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ACCELERATED EDUCATION PROGRAMME

CHEMISTRY

SYLLABUS

Level 1 and 2

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Contents

Foreword

Education is a fundamental tool for protection of conflict-and-disaster-affected children and youths from harm and exploitation. This is a crucial part of UNESCO's advocacy messages. Under appropriate conditions of security, provision of education can protect children and youth from recruitment into fighting forces, forced labour, prostitution, drug abuse and other criminal activities. In post-conflict settings, education contributes to the reintegration into society of former soldiers and other children and youths associated with fighting forces.

The National Curriculum Development Centre (NCDC), in collaboration with War Child Canada, embraced Accelerated Education Programme (AEP) that focuses on providing relevant and appropriate education to learners in refugee camps and the host communities of secondary school age (ages 16-45+) in Adjumani District. The programme will help them to acquire the necessary competencies that will enable them to 'catch-up' and re-join learners of the same (or near) age group in the formal education programme.

Accelerated Education Programme subjects were selected based on the Ugandan regulation which states that learners must study the seven core subjects;—these are: Mathematics, English, Physics, Chemistry, Biology, History and Geography. So learners under AEP shall take all the core subjects. In addition, learners shall take: Religious Education which will help to address the prevalence of early marriages for the girl-child, cases of indiscipline and moral modelling— Personal Social and Health Education/Physical Education which will help to develop physically, learn to live together, develop talents and become emotionally balanced; Guidance and Counselling in which teachers will be trained on integration of guidance and counselling services in the delivery of the education curriculum.

This Programme will equip teachers and other stakeholders in schools and the communities with relevant information, values and skills that will enable them to effectively facilitate the teaching and learning processes.

We recommend AEP and trust that the materials will be valuable; in your endeavour to meet the educational needs of the refugee learners and other beneficiaries from the host communities.

Hon. Janet Kataaha Museveni
Minister of Education and Sports

Acknowledgement

National Curriculum Development Centre (NCDC) would like to express its gratitude to all those who, in one way or another, contributed and worked tirelessly towards the development of this Accelerated Education Programme (AEP) syllabus.

Special thanks go to War child Canada-Uganda for the financial support, their guidance in overseeing and taking timely decisions whenever necessary during the development and production of this syllabus.

We also express our gratitude to NCDC Subject Specialists and panel members for their professional guidance and technical assistance.

Furthermore, NCDC recognises the work of the editors who worked with the writers through the development of this document. NCDC takes responsibility for any shortcomings that might be identified in this syllabus and welcomes suggestions for addressing the inadequacies. Such comments and suggestions may be communicated to NCDC through: P.O. Box 7002, Kampala or e-mail to admin@ncdc.og.ug.

Grace K. Baguma
Director
National Curriculum Development Centre

Introduction to Accelerated Education Programme

Worldwide, substantial alternative schooling programmes are developed to meet the basic education needs of under-reached children. Of recent, it has been increasingly recognized that the goals of Education for All cannot be achieved unless more attention is paid to educating out-of-school children (UNESCO, Global Monitoring Report, 2008). Indeed, the UNESCO Global Monitoring Report 2010 'Reaching the Marginalized' focused on this issue. In a bid to help developing countries achieve the Millennium Development Goals, there should be initiatives to incorporate elements of accelerated learning to achieve SDG 4.

The Accelerated Education Programme (AEP) in Uganda is a form of curriculum option which combines the stronger features of earlier mainstreaming approaches into the new design to raise the success rates for refugee community learners. The AEP secondary school tier is a bigger stride to address the education gap within refugee communities not only in Uganda but also other neighbouring countries. Benchmarking the Primary AEP programmes, the Secondary Education Programme intends to infer the entire process of education and its cognitive, emotional, and social components.

The Accelerated Learning Programme at Secondary school level focuses on completing learning in a shorter period of time, of two years. The AEP is complementary both in providing an alternative route and in matching its curriculum to the 'official' curriculum, thus allowing learners to return to formal schooling at some stage. The programme intends to promote access to education in an accelerated timeframe for disadvantaged groups, out of school and over-age children, and youths who missed out or had their education interrupted due to poverty, violence, conflict, and crisis. The goal of this programme is to provide learners with competencies equivalent to those in the formal system in an accelerated timeframe, with learners either transitioning back into the mainstream education or exiting with some competencies required for work.

Ideally, teaching AEP calls for a methodology that is interactive and learner-centred, incorporating other aspects of multiple-intelligence

learning. Because teaching and learning are accelerated, and the curriculum content is compressed and condensed, the four 'P' elements are at the core of the accelerated learning cycle; processes, psychological, physiological, and physical. These core elements provide the physical and psychological space in which the learner can learn more effectively.

It is intentional to include alternative subjects in this programme e.g. life skills, peace education, environment, HIV and AIDS which are responsive to the context. Learners of AEP need alternative supporting knowledge and life skills to survive in the challenging world. It is equally important to note that this conception of accelerated learning requires an extremely well-resourced classroom and exceptionally well-trained teachers. The expanded learning time from the norm is because the teaching methodology is interactive and learner centred.

It is our hope that AEP will register considerable success in meeting the educational needs of these underserved populations, not only in terms of access and equity but also in being able to return to school and completion, and most importantly in getting measurable learning outcomes.

Introduction to AEP Chemistry Syllabus

The Aim of this AEP Chemistry Syllabus

This syllabus is aimed at providing the teacher with the required guidance to teach Chemistry to learners who will not have gone through the normal four years of Ordinary level classes. It is meant to cover the most critical aspects of Chemistry without affecting its standards. It will adequately prepare learners for Uganda Certificate of Education (UCE). However, the creativity of the classroom teacher is important in this case.

Rationale for Teaching Chemistry

1. Enabling the learners to know:
   i) the basic principles and concepts of Chemistry.
   ii) how theories and models are used to explain concepts in Chemistry.
   iii) the resources available to facilitate discovery about unfamiliar principles and concepts in Chemistry.
   iv) the use of knowledge of the principles and concepts of Chemistry in everyday life situations.
2. Making the learners aware of the effects of scientific discoveries and knowledge on everyday life through some applications of Chemistry

3. Enabling learners to:

   i) develop an experimental attitude by performing experiments in schools
   ii) familiarise themselves with scientific methods.
   iii) develop the necessary skills to design and carry out practical investigations based on the knowledge of Chemistry.
   iv) stimulate interest in and care for the environment and proper utilisation of resources with respect to Uganda.
4. Preparing the learners for further studies in Chemistry and related fields
5. Enabling the learners to appreciate the applicability of Chemistry in other disciplines
6. Enabling the learners to develop:
   i) an initiative for inventiveness.
   ii) skills for practical investigation and exploration.
   iii) capacity to design models and analytical schemes for use

Content Structure

The Accelerated Education Programme (AEP) for Chemistry is divided into **13 topics** which will be taught in two levels. The topics and the respective sub-topics for the two levels are indicated in the table below.

