkenes, alcohols, and carboxylic acids on a poster and then classify common carbon compounds such as ethanol, methanoic acid, butane, ethene, ethane, methanol, butanoic acid, and propene. • Individually, learners revisit prior learning on fractional distillation and use it to explain on a poster how crude oil can be separated into fractions by distillation. Groups discuss and list the main fractions in order of boiling point, and discuss their uses in everyday life (fuel, polymers, drugs, dyes, pesticides, explosives, and soapless detergents). • In groups, learners research and make a poster to explain how methane is used to make other organic compounds which in turn can be used to make a wide range of useful natural or synthetic polymers including plastics, starch, cellulose, proteins, sugars, fats and oils. Research on the properties and uses of some polymers. • Individually, learners research and discuss with the class the chemical nature of biogas, how it is made and why it is described as a renewable fuel, before writing a report. • Groups make a poster to show the structure of ethanol, explaining in an equation how it can be made from glucose sugar, and explain the conditions necessary for successful fermentation. Learners debate and report on the uses of ethanol and how excess consumption of alcoholic drinks can have serious consequences.	• Listen to discussions about the composition of carbon compounds and the process of fractional distillation. Where appropriate, pose questions to secure understanding and assess progress toward the learning outcomes. • Listen to group discussion about methane and invite peer feedback to ensure full understanding. • Observe learners carrying out practical tasks and intervene to steer learning and ensure that scientific method is adhered to. • Evaluate quality of learning through assessment of contributions to discussion and written reports, such as the conversion of glucose sugar to ethanol. Invite peer feedback to ensure full understanding of the conditions necessary to produce ethanol.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
i. know that soapless detergents are made from crude oil and that soapless detergents are better cleaning agents in hard water than the soapy detergents but have a more deleterious effect on the environment (k, u, s) j. understand how organic compounds can be grouped into homologous series, each of which has similarities in structure and properties (k, u)	• In groups, learners use sodium chloride, coconut oil (25cc) and 20% sodium hydroxide (30cc) to create a suspension and 15g salt to create a solid (soap) which is separated by filtering. Individually, learners record the process using flow charts and words such as suspension, precipitation, and solution. • In groups, learners plan, carry out and report on an investigation to find out how effective different types of soap are at removing a food stain on cotton fabric and research on how soap emulsifies fats and oils. • In groups, learners research, discuss and report on why a soapless detergent is more efficient for cleaning in a hard water area than a soapy detergent. Explain why problems are created when soapless detergents are released into the environment. • In groups, learners plan, carry out and report on an investigation to compare how well a soapy and a soapless detergent form lather in soft water and in hard water. • Individually, learners research the structural formulae of common homologous series (alkanes, alkenes, alcohols and carboxylic acids) and identify the functional groups responsible for their characteristic chemical properties. Learners compare their findings with others.	• Listen to discussions about the composition of carbon compounds and the process of fractional distillation. Where appropriate, pose questions to secure understanding and assess progress toward the learning outcomes. • Listen to group discussion about methane and invite peer feedback to ensure full understanding. • Observe learners carrying out practical tasks and intervene to steer learning and ensure that scientific method is adhered to. • Evaluate quality of learning through assessment of contributions to discussion and written reports, like the conversion of glucose sugar to ethanol. Invite peer feedback to ensure full understanding of the conditions necessary to produce ethanol.
ICT Support The learner can: • use the Internet as a research tool for information and images about fractional distillation, production of biogas, and soap.		

SENIOR 3: TERM 1 — Theme: Structures and Bonds

TOPIC 10: STRUCTURES AND BONDS — 18 PERIODS

Competency: The learner appreciates how atoms are composed of fundamental particles, and how molecules and compounds are composed of atoms.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand that atoms are the building blocks from which all matter is made (u) b. understand the terms: 'element', 'atom', 'molecule,' and 'compound', and appreciate how they are related (u) c. understand how atoms of different elements differ in their subatomic structure (u) d. appreciate that atoms are made up of subatomic particles and know the properties of these particles (k, u) e. understand the terms relative atomic mass, proton number, nucleon number and isotopes (u, s) f. understand and appreciate that the atoms of elements join together to form compounds (u, s) g. understand the processes involved in the formation of ionic, covalent and metallic bonds (u) h. recognise the difference in the physical properties of ionic and covalent compounds and relate them to their bonding (u, s)	• Individually, learners revisit prior learning on the names and symbols of some common elements, research on the terms 'element', 'atom', 'molecule' and 'compound' and the names and formulae of some common compounds, and record conclusions. • In groups, learners apply what they know about e.g. water, iron, carbon dioxide, sodium chloride, aluminium, copper (II) oxide, oxygen, hydrochloric acid, chlorine, and gold. Organise them in a table according to whether they are elements or compounds. • In groups, learners research atomic structure and use their understanding to make models of some simple atoms, showing protons, neutrons and electrons, and include the relative charges and approximate relative masses. • Groups research the elements and write: a. the symbols of elements b. the standard representation for an atom of any element. where: $^{A}_{Z}X$ X = element A = nucleon number Z = proton number • In groups, learners discuss how the proton number and the structure of atoms can be used to explain the basis of the Periodic Table. With special reference to the elements of proton numbers (atomic number) 1 to 20, learners make a model to show the build- up of electrons in 'shells,' and explain the significance of the noble gas electronic structures and of valency electrons. • Individually, learners research on how ideas of atomic structure have developed, and then contribute to the class discussion • Individually, learners research on the terms 'proton number' and 'nucleon number' and then in a group, discuss the meaning of the concept of isotopes and compare the composition of isotopes of the same element in a table.	• Observe how learners draw on prior learning to inform their understanding about elements, atoms, compounds and molecules and how their interactions help them make progress towards learning outcomes. • Evaluate quality of learning through assessment of products (reports, tables, models, and posters) and where appropriate intervene to ensure their understanding of how the fundamental particles in an atom are arranged • Listen to discussions and ask probing questions to promote critical thinking and ensure progress towards the learning outcomes.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• In groups, learners research and report on common compounds (e.g. water,salt, carbon dioxide) and identify the elements they are made from. They also explain on a poster: ionic, covalent, and metallic bonds and how the nature of bonding is reflected in their physical properties (e.g. solubility in water).	
ICT Support The learner can: • use Internet to research about isotopes and obtain appropriate simulations.		