LEVEL 1	LEVEL 2
Topic 1: Introduction to Chemistry 1. Chemistry and society 2. Science process skills 3. Laboratory safety and chemical apparatus Topic 2: Particle Nature of Matter 1. States and changes of states of matter 2. Temporary and permanent changes 3. Separation techniques Topic 3: Atomic Structure and the Periodic Table 1. Atomic structure 2. The periodic table Topic 4: chemical bonding and structure Topic 5: acids and alkalis 1. Acids and alkalis 2. Indicators and pH scale 3. Neutralisation 4. Salts Topic 6: Atmosphere and environment 1. Air 2. Water	Topic 7: carbon in the environment 1. Occurrence of carbon 2. Oxides of carbon 3. Hardness of water Topic 8: Carbon in life Topic 9: The mole concept Topic 10: Ion chemistry and electrochemistry Topic 11: Energy changes during Chemical reactions Topic 12: Rates of chemical reactions Topic 13: Industrial processes

Note:

Throughout this Chemistry syllabus, emphasis must be put on:

a) Knowledge:

i) Knowledge of terminology

ii) Knowledge of specific facts

iii) Knowledge of **conventions and units** used in Physics

iv) Familiarity with experiments suggested in the syllabus

v) Knowledge of common laws/principles and generalization identified in the syllabus

b) Comprehension or understanding:

Ability to:

i) explain standard phenomena from laws/principles and models and to describe standard experiments met with before.

ii) translate various forms of information presentation.

iii) use standard methods to solve familiar and unfamiliar numerical types of problems.

iv) draw conclusions from experimental procedures.

v) synthesise ideas from presented data or otherwise.

vi) apply laws and generalizations already learnt to everyday life and new situations.

c) Application to higher abilities and practical skills

Acquisition of the following abilities:

i) Application of knowledge/theory to practical situations

ii) Stating appropriate experimental title or heading

iii) Manipulation of the apparatus and performing experiments

iv) Making and recording observations accurately in column tables, with proper units

v) Presentation of data in an appropriate form especially graphical, with properly labelled axes and using suitable scales

vi) Drawing conclusions from observations made

vii) Assessing suitability of procedure, experiment and observations made in support of the conclusion

viii) Devising projects in which the products employ Physics principles

Features of this AEP Syllabus

This AEP Chemistry teaching syllabus has the following features:

a) Competency

This is a general statement of what a learner can exhibit or do as a result of learning all the concepts within each sub-topic. It is stated at the top of the table for each sub-topic in the detailed syllabus. It shows how the content will be applied in different situations.

b) Learning outcomes

These are the expected behaviour which a learner will exhibit after the study of the sub-topic. ***The teacher must ensure that all the outcomes are achieved***. They have been provided to help the teacher clarify content and scope. Where a higher outcome is stated, lower outcomes are implied. The teacher should use learning outcomes to plan his/her teaching strategies. Learning outcomes also guide in evaluation at the end of the learning process.

c) Duration

This has been provided for each sub-topic. It is meant to guide the teacher in planning so as to cover all the content appropriately. However, the allocated time should allow for flexibility in order to cater for remedial teaching and carrying out practical activities where possible.

d) Suggested learning activities

These provide the teacher with guidance for example, on the tasks which the learners must accomplish to acquire the learning outcomes. However, these are not the only activities since other tasks as may be suggested by the teacher must be used. The teacher should use appropriate strategy e.g. individual or group work for learners to carry out the activities effectively. Teachers should also encourage learners to use a variety of resources such as library and ICT.

d) Sample assessment strategies

These are meant to test the level of understanding for each sub-topic. However, other assessment strategies as suggested by the teacher and textbooks appropriate to the sub-topic should be used to assess the learners' achievement. The sample assessment strategies are not meant to

be a spot work for end of cycle examination but rather to assist the teacher in formative assessment. Some of this assessment is done by observation and can be used to assess attributes like teamwork, confidence, scientific literacy, communication, leadership and organisational skills of learners.

e) References

These have been provided for each sub-topic to help the teacher in the preparation of lessons. This is mainly because the topics are carefully selected and combine aspects that may be found in content for different classes in the normal programme.

f) Hint to the Teacher

These further clarify the scope and depth of coverage for some sub-topics. They should be taken seriously to avoid leaving out content or giving content beyond the scope of the learners.

LEVEL 1

Topic 1: Introduction to Chemistry

Duration: 7 Hours

Competency

The learner should able to assess the application of chemistry in our everyday life and its contribution to our economy.

Sub-topic 1: Chemistry and Society

Duration: 2 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. select appropriate activities to explain what chemistry is. b. understand what the importance of chemistry is and relate the knowledge of chemistry to relevant careers. c. identify the contribution of chemistry to Ugandan economy.	▪ Working in group of 5 or 6, learners discuss how the knowledge of chemistry is related to the applications in various fields such as: pharmaceutical and cosmetics, plastics, food and beverages, soaps and detergents, water treatment, indigenous chemistry in local environments ▪ In groups, learners brainstorm on careers related to knowledge of chemistry; such as human and animal medicine, pharmacy, chemical engineering,	1. Observe learners discussing the reasons for studying chemistry and brainstorming on the careers relating to the study of chemistry. 2. Engage the learners through questions to explain what their understanding of chemistry is and why it is an important area of study. 3. Ask the learners to write down the careers relating to the study of chemistry and write a report on any field

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	teaching, etc. ▪ Explain how chemistry contributes to the economy of Uganda: medicines, industries, transport, agriculture, ▪ Make field visits and Research to explore the common industrial products in our country and relate their uses to the importance of chemistry (write a simple report on their research and present it in class).	visit they have made to a nearby industry. 4. Ask learners to write an essay on the contribution of chemistry to the economy of Uganda.

Hint to the Teacher

i) The field visit mentioned in this chapter could mean any process in the neighbourhood e.g. welding, local beer making, agricultural farm etc. but not the big industries

ii) Use examples in the surroundings of the learners as much as possible to inculcate interest in the learner.

References

Emanuel Otim, Muwanga Lwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 1) Pages 1 -4, MK Publishers.

Sub-topic 2: Science Process Skills

Duration: 2 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. appreciate that the learning of chemistry involves experimentation. b. understand that experimentation is a uses a systematic process. c. apply science process skills in conducting scientific experiments.	▪ Brainstorm as a class on the meaning of experiments and how they help in learning chemistry ▪ In groups of 5 – 6, design and plan an experimental investigation of measuring volumes of liquids following the scientific method of studying chemistry: - Identification of problem - Formulation of hypothesis - Identification of variables - Planning investigation - Collection of data - Writing of report - Communication of results ▪ Carry out an experiment and use systematic format to document the process	1. Observe the learners discuss the steps involved in designing an experiment. 2. Discuss with the learners what is involved in each of the steps involved in experimental design and why they are important. Assess how learners communicate 3. Assess reports by the learners of experimental format from a sample experiment.

Hint to the Teacher

i) Try as much as possible to use simple examples
ii) Solubility of salts in water (cold and warm water)
iii) Teacher can use common salt

Sub-module 3: Laboratory Safety and Chemical Apparatus

Duration: 3 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample assessment strategies
The learner should be able to: a. understand the common laboratory rules and regulations b. effectively handle and use common laboratory apparatus /equipment (e.g. fire extinguishers, measuring cylinder, separating funnel, thermometer, Bunsen burner and balance). b. select apparatus (such as burettes, pipettes, measuring cylinders and gas syringes) appropriately for measuring time, temperature, mass and volume. c. suggest suitable	▪ In groups, research and make a presentation about the laboratory rules and regulations. ▪ Perform role plays on measures that can be taken in case of a fire in a laboratory. Demonstrate how a fire extinguisher is used. ▪ Make a laboratory visit and observe: - Different equipment and reagents. - Safety precautions charts - the signs on different chemical containers. ▪ In small groups, carry out experiments using some of the laboratory apparatus (e.g. measuring cylinder, separating funnel, thermometer, Bunsen burner and balance) ▪ Measure the volume of liquids using measuring cylinders, pipettes and burettes. Read the graduation aligning correctly to the amount of liquid (parallax errors)	1. Observe the learners engage in a discussion on the important safety procedures in the laboratory and perform activities aimed at creating awareness of safe usage of the laboratory. The learners also demonstrate the use of different apparatus for different purposes in the laboratory. 2. Discuss with the learners the importance of rules and regulations in the lab and choice of apparatus to be used for different laboratory activities. 3. Evaluate reports on a laboratory visit, sample laboratory rules formulated by the learners, reports of some

Learning Outcomes	Suggested Teaching and Learning Activities	Sample assessment strategies
apparatus, given relevant information, for a variety of simple experiments, including collection of gases and measurement of rates of reaction.	▪ Using a thermometer, measure the temperature of water in a beaker and record.	sample experiments carried out using the equipment in the lab.

Hint to the Teacher

i) Laboratory rules should not be used to scare the learners but to create awareness about safety precautions in the laboratory

ii) Teacher should where necessary improvise for simple apparatus using local materials such used plastic water bottles as funnels and beakers, used shoe polish tins, pins, syringes, etc.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 1) Pages 1 -4, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book One) Pages 1-6, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry

Topic 2: Particle Nature of Matter

Duration: 15 Hours

Competency

The learner should be able to use the knowledge of the arrangement and motion of particles in states of matter to explain the properties of solids, liquids and gases.

Sub-topic 1: States of Matter and Changes of State

Duration: 5 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand what matter is and why it is studied. b. demonstrate that solids, liquids and gases have different properties.	▪ Discuss in small groups what matter is ▪ Carry out experiments showing that matter exists in different states and give common examples of solids, liquids, gases and plasma. ▪ Gather information on how common examples of solids, liquids and gases are used in everyday life. ▪ In groups, learners investigate the properties of solids, liquids and gases, including shape, pouring and compressing. ▪ Learners perform experiments to show the changes of state	1. Observe the learners as they: • discuss in small groups the meaning of matter, • conduct activities to show the existence of matter, • Perform experiments to demonstrate change of state • Perform activities to demonstrate diffusion in gases and liquids 2. In a conversation, ask the learners to identify the uses

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	of matter, e. g melting a candle wax, or ice, boiling water (observe the change of state with temperature), heating iodine or naphthalene. Make observations and conclusions. ▪ Perform experiments to show diffusion in a gas, liquid and solid using: • Ammonia, from concentrated ammonia solution and hydrogen chloride, from concentrated hydrochloric acid, to form ammonium chloride or bromine in air. • Potassium manganate(VII) in water and in a hot gel solution. Write a report of the findings. • Illustrate a similar effect to Brownian motion e.g. boiling water with visible particles like chalk powder	matter in everyday life and why matter changes state from one state to another on heating and cooling. 3. Evaluate reports on the experiments carried out to investigate the existence of matter, changes of state, and diffusion in gases and liquids
c. use the particle theory of matter to explain the properties of	▪ In groups, learners discuss the application of scientific knowledge	1. Observe a discussion on: • How the particle theory accounts for

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
solids, liquids and gases, changes of state and diffusion. d. use different activities to demonstrate that a change from one state to another involves either heat gain or heat loss. e. recognise the cooling effect of evaporation and explain how it contributes to maintaining constant body temperature.	of the particle theory to account for the properties of solids, liquids and gases. ▪ In groups, learners plan and carry out an activity to demonstrate that diffusion takes place faster in a gas than in a liquid or a solid and explain why this is the case. ▪ Using scientific knowledge of the particle theory to explain common phenomena such as gas pressure, clothes drying, rain formation and making a cup of tea. ▪ In small groups, learners demonstrate the changes of state of matter resulting from heating and cooling. ▪ Using diagrams or models learners explain why heat is taken in during melting and boiling but given out during condensing and	the properties of solids, liquids and gases. • How science explains gas pressure, clothes drying, raining and related phenomena • Importance of evaporation on maintenance of body temperature 2. Discuss with learners how the particle theory of matter explains different phenomena that take place in everyday life. 3. Report on the experiments carried out to demonstrate changes of state involving heating and cooling. Evaluate the diagrams or models demonstrating why heat is taken in during melting and boiling but given out during condensing and freezing.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	freezing. ▪ Learners discuss in groups, the importance of evaporation in preventing the body from overheating on a hot day.	

Hint to the Teacher

i) Care should be emphasised when using ammonia gas as inhaling lots of the gas may lead to serious health problems.
ii) Emphasise the practice of learners writing reports as learnt in Sub-topic 2.
iii) Brownian motion using smoke cell should not be demonstrated but mentioned by the teacher.
iv) Teacher can use tea-bags to illustrate diffusion.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 1) Pages 29 -37, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book One) Pages2 4-41, Fountain Publishers Kampala-Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lambert Anew Certificate Chemistry

Sub-topic 2: Temporary and Permanent Changes

Duration: 4 Hours

Learning Outcomes:	Suggested Teaching Learning Activities	Sample Assessment Strategies
The learner should be able to: a. use experiments to show that many substances undergo permanent changes when they are heated or burnt b. identify temporary (reversible) and permanent (irreversible) changes to matter under different conditions.	▪ In groups, learners demonstrate, using everyday examples, that permanent changes take place when substances are heated or burnt (e.g. boiling eggs, burning fuels, firing clay, setting cement). ▪ Working individually learners classify the following processes into permanent and temporary changes: fermentation of sugar, melting of ice, boiling of eggs, dissolving of salt in water, rotting of tomatoes, rusting, ripening of banana. ▪ Learners carryout experiments in small groups involving temporary and permanent changes: Boiling and condensing water, heating and cooling candle wax, sublimation of iodine, breaking a wooden stick, burning of wood, etc. ▪ In groups, learners gather information on temporary and permanent changes that occur in everyday life and make a report	1. Observe a brainstorming session about the meaning of temporary and permanent changes and their application in everyday life. 2. Engage the learners in a discussion to identify the differences between permanent and temporary changes. 3. Evaluate reports of the experiments carried out to demonstrate temporary and permanent changes.

Hint to the Teacher

Candle wax is flammable and should be handled with care.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 1) Pages 29 -37, MK Publishers.
2. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
3. Arthur Atkinson Certificate Chemistry
4. Holderness and Lambert Anew Certificate Chemistry

Sub-topic 3: Separation Techniques

Duration: 6 Hours

Learning Outcomes:	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. classify substances and their purity by using their melting and boiling points b. classify substances as elements, compounds and mixtures c. apply suitable methods of purification of mixtures, given information about the substances involved. d. interpret chromatograms and identify the dyes present.	▪ In small groups, learners carry out experiments to determine the melting and boiling points of substances to show their purity ▪ In groups or as individuals, learners gather information and discuss i) what elements, compounds and mixtures are, using common examples ii) symbols of the common examples of elements iii) the differences between compounds and mixtures ▪ In groups of 5-6, carry out experiments using appropriate methods to separate known mixtures ▪ Carry out chromatography using some common dyes to obtain chromatograms and apply knowledge of paper chromatography and interpret chromatograms	1. Observe a discussion by the learners on the meaning of elements, compounds and mixtures 2. Engage the learners in a discussion to identify the differences between compounds and mixtures and to classify substances as elements, compounds and mixtures. 3. Assess reports of experiments carried out to: • determine melting and boiling points of substances. • purify named impure substances. • separate components of dyes.