SENIOR 3: TERM 2 Theme: Using Equations in Chemistry

TOPIC 11: FORMULAE, STOICHIOMETRY AND MOLE CONCEPT 30 PERIODS

Competency: The learner uses formulae and equations to determine quantities of matter.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand the concepts of relative atomic mass and relative molecular mass (k, u) b. analyse the relationship between the number of moles and the number of particles (k, u) c. analyse the relationship between the number of moles of a substance and its mass (k, u) d. analyse the relationship between the number of moles of a gas and its volume (k, u) e. synthesise chemical formulae (u) f. interpret chemical equations (k, u) g. practise scientific attitudes and values in investigating matter (u)	• In groups, learners collect and interpret data concerning relative atomic mass and relative molecular mass based on carbon-12 scale and discuss its use as a standard for determining relative atomic mass and relative molecular mass. • In groups, learners research on the mole concept on a computer simulation (where available) and research the relationship between the number of particles in one mole of a substance with the Avogadro constant, and how to convert the number of moles to the number of particles for a given substance. • In groups, learners collect and interpret data on molar volume of a gas and use computer simulation (where available) or graphic representation to explain the relationship between molar volume and Avogadro constant. They also make generalization on the molar volume of a gas at STP or room conditions. • Groups: • construct a mind-map to show the relationship between number of particles, number of moles, mass of substances and volume of gases at STP and room conditions.	• Listen to group discussion and intervene appropriately to help understanding of relative atomic and molecular mass, and the significance of the Avogadro constant and its relationship with molar mass. • Listen to group discussion and ask questions to identify misconceptions and to clarify understanding about particles, moles, mass of a substance and volume of gases, the chemical formulae of compounds and the construction of balanced equations. • Observe group activities and step in as appropriate to guide learners build knowledge and understanding. • Evaluate quality of learning through assessment of products and presentations. Encourage group feedback and determine progress towards meeting the learning outcomes.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• carry out problem solving activities involving number of particles, number of moles, mass of a substance and volume of gases at STP or room conditions. • calculate the volume of gases at STP (or room conditions) from the number of moles and vice versa. • determine the empirical formula of copper (II) oxide and magnesium oxide, using computer simulation (where available). , Compare and contrast empirical formula with molecularformula. • carry out problem solving activities involving empirical and molecular formulae • construct chemical formulae of compounds from a given ionic formula, and state names of chemical compounds using IUPAC nomenclature. • construct balanced chemical equations for the selected reactions and display on a poster • In groups, learners research on and prepare a presentation to identify and justify positive scientific attitudes and values practised by scientists in doing research on mole concept, chemical formulae and chemical equations for easy and systematic communication in the field of chemistry.	

SENIOR 3: TERM 2 — Theme: Structures of Substances

TOPIC 12: PROPERTIES AND STRUCTURES OF SUBSTANCES — 18 PERIODS

Competency: The learner appreciates that in a chemical reaction, starting materials or reactants interact to form products.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand the concepts of relative atomic mass and relative molecular mass (k, u)
b. analyse the relationship between the number of moles and the number of particles (k, u)
c. analyse the relationship between the number of moles of a substance and its mass (k, u)
d. analyse the relationship between the number of moles of a gas and its volume (k, u)
e. synthesise chemical formulae (u)
f. interpret chemical equations (k, u)
g. practise scientific attitudes and values in investigating matter (u)
	• In groups or pairs, learners:
	  • research and report on the physical properties of giant molecular, giant ionic and giant metallic structures and explain the differences in physical properties on a poster or presentation.
	  • write equations for common covalent reactions and show that some bonds are broken, and others are formed,
	  • carry out simple stoichiometric calculations using the mole concept.
		• Observe groups involved in activities and check their understanding about chemical reactions using the mole concept. Check also, their progress towards the learning outcomes.
		• Listen to discussions and ask questions to promote thinking and deepen learning.
		• Evaluate learning through products: reports, posters, presentations, balanced equations, and stoichiometric calculations.