Hint to the Teacher

1. When determining melting and boiling points of ethanol, the tube must be placed in boiling water not heated directly.
2. Emphasise criteria for applying particular methods of separation to encourage application and knowledge transfer.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 1) Pages 54 -74, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book One) Pages 31, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lambert Anew Certificate Chemistry

Topic 3: Atomic Structure and the Periodic Table

Duration: 10 Hours

Competency

The learner should be able to investigate the diversity of the elements in the Periodic Table and relate their atomic structure to the families they belong to.

Sub-topic 1: Atomic Structure

Duration: 4 Hours

Learning Outcomes:	Suggested Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand what is meant by an atom. b. state the meaning of the terms: atomic number, mass number and Isotope. c. describe the arrangeme	▪ In groups, learners construct models or make use of computer simulations to show the structure of the atom in terms of the nucleus, energy levels and subatomic particles ▪ Gather information on the relative charges and approximate relative masses of protons, neutrons and electrons ▪ In groups, learners write the full symbol of an atom of an element using the notation below: $\mathrm{{}^{A}_{Z}X}$ where: X = element A = nucleon number Z = proton number ▪ In small groups, discuss the meaning of isotopes and compare the composition of isotopes of the same element by copying and completing the following table and adding the missing numbers.	1. Observe learners discuss the meaning of an atom and make models or draw models of an atom, discussing how the fundamental particles in an atom are arranged. Assess how they communicate. 2. Engage the learners in a discussion through questions on the charges that the fundamental

<table>
<tr><th>Learning Outcomes:</th><th>Suggested Learning Activities</th><th>Sample Assessment Strategies</th></tr>
<tr>
<td>nt of electrons in an atom.

d. understand how ions are formed.</td>
<td>
<table>
<tr><td></td><td colspan="4">Element</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>No. of protons</td><td>11</td><td>12</td><td></td><td></td></tr>
<tr><td>No. of electrons</td><td></td><td>12</td><td>7</td><td>13</td></tr>
<tr><td>No. of neutrons</td><td>12</td><td></td><td>7</td><td></td></tr>
<tr><td>Mass number</td><td></td><td>24</td><td></td><td>27</td></tr>
</table>

In small groups, learners make models to show the distribution of electrons in ‘shells’ and explain the significance of the noble gas electronic structures.
Use models to demonstrate the formation of ions through loss and gain of electrons by atoms.

</td>
<td>particles carry.

3. Engage the learners in a plenary to report on the finding of the meaning of the terms proton and nucleon number; and isotopes.

4. Observe learners make model to show the distribution of electrons in ‘shells’ (energy levels) and to demonstrate the formation of ions through loss and gain of electrons by atoms.

5. Engage the learners in a conversation to report on the electronic configurations of the first 20 elements in the Periodic Table.</td>
</tr>
</table>

Learning Outcomes:	Suggested Learning Activities	Sample Assessment Strategies
		6. Ask learners to write a report on the formation of ions and explain the significance of the noble gas electronic structures. Assess how the learners communicate ideas.

Hints to the Teacher

Provide a lot of practice exercises on this sub-topic.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 2) Pages 30 -31, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Two) Pages 26-41, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lambert Anew Certificate Chemistry

Sub-topic 2: The Periodic Table

Duration: 6 Hours

<table>
<tr><th>Learning Outcomes</th><th>Suggested Teaching and Learning Activities</th><th>Sample Assessment Strategies</th></tr>
<tr>
<td>The learner should be able to:

a. recognise that the Periodic table is a classification of elements according to their atomic or proton number.

b. arrange elements in a section of the periodic table showing the groups and periods for the first 20 elements.

c. classify elements in the periodic table as metals, non-metals and semi-metals and state the trend in metallic character of the elements.
d. discuss the chemical properties of</td>
<td>▪ In groups, learners discuss the relation between the electron arrangement of an element to its group and period.
▪ Draw a diagram or make a display of the Periodic Table up to element 20 (calcium), showing the positions of metals, non-metals and semi-metals.
▪ In groups, learners discuss and arrange the following elements into two lists according to whether they are metals or non-metals: iron, sulphur, copper, hydrogen, Silver, aluminium, oxygen, chlorine, argon, sodium, magnesium, calcium,
▪ In groups, learners discuss the chemical properties of the elements of Groups I, II, VII and VIII of the Periodic Table, using simple laboratory experiments</td>
<td>1. Engage learners on activities to predict the group and period of an element based on its electron arrangement and make a display of the Periodic Table up to element 20 (calcium)
2. Ask the individual learner, using the table below, to identify the elements represented by the letters and state the group of the Periodic Table to which each elemrnt belongs.
<table>
<tr><th>Element</th><th>Proton number</th></tr>
<tr><td>A</td><td>4</td></tr>
<tr><td>B</td><td>3</td></tr>
<tr><td>C</td><td>12</td></tr>
<tr><td>D</td><td>11</td></tr>
<tr><td>E</td><td>20</td></tr>
<tr><td>F</td><td>9</td></tr>
<tr><td>G</td><td>17</td></tr>
<tr><td>H</td><td>5</td></tr>
</table>
</td>
</tr>
</table>

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
the elements in the periodic table with air, water and dilute acids (emphasise the non-reactivity of noble gases).		
e. relate the physical properties of metals and non-metals to their uses. f. understanding what alloys are and relate their properties to their uses. g. understand of the relationship between the position of elements in groups and the charge on the ion that they form. h. recognise that the valency of an element in the periodic	▪ In groups, learners research and discussion the relationship between the physical properties of metals and their uses ▪ Look at some examples of pure metals and materials made of alloys in daily life. List and discuss their properties. ▪ In groups, learners discuss why a full outer shell leads to the lack of chemical reactivity and how this is demonstrated by the lack of chemical reactivity of the Group VIII elements. ▪ In groups, learners write electronic configuration of the first 20 elements in	3. Engage the learners in a discussion through questions on the properties of elements of group I, II and VII of the Periodic Table with; Air, water, and dilute acids. 4. Ask learners to write and present a report on what happens when metals and non-metals are heated in air, the products are dissolved in water and the solutions are tested to determine whether they are acidic or alkaline. 5. In a conversation, learners explain the meaning of an alloy; identify common alloys, their compositions and uses.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
table is related to the number of electrons in its outer energy level. i. write the formula of a compound using the valency of the elements. j. use the knowledge of formula of compounds to write balanced chemical equations.	the periodic table and use the configurations to derive the valency of each element. ▪ Learners write the symbols formulae of common ionic binary compounds based on knowledge of the position of their elements in the Periodic Table. ▪ Basing on simple laboratory experiments, learners write equations for the reactions of common elements with air, water and dilute acids.	

Hints to the Teacher

Provide a lot of opportunities for learners to practice the relation between groups, valences and reactions

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 2) Pages 43 -81, MK Publishers.
2. Walugere, R. Fountain Chemistry for Secondary Schools (book Two) Pages 42-55, Fountain Publishers Kampala- Uganda
3. Ngaruiya, G., Kimaru, J., Mburu, P., Longhorn Secondary Chemistry
4. Arthur Atkinson, Certificate Chemistry

Topic 4: Chemical Bonding and Structure

Duration: 4 Hours

Competency

The learner should be able to appreciate how molecules and compounds are formed from atoms and how their physical and chemical properties are related to the structures.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. Understand of the processes of formation of ionic, covalent and metallic bonds. b. Recognise the difference in the physical properties of ionic and covalent compounds and relate them to their bonding c. Compare the physical properties of substances containing ionic, covalent and metallic bonds	▪ In groups, learners gather information on the formation of ionic, covalent and metallic bonds and give suitable examples of each. ▪ In small groups, learners make models or drawing of how formation of ionic, covalent and metallic bonds occur. ▪ Learners discuss differences in physical properties of ionic, metallic and covalent substances in terms of their bonding.	1. Engage the learners in a discussion through questions on how each type chemical bond is formed. 2. Asking learners to write report on chemical bonding. 3. Observing learners discussing and comparing the properties of ionic and covalent compounds and intervene where necessary to remove misconceptions

Hint to the Teacher

1. Guide learners make models or use computer simulations showing formation of ionic, covalent and metallic bonds.

2. Guide learners in small group discussions on the physical properties of ionic & covalent compounds and metallic structures

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 2) Pages 83 -99, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Two) Pages 58-68, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lambert Anew Certificate Chemistry

Topic 5: Acids and Alkalis

Duration: 13 Hours

Competency

The learner should be able to appreciate the properties and importance of acids, bases and salts in everyday life.

Sub-topic 1: Acids and Alkalis

Duration: 4 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. recognise that locally available materials substances are either acidic or alkaline. b. state the differences between the acids and alkalis. c. state the uses of acid and alkali in daily life.	• In groups of 5 to 6 carry out an activity to classify locally available substances as either acidic or alkaline • Learners carry out activities to investigate the differences between the properties of acids and alkalis • In groups, learners identify the common characteristics of acids and alkalis (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 make a report • Learners discuss and report on the uses of acids and alkalis in everyday life	1. Engage the learners in a discussion through questions on substances in everyday life that are acidic, and that are alkaline 2. Ask learners to write a report on differences between acids and alkalis and their uses in everyday life. Assess how learners communicate their ideas.

Hint to the Teacher

Guide learners to carry out experiments in suggested learning activities column so that they appreciate the properties of acids and alkalis.

References

1. Otim, Emanuel, Muwanga Lwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 2) Pages 121 -124, MK Publishers.
2. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
3. Arthur Atkinson Certificate Chemistry
4. Holderness and Lumbert A New Cetificate Chemistry

Sub-topic 2: Indicators and pH Scale

Duration: 2 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. prepare indicators from locally available materials and use them to show that a solution is acidic or alkaline. b. explain how pH is used as a measure of the strength of acids and alkalis. c. relate strength or weakness of an acid or alkali with degree of dissociation and with degree of dissociation.	▪ Carry out experiments to show that some common solutions are acidic or alkaline using both industrial and locally prepared indicators (lemon juice, vinegar, papaw leaf extract, ash filtrate etc.) ▪ In groups, learners prepare indicators from plant extracts (flowers, leaves or roots) and use them to test for acidity and alkalinity ▪ Learners discuss and report on the concept of pH and its implications on the strength of acids or alkalis ▪ Learners carry out a class activity to make a model of the pH scale using universal indicator ▪ Learners discuss and report on the concept of pH and its implications on the strength of acids or alkalis	1. Observe learners using indicators to distinguish between an acid and an alkali and assess their reports. 2. Engage learners in a discussion on effectiveness of indicators from plant extracts as compared to universal /industrial indicator. 3. Asking learners to present a model of the pH scale and use it to explain how it indicates the degree of acidity or alkalinity.

Hint to the Teacher

Gide learners through practical demonstration to identify characteristic colours of the following indicators in acid and base:

- Methyl orange
- phenolphthalein

References

1. Otim, Emanuel, Muwanga Lwanga and Afidra, Jimmy, MK Secondary Chemistry (Student's Book 2) Pages 127 -139, MK Publishers.
2. Ngaruiya, George, Kimaru, Joan & Mburu Paul, Longhorn Secondary Chemistry
3. Arthur Atkinson Certificate Chemistry
4. Holderness and Lumbert A New Cetificate Chemistry

Sub-topic 3: Neutralization

Duration: 2 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of neutralisation and write an equation for the reaction between an acid and an alkali. b. explain through examples the uses of neutralisation in daily life. c. understand of the reaction between acids and carbonates.	▪ Carry out experiments to show that acids and alkalis undergo neutralisation reactions to produce salts and water only and write equation for the reaction ▪ In groups, learners discuss the importance of neutralisation in daily life and make a report ▪ Learners plan and carry out an activity to demonstrate the reaction between an acid and a carbonate, and show that the gas evolved is carbon dioxide.	Observe learners discuss neutralisation reactions to produce salts and water only and write word equations for neutralisation reactions.

Hint to the Teacher

Use practical demonstrations to help learners appreciate the importance of neutralization

References

1. Otim, Emanuel, Muwanga Lwanga and Afidra, Jimmy, MK Secondary Chemistry (Student's Book 2) Pages 144 -147, MK Publishers.
2. Ngaruiya, George, Kimaru, Joan and Mburu Paul, Longhorn Secondary Chemistry
3. Arthur Atkinson Certificate Chemistry
4. Holderness and Lambert Anew Certificate Chemistry

Sub-topic 4: Salts

Duration: 5 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand the meaning of a salt, using examples. b. identify soluble and insoluble salts and give examples of each type. c. describe how a named soluble and insoluble salts can be prepared by a suitable method. d. purify soluble salts by re-crystallisation.	▪ In groups, learners discuss and report on: - naturally existing salts - the meaning of salt - uses of salts in agriculture, medicinal field, preparation and preservation of food ▪ In groups learners carry out investigations to compare the solubility of nitrate, sulphate, carbonate and chloride salts. ▪ In groups, learners prepare and purify soluble salts by reacting: - acid with alkali - acid with metallic oxide - acid with metal	1. Observe learners discuss the meaning of salt, examples of salts, uses of salts and solubility of salts. 2. Engage learners in a discussion on methods of preparation of salts and their uses. 3. Asking learners to present a report on: - solubility of salts - methods of preparation of salts - purification of salts.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
e. determine the action of heat on salts. f. understand the action of different testing reagents on common ions in salts.	- dilute acid with metallic carbonate ▪ Learners prepare insoluble salts such as lead (II) chloride, PbCl2, Copper (II) carbonate, CuCO3, and barium sulphate, BaSO4, through precipitation reactions and make reports. ▪ Learners add common reagents to solutions of salts and state observation and make reports	

Hint to the Teacher

i) Guide and support learners through brainstorming/ small group discussions to collect data on:
   - meaning of salt
   - uses of salts in Agriculture, medicine, preparation and preservation of food

ii) Guide and support learners in small groups to carry out experiments to prepare common salts by
   - neutralisation
   - precipitation
   - synthesis

iii) Guide and support learners in small groups to test and identify common ions in solution.