ICT Support

The learner can:

- use equation editor to write balanced chemical equations for common chemical reactions.
- use spreadsheets to carry out simple stoichiometric calculations.

SENIOR 3: TERM 3 — Theme: Fuels and Energy

TOPIC 13: FOSSIL FUELS — 20 PERIODS

Competency: The learner understands the origins of fossil fuels and appreciates their importance as an energy resource.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand the types and origins of fossil fuels and why they can be used as sources of energy and useful materials. (u, s)	• In pairs, learners brainstorm and research on common fossil fuels and produce reports explaining: • why they all contain carbon • how they were formed, using diagrams (including gas, oil, and coal) • how they can be used as sources of energy and useful materials • why they are described as non-renewable and their use is unsustainable.	• Observe pair interaction and engagement in the activity, intervening to ensure that all make progress towards learning outcomes. • Listen to discussions and ask questions to deepen learning. • Evaluate learning through quality of reports.
ICT Support The learner can: • use the Internet to research on fossil fuels.		

SENIOR 3: TERM 3 — Theme: Reactants and Products

TOPIC 14: CHEMICAL REACTIONS — 28 PERIODS

Competency: The learner understands the effects of external conditions on the rate of reaction and how this can be explained in terms of a kinetic particle model.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand and appreciate that chemical reactions take place at different rates (u) b. understand the effect of various factors on the rate of chemical reactions and recognise that many reactions are reversible (u, s) c. Understand the importance of reversible reactions in industrial processes (u)	• In groups, learners plan, carry out and report on several investigations to find out how temperature, the concentration of reactants, and particle size affect the rate of chemical reactions. They also identify whether reactions can be reversed or not. Groups report on results and conclusions, making use of graphs to show patterns. • Individually, learners research on examples of reversible reactions, including the reversible steps in the industrial manufacture of sulphuric acid, and explain using a flow chart.	• Observe learners planning and carrying out investigations, check that their procedures will lead to meaningful results and intervene as required. • Listen to groups planning and interpreting results, asking questions to ensure that valid results are achieved and valid conclusions are drawn. • Evaluate quality of learning and progress towards the learning outcomes through assessment of products: reports on procedures and effects of factors on rates of reaction; recognition of significance of reversible/irreversible reactions.
ICT Support The learner can: • use an online or downloaded simulation to illustrate key aspects of chemical reactions.		

SENIOR 4: TERM 1 — Theme: REDOX Reactions

TOPIC 15 : OXIDATION AND REDUCTION REACTIONS — 18 PERIODS

Competency: The learner understands oxidation and reduction in terms of gain or loss of oxygen and in terms of electron transfer, and he/she appreciates that the two processes always occur together.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. understand the processes of oxidation and reduction and their importance in the chemical industry (u, s)
b. explain redox reactions in terms of electron transfer (u)
c. understand the changes that take place during the electrolysis of some compounds (u, s)
	• In groups, learners research, explain and report on the terms: 'oxidation' and 'reduction' in terms of:
	  • loss or gain of oxygen
	  • loss or gain of hydrogen
	  • transfer of electrons
	  • change in oxidation number
	Individuals then calculate the oxidation number of an element in a compound.
	• In groups, learners:
	  • collect and interpret data on the existence of various ores in Uganda and
	  • produce a chart to explain the contribution of metal extraction to the Ugandan economy
	  • explain the relevance of reduction/ oxidation to metal extraction
	• In groups, learners plan, investigate and report on oxidation and reduction in a selection of reactions. Write ionic equations and explain reactions in terms of electron transfer
	• Groups discuss electrolysis and produce illustrations to explain:
	  • the meaning of electrolyte
	  • moving ions and electrical conductivity
	• Groups use carbon electrodes in the electrolysis of copper (II) sulphate solution and dilute sulphuric acid and:
	  • identify cations and anions in the aqueous solutions
	  • describe the electrolysis of the aqueous solutions
	  • write half equations for the discharge of ions at the anode and the cathode
		• Listen to group discussions and intervene appropriately to check understanding of oxidation and reduction, especially in terms of electron transfer. Pose questions to check understanding of electrolytes and electrolysis in terms of discharge at the electrodes.
		• Observe groups engaged in activities and offer guidance to deepen learning.
		• Evaluate quality of learning through assessment of products: presentations about chemical change and equations to determine progress towards the Learning Outcomes.