Cations: NH_4^+, Zn^{2+}, Al^{3+}, Pb^{2+}, Ca^{2+}, Mg^{2+} using NaOH andNH_3 , KI

Anions: CO_3^{2-}, SO_4^{2-}, NO_3^-, Cl^-, using dilute HCl, HNO_3, $Ba(NO_3)_2$, $AgNO_3$, $Pb(NO_3)_2$ solution

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 2) Pages 151 -178, MK Publishers.
2. Walugere, R. Fountain Chemistry for secondary Schools (book Three) Pages 4-8, Fountain Publishers Kampala- Uganda
3. Ngaruiya, George, Kimaru, Joan, Mburu, Paul Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lambert A new Certificate Chemistry

Topic 6: Atmosphere and Environment

Duration: 11 Hours

Competency

The learner should be able to appreciate that air as a mixture of gases in which oxygen is the active constituent and demonstrates processes that may affect air quality.

Sub-topic 1: Air

Duration: 6 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. demonstrate that air is a mixture of different gases whose components can be separated and used. (u)	▪ In groups, learners discuss the components of air, their composition and uses, and construct a pie chart to explain the percentage of nitrogen, oxygen, inert gases and carbon dioxide in air. ▪ Carry out experiments to show: - the percentage of oxygen in air, - that air contains water	1. Asking learners to: - give reasons why air is said to be a mixture. - explain how the components of air can be separated. 2. Observe learners carry out experiments to show/find out: - the percentage of oxygen in air, - presence of water vapour in air - presence of microorganisms and dust - deliquescent property of substances - hygroscopic property of substances - efflorescent property of

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	vapour, microorganisms and dust. ▪ Investigate and report with help of a flow chart how air can be separated into its components. ▪ In groups, learners prepare oxygen using laboratory reagents and make a report	substances - that air contains carbon dioxide 3. Evaluate learners competence in: - drawing of pie chart to illustrate the percentage components of air - report on the process of separation of components of air - drawing of flow chart showing separation of different components of air during fractional distillation of liquid air
b. appreciate that processes such as burning and rusting/corrosion use oxygen from the air to form oxides. (u)	▪ In groups of 5-6, learners design an experiment to show that about one-fifth of air is oxygen. ▪ In groups, learners discuss and compare the processes of rusting and burning and determine if they are the same kind of chemical reaction or not. ▪ Learners	4. Observe the learners' ability to carry out experiment to find out; - that air or oxygen is needed for combustion - conditions required for rusting to take place 5. Ask the learners to clearly explain: • the similarity between rusting and burning • the difference between burning and rusting • why is rusting an important process in

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	investigate the rusting of iron under a variety of conditions. ▪ Learners discuss and evaluate the effectiveness of different ways of preventing rusting. ▪ In groups, learners discuss the reactions between elements (metals and non-metals) and oxygen when they burn to form oxides and write word equations for the reaction	life and why it must be prevented • the effectiveness of the different methods that can be used to prevent rusting. 6. Examine how learners can: • Write formulae of - selected oxides of some metals and non-metals formed after burning in air - Rust and gives its name. • Write equations for reaction when burning of some metals and non-metals takes place in air • Write equation the reaction that takes during rusting
c. understand how air pollution can affect the atmosphere. (u)	Investigate and report on the sources and effects of common air pollutants.	7. Assess learners' knowledge and understanding by asking them to: • describe human activities that can cause air pollution. • state the sources of air pollution. • explain effects of common air

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
		pollutants and the different ways of controlling air pollution. • explain the importance of keeping the air clean and how life would be without clean air.

Hint to the Teacher

The use of real life situations to explain the effects of rusting is recommended.

References

1. Otim, Emanuel, Lwanga, Muwanga and Afidra, Jimmy, MK Secondary Chemistry (Student's Book 1) Pages 76 -100, MK Publishers.
2. Walugere, R., Fountain Chemistry for Secondary Schools (book Three) Pages 4-8, Fountain Publishers Kampala- Uganda
3. Ngaruiya, George, Kimaru, Joan, Mburu, Paul Longhorn Secondary Chemistry
4. Arthur Atkinson, Certificate Chemistry

Sub-topic 2: Water

Duration: 5 Hours

Competence

The learner appreciates water as a very important resource for life, having distinct properties and, its sources as well as cycle of flow in our natural environment deserve to be protected.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand the occurrence of water as a natural resource, its physical and chemical properties and importance in everyday life.	▪ In groups, learners carry out laboratory chemical tests for water ▪ In groups, learners investigate the presence of water in many foods and show that some fruit juices are aqueous solutions. ▪ Learners carry out a project to demonstrate how dirty or muddy water can be purified for domestic use. ▪ Learners discuss the types of water (soft and hard water)	1. Observe learners presenting information about their knowledge on the following questions and evaluate their responses: • How to show that water is a compound of oxygen and water • How to carry out the chemical test for water (By describing what is observed when a couple of drops of water is placed on; Anhydrous copper(II) sulphate and Blue cobalt chloride paper • Explain the forms in which water exists in the environment • Explain the different steps that can be taken during the process of water

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
		purification
b. appreciate how water is recycled by the various natural processes.	▪ In groups, learners draw a flow diagram of the water cycle and discuss the role of the Sun in providing the energy to drive the water cycle.	Assess learners' understanding of the water cycle by asking the them to: • state the natural sources of water in the environment. • draw a labelled diagram of the water cycle. • use the diagram to explain how the water that comes out of the tap in your home originally came from the sea or a lake. • explain the changes that take place in the water cycle and the role of the Sun in providing the energy to drive the water cycle.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
c. understand the process of water and sewage treatment. d. understand how water is cleaned in a sewage processing plant.	▪ In groups, discuss with the aid of a model or diagram, how sewage is purified. ▪ In small groups, learners discuss how to apply scientific knowledge of the action of putrefying bacteria to the treatment of pit latrines. ▪ Investigate and write a report on processes used at sewage plants to obtain clean water. ▪ Learners designs a simple water purifier and make a report	1. Observe learners: • develop for water treatment sewage treatment. • draw a flow chart for sewage treatment. 2. Evaluate learners' understanding of the process of sewage treatment by asking them to: • describe the steps in the process of sewage treatment. • how water from sewage is cleaned to be recycled for domestic use.

Hint to the Teacher

i) Guide learners do develop a water purifier at school from simple materials such as:,
   - Plastic bag OR jerry can
   - Gravels of various sizes from large size to small size, Sand

ii) Draw a well labelled cross section of the water purifier showing the arrangement of the different components section.

iii) Indicate the roles of the different parts in the cross section in the process of water purification.

iv) A study tour to a water treatment or sewage treatment plant would be advisable

Reference

Otim Emanuel, Lwanga Muwanga and Afidra Jimmy, MK Secondary Chemistry (Student's Book 2) Pages 151 -178, MK Publishers.

Level 2

Topic 7: Carbon in the Environment

Duration: 11 Hours

Competency

The learner should be able to appreciate the diversity of carbon compounds in the environment and devise ways of how best they can be harnessed.

Sub-topic 1: Occurrence of Carbon

Duration: 3 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand that carbon exists in different forms/allotropes. b. relates the properties and uses of the allotropes of carbon to their structures.	▪ In groups, learners discuss the properties of the allotropes of carbon ▪ In groups, make models of the structure of diamond and graphite. ▪ In groups, use the models to discuss how the structure of diamond and graphite are related to their use. Then, draw a table to illustrate the difference between diamond and graphite ▪ Demonstrate how the properties of diamond and graphite are related their structures	▪ Examine learners' knowledge about allotropy and allotropes of carbon by verbal and written expression to the following questions: ▪ What is allotropy and why some elements have allotropes • How can you prove that graphite and diamond forms/allotropes of carbon. • Evaluate learners understanding of the structure, properties and use; of diamond

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	and uses. ▪ In groups of 5 learners, gather information on forms of amorphous carbon, their uses, and present to the class. Then, state some of the uses of carbon structures such carbon fibres and graphene.	and graphite by presenting answers to the following questions: • Use the diagram drawn to explain why; - diamond is hard and a non-conductor of electricity. - graphite is soft and a good conductor of electricity.

Hint to the Teacher

i) Use simple locally available materials (such as small fruits or beads, tooth picks or small sticks to develop models of the structures of graphite and diamond.
ii) Teacher should burn charcoal/wood as local material to release heat and soot.

Reference

Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 13 -22, MK Publishers.

Sub-topic 2: Oxides of Carbon

Duration: 5 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand the behavior of the different oxides of carbon. b. prepare carbon dioxide and study its physical and chemical properties c. relate the knowledge of properties of carbon dioxide to its various uses. d. appreciate the existence of carbonic acid due natural reaction of carbon dioxide with water in the atmosphere. e. relate the increase in carbon dioxide in the air to global warming (causing the atmosphere and the oceans to get warmer).	▪ In groups, learners discuss the conditions leading to production of carbon monoxide in charcoal stoves and its effect on human beings ▪ Learners design an activity to prepare carbon dioxide by reaction of limestone (calcium carbonate) and dilute hydrochloric acid and make a report. ▪ Investigate the properties of carbon dioxide ▪ In small groups, carry out a chemical test for carbon dioxide and changes that take place when carbon dioxide is bubbled through calcium hydroxide solution for a long time. ▪ In small groups, learners discuss the uses of carbon dioxide gas in relation to the properties ▪ In groups, discuss the formation of carbonic acid and find out the properties of carbonates and hydrogen carbonates ▪ In groups or as individuals, learners	• Engage in a conversation in which learners describe: - how carbon monoxide is naturally produced - occurrence and natural sources of carbon dioxide - Lab preparation of carbon dioxide - Uses of both carbon monoxide and carbon dioxide • In a conversation, ask learners to describe the exchange of carbon between living things and their environments • Engage learners to recognise the effect of increasing the amount carbon dioxide in the atmosphere by discussing and asking them to: - identify human activities that lead to increase in the amount of carbon dioxide in the atmosphere. - explain why

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
f. understand what greenhouse gases are, where they come from and how they are affecting climate. g. appreciate how greenhouse effect is responsible for global warming.	brainstorm on how carbon dioxide is a greenhouse gas and how it increases in the atmosphere ▪ In groups, learners research information on the greenhouse effect and how heat is trapped in a greenhouse and how this is responsible for global warming and make reports	carbon dioxide is a greenhouse gas. - draw a sketch diagram to illustrate the greenhouse effect. • Explain how: - the greenhouse effect can lead to global warming. - amount of carbon dioxide in the atmosphere can be controlled and the excess removed.

Hint to the Teacher

Guide learners to draw a sketch of the green house and use it to demonstrate or explain the greenhouse effect.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 13 -22, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Three) Pages 4-8, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry

Sub-topic 3: Hardness of Water

Duration: 3 Hours

Learning Outcomes	Suggested Teaching and Learning Activities	Suggested Assessment Strategies
The learner should be able to: a. demonstrate that water has dissolved salts that some of which cause hardness. b. identify the difference between temporary and permanent hardness of water. c. demonstrate the different methods of softening hard water. d. know the advantages and disadvantages of hard water	• In groups carry out an experiment to show how rainwater becomes hard as it soaks through limestone. • Carry out an experiment to investigate the different hardness of a water sample using soap solution. • Research on the different methods of softening hard water and write a report. • Research on the disadvantages and advantages of hard water and write a report. • Learners give examples of soft and hard water	Observe learners carrying out experiment to demonstrate effect of hardness of water and how they use the results to: • Explain: - what changes take place when soap is added to hard water. - what is meant by hardness of water. • Describe how temporary hardness of water of water is produced (include suitable equations).

Hint to the Teacher

i) Help learners demonstrate the concept of hardness using common soap.
ii) Teacher asks learners to discuss the importance of soft water in society.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 4) Pages 115 -121, MK Publishers.
2. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
3. Arthur Atkinson Certificate Chemistry
4. Holderness and Lambert Anew Certificate Chemistry

Topic 8: Carbon in Life

Duration: 8 Hours

Competency

The learner should be able to know that all living things are made from organic compounds based on chains of carbon atoms.

Learning Outcomes	Suggested Teaching and Learning activities	Suggested Assessment Strategies
The learner should be able to: a. recognise the diversity of carbon compounds in living things and materials derived from living things, and classifies them into hydrocarbons and non-hydrocarbons.	▪ In groups, learners discuss the meaning of carbon compound, the meaning of organic compounds with respect to their sources, content and combustion products, meaning of hydrocarbon, inclusive of saturated and unsaturated hydrocarbons, sources of hydrocarbon ▪ In groups, learners discuss to generalise the characteristics of homologous series in terms of having the same general formula, similar methods of preparation, steady changes in physical properties, and similar chemical properties	1. Engage learners in a conversation to identify some of the common organic compounds in use in everyday life.(e. g detergent, kerosene, alcohol, Edible oil, Cooking gas) 2. Engage learners into conversation/discussion to answer the following questions: • What is meant by term homologous series • Functional groups • Isomers
b. understand that alkanes have the same general formula and can be prepared by similar	▪ In groups, learners construct molecular models and draw structural formulae of the first five straight-chain alkanes. ▪ Construct a table	1. Engage learners in a conversation to deduce structural formula of alkanes from general formula. 2. Ask learners to make

Learning Outcomes	Suggested Teaching and Learning activities	Suggested Assessment Strategies
methods.	showing names, molecular formulae, structural formulae and physical properties of the first six straight-chain alkanes. ▪ In groups, learners discuss: a) physical properties of alkanes, i.e. melting and boiling points, density, physical state at room temperature, solubility in water and electrical conductivity, b) chemical properties of alkanes, i.e. combustion, substitution reactions with halogen c) the relationship between changes in physical properties with increase in the number of carbon atoms in alkane molecules	a presentation on how the general trend in the physical properties of alkanes vary with number of carbon atom in the chain.
c. understand the unsaturated nature of alkenes and use the reactions of ethene to demonstrate this.	▪ In groups, learners develop molecular models and draw structural formulae of the first two alkenes and make reports ▪ In groups, learners discuss the preparation of ethene	1. Engage learners in conversation to ensure that they can clearly do the following: • State conditions and write equations for laboratory

Learning Outcomes	Suggested Teaching and Learning activities	Suggested Assessment Strategies
	with emphasis on conditions for the reaction ▪ Learners discuss chemical properties of alkenes, i.e. combustion, addition reaction and polymerisation and make reports	preparation of alkenes by using ethene as an example. • Explain addition reaction as applied to alkenes by using ethene as an example for illustration. 2. Evaluate learners' ability/competence in correctly presenting written equations about the following reactions and in each case state the conditions: Ethene reacting with: - bromine - bromine water - hydrogen - oxygen (combustion)
d. understand the concept of isomerism using simple compounds such as butane and pentane.	In groups, learners discuss and write the structural formulae of the isomers of butane and pentane and name them. Where possible, examine isomerism through models or computer simulations.	Ask learners to draw structural formula of isomers and write the name of each of the isomers of butane
e. understand that alcohols are some of the important organic	▪ In groups, learners discuss the production of local alcohol (ethanol) in their home area through	Learners make written reports about: • the processes of preparation of ethanol by