SENIOR 4: TERM 1

Theme: REDOX Reactions

TOPIC 16: INDUSTRIAL PROCESSES

30 PERIODS

Competency: The learner appreciates the principles behind some industrial processes and the importance of the products formed.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. know about some of the main industries that produce useful chemicals, such as the oil industry for our organic chemicals, the production of metals, the acid industry, the alkali industry, the fertiliser industry and the cement industry (k, u)
b. understand the processes for obtaining useful chemicals from rocks (k, u)
c. understand the processes involved in extracting and purifying metals, with particular reference to processes used in Uganda (k, u)
d. understand the importance of nitrates as fertilisers in food production and know how they are produced from the nitrogen in the air (k, u)
e. outline four industrial processes that make use of natural resources obtained in Uganda
f. recognise the importance of industrial processes in utilising natural resources to make useful chemicals, and appreciate that industrial processes have social benefits and cause problems of pollution and environmental destruction. (u, s)
g. describe some of the dangers to the community arising from these industrial processes and the steps that may be taken to minimise these dangers (u)
h. understand the process in the manufacture of lime and cement (u)
i. understand the production of alkali and chlorine by the electrolysis of salt solution (u)
j. evaluate uses of synthetic polymers(u)
	• In pairs, learners list some common products and identify which of the main chemical industries in Uganda were involved in their production.
	• Pairs research and describe the reactions involved in the extraction and purification of metals from their ores (iron, copper, and aluminium) and prepare presentation flow charts outlining the main processes.
	• In pairs, learners research on the importance of nitrogen and show in a flow chart how nitrogen from the air is captured and eventually becomes nitrogen in nitrate fertiliser.
	• In groups, learners identify four industrial processes that make use of natural resources obtained in Uganda (including the manufacture of lime and cement and the production of chlorine). They create charts to:
	  • explain the processes
	  • identify the social benefits
	  • identify some of the dangers to the community arising from these industrial processes
	  • identify steps taken to minimise the dangers
	  • In groups, learners research and prepare a presentation about natural and synthetic polymers, methods of disposal, the uses of biodegradable polymers and the environmental effects of non-biodegradable synthetic polymers
		• Observe pairs and groups working and offer advice and guidance to aid their progress towards the learning outcomes.
		• Listen to learners' discussions and provide opportunities for pairs/groups to present their charts and ideas to the class. Encourage peer review and ask questions to promote thinking and deepen learning.
		• Evaluate quality of learning through assessment of products and presentations about the benefits and problems associated with industrial processes.

ICT Support

The learner can:

- use the Internet to research on extraction and purification of metals, and manufacture of lime and cement.
- use an appropriate software to prepare an electronic flow diagram for any process.

SENIOR 4: TERM 2

Theme: Periodicity

TOPIC 17: TRENDS IN THE PERIODIC TABLE

20 PERIODS

Competency: The learner appreciates the diversity of properties of elements and how these properties change across the periods and groups of the Periodic Table.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. know the trends in physical properties of the elements across the periods in the Periodic Table (k)
b. know the trends in typical, physical, and chemical properties of simple compounds of the elements of the third period (u, s)
c. predict physical and chemical properties of different elements in Group 1 (u, s)
	• In groups, learners revisit prior learning about the Periodic Table and identify patterns in the arrangement of elements in groups and across periods in terms of:
	  • proton number
	  • electron arrangement
	  • properties
	• In groups, learners research, discuss and report on:
	  • the electron arrangement of elements in each group and across each period
	  • the positions of the metals,non-metals and semi-metals
	  • trends in physical properties, such as melting point, boiling point, and density, across the periods
	  • trends from metals to non-metals from sodium to argon
	  • reactions of the elements of the third period with water, oxygen, and chlorine
	Groups contribute to class discussion and conclusions about trends.
	• In groups, learners research, discuss and report on group 1 elements:
	  • general physical properties of lithium, sodium, and potassium
	  • changes in the physical properties from lithium to potassium with respect to hardness, density, and melting point
	  • chemical properties of lithium, sodium, and potassium
	  • the similarities in chemical properties of lithium, sodium, and potassium
	  • the relationship between the chemical properties of Group 1 elements and their electron arrangements
	Groups contribute to class discussion and conclusions about group 1 elements.
		• Listen to group discussion and debate and gauge learners' understanding of how the electron arrangement of an element determines its position in the Periodic Table and trends in physical and chemical properties. Ask questions to boost learning.
		• Observe group interactions, intervening to consolidate and deepen learning and accelerate progress towards the Learning Outcomes.
		• Evaluate quality of learning through assessment of products: reports on elements of the periodic table in general and group 1 in particular.

SENIOR 4: TERM 2 Theme: Thermochemistry

TOPIC 18: ENERGY CHANGES DURING CHEMICAL REACTIONS 28 PERIODS

Competency: The learner appreciates that in any chemical reaction, energy --- usually in the form of heat --- is lost or gained.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. recognise and appreciate the difference between endothermic and exothermic reactions and understand that substances store chemical energy in their bonds (k, u)
b. understand and appreciate the importance of exothermic and endothermic reactions in our everyday lives (u, s)
c. recognise that the burning of fuels is an exothermic process producing useful energy (u, s)
d. understand the concept of heat of reaction and interpret energy profiles of chemical reactions (u, s)
	• In groups, learners research, discuss and report on:
	  • examples of important everyday reactions (such as fermentation, respiration, cooking, burning, etc.) in which energy is either absorbed or released
	  • investigations of endothermic or exothermic reactions using the scientific method of dissolving substances (e.g. sodium hydroxide, sodium hydrogen carbonate, ammonium nitrate, etc.) in water and noting the temperature changes in each case as the energy stored in bonds is released.
	  • the energy transformations in burning ethanol, paraffin or wood and the change from chemical energy to heat and light.
	• Individually, learners research the flow of energy through an ecosystem in which reactions are endothermic (e.g. photosynthesis) and exothermic (e.g. respiration) and produce a chart to explain energy flow and loss.
	• In groups, learners design and carry out an investigation to compare the heat given out when different fuels burn (e.g. peanuts, oils, paper, and wood)
	• In groups, learners research on heat of reaction, and interpret energy profiles, they create a presentation to explain energy profile diagrams for exothermic and endothermic chemical reactions.
		• Listen to group discussions and pose questions to gauge the level of understanding and promote critical thinking.
		• Observe learners' interactions and offer advice to improve progress and deepen learning.
		• Evaluate quality of learning through assessment of products. Determine and encourage progress towards the learning outcomes.

SENIOR 4: TERM 3 — Theme: Consumable Chemicals

TOPIC 19 : CHEMICALS FOR CONSUMERS — 20 PERIODS

Competency: The learner appreciates that the products used in everyday life exist as chemicals and some of them can be prepared at home or in the laboratory.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY

a. analyse properties of soap and detergent and compare and contrast the effectiveness of their cleansing action (u, s)
b. evaluate the use of food additives (k, u, s)
c. understand the importance of chemicals in medicine (k, u)
d. appreciate the importance of the chemical industry and its contribution to our lives (u)
	• Groups revisit prior learning on the production of soap and its cleansing action and research and interpret data in the form of a presentation on:
	  • the history of soap manufacturing
	  • the chemical nature of soap and detergent
	  • the additives in detergent such as biological enzymes and whitening agents
	  • the preparation of detergents
	• Groups plan, carry out and report on an investigation to find the differences in the effectiveness of the cleansing action of soap and detergent.
	• In pairs, learners collect and interpret data and report on the types of chemicals used in food additives and their functions as:
	• preservatives and antioxidants, e.g. sodium nitrite, sodium benzoate, ascorbic acid
	• flavouring agents, e.g.monosodium glutamate (MSG), aspartame
	• stabilizers and thickening agents, e.g. gelatine, acacia gum
	• dyes, e.g. azo compound, triphenyl compound
	• the use of banned substances such as alkyl benzene sulphonate
	• In groups, learners collect and observe food labels and identify the additives used. Discuss and report on: :
	  • the rationale for the use of food additives
	  • the effect of food additives on health and the environment
	  • life without food additives
	• In groups, learners carry out research and prepare a presentation on types and functions of chemicals used in medicine, e.g.:
	  • traditional medicines derived from plants and animals
	  • analgesics such as aspirin, paracetamol, and codeine
	  • antibiotics such as penicillin and streptomycin
		• Listen to learners' discussions to gauge progress towards achievement of learning outcomes. Ask probing questions to promote critical thinking.
		• Observe how learners interact, collect, and analyse data and present reports. Offer guidance to deepen learning.
		• Evaluate quality of products: reports and interpretation of research exercises.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
	• psychotherapeutic medicine such as stimulants, antidepressants, and antipsychotics Reports should also focus on the side effects of modern and traditional medicines, and the importance of the correct usage of modern and traditional medicines. • In groups, learners carry out research and prepare a presentation on chemicals that have had a significant impact on humanity: • discovery of chemicals that improve the quality of life, such as antibiotics and detergent • side effects of chemicals on life and the environment • In pairs, learners research and report on good practice and common traits among scientists in carrying out research, such as patience, meticulousness, and perseverance.	

SENIOR 4: TERM 3 — Theme: Consumable Chemicals

TOPIC 20 : NUCLEAR PROCESSES — 12 PERIODS

Competency: The learner understands atomic structure and the nuclear processes by which energy is released.

LEARNING OUTCOMES The learner should be able to:	SUGGESTED LEARNING ACTIVITIES	SAMPLE ASSESSMENT STRATEGY
a. understand atomic structure, the processes of nuclear fission and fusion, the use we can make of them, and the dangers associated with them (k, u) b. understand the spontaneous and random nature of nuclear decay and interpret decay data in terms of half-life (u, s) c. understand and appreciate that there are significant social, political, and environmental dimensions associated with use of nuclear power (u)	• In pairs, learners research atomic structure, nuclear decay, and radioactivity; produce a joint report which will consider: • the structure of the atom, sub-atomic particles, nuclides and their atomic and mass numbers • nuclear fission and nuclear fusion • radioactivity and the types and properties of the particles emitted • types and properties of radiation emitted during radioactive decay and balanced equations for nuclear reactions • interpretation and drawing of graphs showing the decay of radioactive isotopes and the concept of half-life • the applications of radioactivity, its dangers, and safety precautions	• Listen to pairs' conversations and their explanations of their research findings to others in plenary sessions. Ask questions to encourage critical thinking and to deepen learning. • Observe pairs carrying out research and preparing reports. Offer guidance to help learners understand and develop their skills. • Evaluate quality of learning through assessment of products/presentations. Provide feedback as appropriate to accelerate progress towards the learning outcomes.

ASSESSMENT

Assessing the new expectations for learning

The new curriculum sets new expectations for learning, with a shift from Learning Outcomes that focus mainly on knowledge to those that focus on skills and deeper understanding. These new Learning Outcomes require a different approach to assessment.

The "Learning Outcomes" in the syllabuses are set out in terms of Knowledge, Understanding, Skills, Values, and Attitudes. This is what is referred to by the letters k, u, s, v/ a.

It is not possible to assess values and attitudes in the same way as knowledge, understanding, and skills because they are more personal and variable and are long-term aspirations. This does not mean that values and attitudes are not important. It means that we must value things that we cannot easily assess.

So, this guidance booklet focuses on knowledge, skills and understanding. Each has its own implications for learning and assessment.

Knowledge	The retention of information.
Understanding	Putting knowledge into a framework of meaning – the development of a 'concept'.
Skills	The ability to perform a physical or mental act or operation.
Values	The inherent or acquired behaviours or actions that form a character of an individual.
Attitudes	A set of emotions, beliefs or behaviours toward a particular object, person, thing or event.

To assess knowledge, skills, and understanding, we need to look for different things. Knowledge can be assessed to some extent through written tests, but the assessment of skills and deeper understanding requires different approaches. Because of this, the role of the teacher in assessment becomes much more important.

Knowledge

Knowledge is the easiest to assess because it is fairly straightforward to find out whether or not a learner has retained some information: a simple question can usually find this out. We ask them to name something, state something, or label a diagram.

Skills

Skills are the ability to perform a mental or physical operation, so we have to observe the skill being performed, look at the product, or outcome of the skill; for example: a piece of writing, a picture or diagram.
Some skills, such as speaking and physical education do not have a product so they need to be observed.

Understanding

Assessing deeper understanding is much more difficult, so we usually ask learners to explain, compare or outline a process. This can be done orally (in conversation) or in writing, and will give us some idea of the extent of learners' understanding.

Values and Attitudes

Values and Attitudes determine how we interact with others, working in a team, meeting deadlines, being self-driven, holding democratic values, and having respect for democracy, race, gender, disability, human dignity, culture, nation, life, and social justice.

Examinations

There will be examinations or tests set at the end of every year. There will also be a summing up of on-going teacher assessments made in the context of learning.

Formative Assessment

Assessments are used for a wide range of purposes in schools and education systems. Just as academic lessons have different functions, assessments are typically designed to measure specific elements of learning e.g., the level of knowledge a student already has about the concept or skill the teacher is planning to teach or the ability to comprehend and analyse different types of texts and readings. This syllabus focuses on the evaluation of progressive day to day classroom learning; hence, Formative Assessment.

Formative assessment refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, or activity.

The general purpose of formative assessment is to improve learning and achievement; give educators in-process feedback about what students are learning or not learning so that instructional approaches, teaching materials, and academic support can be modified accordingly. Formative assessments are usually not scored or graded, and they may take a variety of forms, from more formal quizzes and assignments to informal questioning techniques and in-class discussions with students.

The general goal of formative assessment is to collect detailed information that can be used to improve instruction and student learning while it's happening. What makes an assessment "formative" is not the design of a test, technique, or self-evaluation, per se, but the way it is used, that is, to inform in-process teaching and learning modifications.

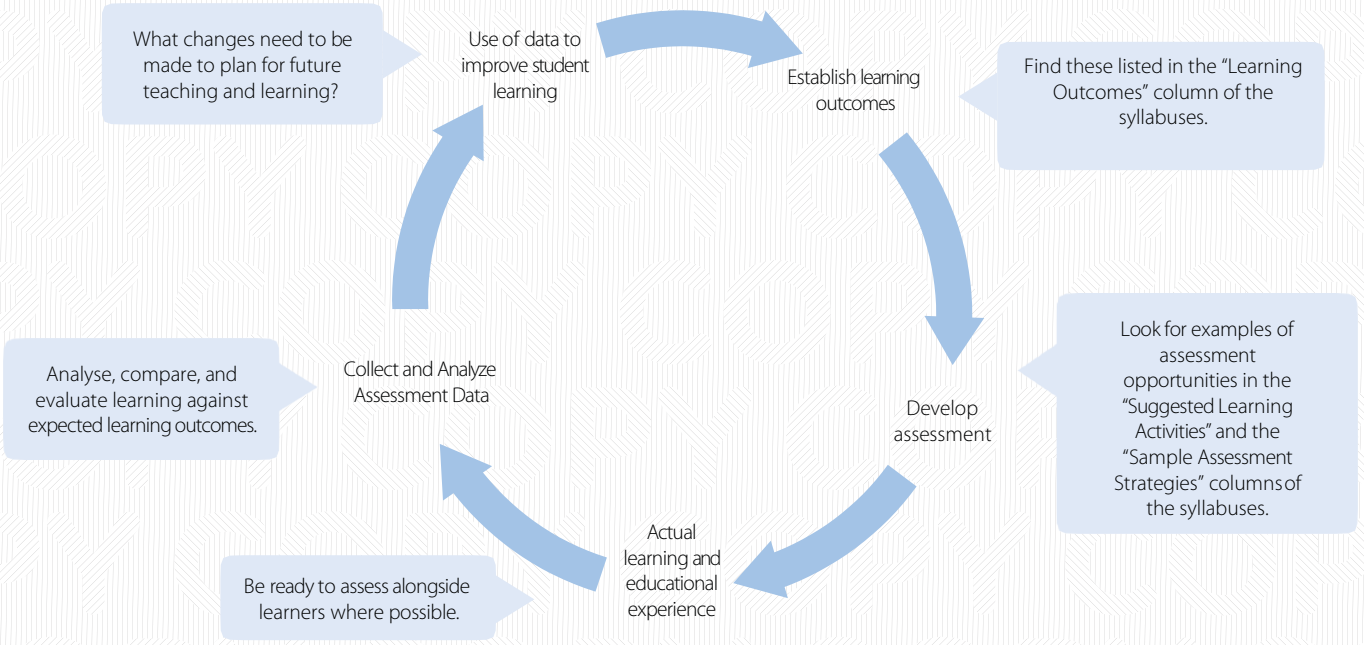
The final examination at the end of Senior 4 will be very different in nature, and will focus on the learners' ability to apply their learning in new situations, rather than on the ability to recall information.

If assessment is to make a difference to teaching and learning, then teachers must use the information they gain from assessment to make **some change** to the teaching and learning process. The changes that can be made include decisions about:

- What needs to be learned next?
- Whether an element of the syllabus needs to be taught again in a different way.
- Changing teaching approaches if necessary.
- Identifying learners who need more support, or who are making exceptional progress.
- Enabling learners to understand what they have to do to improve.

ASSESSMENT

The process of teaching, making formative assessments, and then changing the teaching and learning in some way can be seen as a cycle:



FORMATIVE ASSESSMENT INVOLVES USING ALL PARTS OF THE CYCLE.

How do we find the opportunity to make formative assessments?

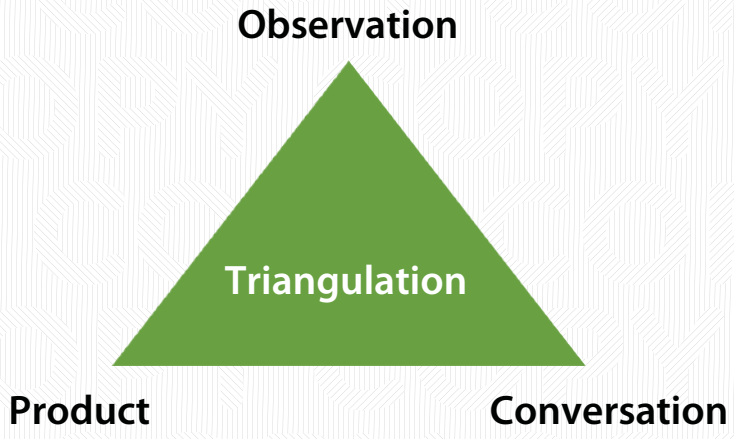
In the new curriculum, the teacher's assessment role is not to write tests for learners, but to make professional judgements about learners' learning in the course of the normal teaching and learning process. The professional judgement is about how far the learner meets the Learning Outcomes that are set out in this syllabus. To make these judgements, the teacher needs to look at how well the learners are performing in terms of each Learning Outcome.

School-based formative assessment is a part of the normal teaching and learning process, and so the assessment opportunities will also occur during this normal process. It is not something that needs to be added on after learning; it is an integral part of it.

These opportunities occur in three forms and are often called:

- Observation – watching learners working (good for assessing skills and values)
- Conversation – asking questions and talking to learners (good for assessing knowledge and understanding)
- Product – appraising the learner's work (writing, report, translation, calculation, presentation, map, diagram, model, drawing, painting etc.). In this context, a "product" is seen as something physical and permanent that the teacher can keep and look at, not something that the learner says.

When all the three are used, the information from any one can be checked against the other two forms of assessment opportunity (e.g. evidence from "observation" can be checked against evidence from "conversation" and "product"). This is often referred to as "triangulation".



Triangulation of assessment opportunities

To find these opportunities, look at the syllabus units. These set out the learning that is expected and give 'Sample Assessment Activities", and in doing so they contain a range of opportunities for the three forms of assessment.

ASSESSMENT

Generic Skills

The Generic Skills have been built into the syllabuses and are part of the Learning Outcomes. It is, therefore, not necessary to assess them separately. It is the increasingly complex context of the subject content that provides progression in the Generic Skills, and so they are assessed as part of the subject Learning Outcomes.

Attitudes

It is not possible to assess attitudes in the same way as knowledge, understanding, and skills because they are more personal and variable and are long-term aspirations. This does not mean that attitudes are not important. It means that we must value things that we cannot easily assess.

Record keeping

Keeping detailed records of learners' individual progress is always difficult with very large numbers of pupils. For the purposes of school-based formative assessment, it is not even always necessary to keep such detailed records anyway. If feedback is given immediately and action is taken, then learning is changed and the record would soon become out of date and redundant.

Most formative class-based assessments are dynamic in that they feed straight back into the teaching and learning process. Therefore, detailed records of these are not appropriate.

What is needed is record of assessments of learners' learning made in terms of each Topic or unit. This means recording the on-going summative assessments of each unit. There is no need to make separate records of each of the Learning Outcomes because this would be very time-consuming and also unnecessary. It is much more useful to make an overall assessment about whether or not each learner met the Learning Outcomes for each Topic as a whole.

Each Topic is made up of a number of Learning Outcomes. Therefore, teachers need to consider all the Learning Outcomes when making an overall judgement about the Topic as a whole. It is not always necessary for every individual Learning Outcome to be achieved for the Topic as a whole to be achieved. This will vary with the Subject and Topic.

By looking at the Learning Outcomes within each Topic, it is possible to identify four broad groups of learners in terms of their achievements:

Descriptor
No Learning Outcome (LO) achieved
Some LOs achieved, but not sufficient for overall achievement
Most LOs achieved, enough for overall achievement
All LOs achieved – achievement with ease

These overall assessments should be made on the basis of the many formative assessments that the teacher has made during the course of teaching the unit. If teachers have been working with the learners over the course of the unit, they will be able to make a broad judgment about which learners have achieved or have failed to achieve the unit's overall Learning Expectation. These "Authentic Assessments" will be more valid and valuable than a test set by the school.

Recording these overall assessments will be simple, manageable and, yet valuable, and can be recorded on a sheet such as the one below in which the categories are indicated with a number.

Although a very simple process, these four categories will give rich data when a comparison is made between the learners in each category for different subjects and units. They will also identify easily those learners who need extra support or who may not be ready to move on to the next grade at the end of a year.

If records are kept of the learning outcomes of each syllabus unit through the year, then there will be no need for an end of year test. Teachers will already have a record of those learners who have met the learning outcomes, and those who have not done so. Therefore, teachers will know if there were any learners not ready to progress to the next grade.

An overall record should be made of the individual unit assessments by subject in terms of the 4 descriptors. If numbers (0-3) are used as identifiers, then it will be possible to arrive at an overall number for a year by aggregating the identifiers for each unit.

Descriptor	Identifier
No Learning outcome achieved	0
Some LOs achieved, but not sufficient for overall achievement	1
Most LOs achieved, enough for overall achievement	2
All LOs achieved – achievement with ease	3

In the example below, the table shows the end-of-unit assessment for six learners.

Chemistry										
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**
Learner A	3	3	2	3	3	3	3	2	3	3
Learner B	2	2	3	2	3	2	2	2	3	2
Learner C	1	1	2	1	1	2	2	3	2	3
Learner D	1	1	2	1	1	2	1	1	2	1
Learner E	0	1	2	1	0	1	0	1	1	1
Learner F	0	0	1	0	0	1	0	0	1	0

This method will give much more information than using a tick. For example, at a glance it can be seen that learners A & B are achieving much higher than learners E & F. It can be seen that Learner C has improved during the year. We can even see that more learners achieved success in Topic 9 than Topic 7.

All of this is very valuable assessment information and can be used to improve learning.

This summative teacher assessment will contribute to the final grade of the School Leaving Certificate.

ASSESSMENT

Glossary of Key Terms

TERM	DEFINITION
Competency Curriculum	One in which learners develop the ability to apply their learning with confidence in a range of situations.
Differentiation	The design or adaptation of learning experiences to suit an individual learner's needs, strengths, preferences, and abilities.
Formative Assessment	The process of judging a learner's performance, by interpreting the responses to tasks, in order to gauge progress and inform subsequent learning steps.
Generic skill	Skills which are deployed in all subjects, and which enhance the learning of those subjects. These skills also equip young people for work and for life.
Inclusion	An approach to planning learning experiences which allows each student to feel confident, respected, safe, and equipped to learn at his or her full potential.
Learning Outcome	A statement which specifies what the learner should know, understand, or be able to do within a particular aspect of a subject.
Process Skill	A capability acquired by following the programme of study in a particular subject; enables a learner to apply the knowledge and understanding of the subject.
Sample Assessment Strategy	A strategy which gives a learner the opportunity to show the extent to which s/he has achieved the Learning Outcomes. This is usually part of the normal teaching and learning process, and not something extra at the end of a topic.
Suggested Learning Activity	An aspect of the normal teaching and learning process that will enable formative assessment to be made.

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