Learning Outcomes	Suggested Teaching and Learning activities	Suggested Assessment Strategies
compounds though they are not hydrocarbons.	fermentation and distillation and make a report. ▪ Learnersdiscuss the physical properties of ethanol (C_2H_5OH), i.e. colour, odour, boiling point, physical state at room temperature, volatility and solubility ▪ Learners discuss chemical properties of ethanol in terms of: - combustion, - oxidation, - dehydration and represent them with appropriate chemical equations ▪ In a class discussion, learners brainstorm on: - uses of alcohols in everyday life, - effects of alcohol misuse and abuse	fermentation • the following reaction of ethanol - dehydration - combustion
f. appreciate that biogas is a carbon-based fuel used for cooking and lighting.	▪ Learners research and discuss on - the main components of biogas. - how a biogas fermenter works ▪ learners produce biogas from organic waste and show that it can burn and then make a report	The learners should be able to explain; - What bio gas is - How bio gas is generated - How bio gas generator works (with the help of a labelled diagram)

Learning Outcomes	Suggested Teaching and Learning activities	Suggested Assessment Strategies
g. know some common synthetic and natural polymers and how their properties relate to their uses or structure.	▪ In groups and using some household items, learners classify polymers as natural or synthetic, including plastics, starch, cellulose, proteins, sugars, fats and oils. ▪ In groups, learners discuss the types of polymerisation and identify polymers formed in each type and then make reports	Assess learners' reports on: a) the properties of polyethene that make it suitable for making bags for carrying or shopping. b) the advantages and disadvantages of synthetic and natural polymers c) why; - a cloth made of cotton absorbs more water than a similar-sized cloth made of nylon. - cotton decomposes in the ground but polythene or nylon does not
h. understand that soaps are organic salts and that they are prepared from fats and oils reacting with alkalis	▪ In groups, learners discuss the meaning of soaps and detergents and make reports ▪ In groups, learners prepare a local soap using available raw materials and make a report ▪ In groups, learners discuss the advantages and disadvantages of soaps and detergents	Assess the written description of the preparation of soaps

Hint to the Teacher

i) Examples of isomers should not include cyclic carbon compounds.
ii) Assessment exercises on naming alkanes and alkenes should not

exceed five carbon atoms.

iii) Methane may be used as examples for combustion and substitution reactions.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 67 -92, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Three) Pages 24-42, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lumbert, A New Certificate Chemistry

Topic 9: The Mole Concept

Duration: 10 Hours

Competency

The learner should be able to use formulae and equations to determine quantities of matter.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand the mole as unit of measurement. b. relate the concepts of relative atomic mass and relative molecular mass to mass of a single particle on carbon 12 scale. c. describe the relationship between relative atomic or molecular mass and molar mass, percentage composition of compounds by mass.	▪ Learners discuss relative atomic mass, relative molecular mass and molar mass basing on carbon-12 scale and make a report ▪ In groups, learners calculate the relative molecular mass of compounds based on the given chemical formulae, for example HCl, CO_2, Na_2CO_3, $Al(NO_3)_3$, $CuSO_4.5H_2O$	1. In a conversation, discuss with the learners the use of carbon-12 as a standard for determining relative atomic masses 2. Assess the learners on the calculations for relative molecular masses of substances and percentage composition by mass of substances based on chemical formula.
d. understand the relationship between the number of moles with the number of particles. e. understand the relationship	In groups or as individuals, learners: ▪ discuss the relationship between the number of particles in one mole of a substance with the Avogadro constant ▪ solve problem involving	1. Observe the learners discuss the relationship between moles, molar mass, and Avogadro's constant. 2. Engage the learners in activities on sample calculations on moles,

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
between the number of moles of a substance with its mass.	the number of moles and the number of particles for a given substance and vice versa. ▪ Discuss relation between: a) molar mass with the Avogadro constant, b) molar mass of a substance with its relative atomic mass or relative molecular mass and make presentations ▪ solve problem to convert the number of moles of a given substance to its mass and vice versa	molar mass. 3. Assess the learners on calculations on number of moles, and molar mass i.e how they substitute the right data and solve the final expression
f. understand the relationship between empirical formulae and molecular formula.	In groups, learners determine empirical formulae and molecular formula of: copper(II) oxide, magnesium oxide, and other compounds using various data	Observe the learners carry out an activity to determine empirical formula of a stated simple compound and assess how they use the formulae.
g. analyse the relationship between the numerical values of mole ratios in a balanced equation and quantity of reactant or products. h. understand the relationship between the number of moles of a gas with its	▪ State and explain Avogadro's law of volumes of gases, and its application in deriving molar gas volume ▪ In groups, learners discuss: a. the relationship between molar volume and Avogadro constant, b. the relation between molar volume of a gas at STP or room conditions (r.t.p.).	1. Observe the learners carry out an activity to calculate the volume of gases at STP or room conditions from the number of moles and vice versa. 2. Engage the learners in a discussion on the relationship between molar volume and Avogadro constant 3. Assess the learners on calculations involving

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
volume.	▪ Carry out an activity to calculate the volume of gases at STP or room conditions from the number of moles and vice versa using chemical equations ▪ State Gay Lussac's law and apply in solving problems related volumes of gaseous reactants and products in a balanced equation. ▪ Learners interpret chemical equations quantitatively and qualitatively and solve numerical problems using chemical equations (stoichiometry).	mass-mass, mass-volume and volume-volume relationships
Understand the measurements of amounts of substances in solution	In groups, learners discuss: a) different forms in which concentration of solutions can be expressed with emphasis on molarity b) The meaning of Standard solution standardisation process c) Carry out titration/volumetric analysis experiments and analyse the results appropriately	1.Observe learners conduct a titration exercise in the laboratory to determine molarity of a solution using a suitable indicator 2. Assess the answers to calculations on molarity.

Hint to the Teacher

i) Provide a variety of numerical problems and practical activities for this topic

ii) The concept of symbols and valences should be applied in the writing of correct formula of compounds as already seen under the periodic table.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 108 -178, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Three) Pages 51-85, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry

Topic 10: Ion Chemistry and Electrochemistry

Duration: 6 Hours

Competency

The learner appreciates reactions that lead to precipitation and those involving oxidation-reduction (redox) processes.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. understand why Precipitation reaction takes place and their significance.	In groups, learners investigate precipitation when solutions of some salts are mixed e.g.: ▪ copper(II) sulphate solution and sodium carbonate solution ▪ lead(II) nitrate solution and potassium iodide solution ▪ copper(II) nitrate solution and dilute sodium hydroxide solution ▪ Barium chloride solution and dilute sulphuric acid In groups learners carry out qualitative analysis experiments to determine the ions in a given salt and write a report.	1. Guide and observe learners carry experiments to show, as well as state appropriately the changes that take place during precipitation of common substances e.g. select suitable solutions to show changes that take place during precipitation of; - potassium iodide, - copper(II) carbonate, - copper(II) hydroxide, - barium sulphate, - lead chloride 2.Engage learners into a discussion to whether any changes involving precipitation will

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
		be observed or not if some pair of solutions are mixed e.g.: - Aluminium chloride solution and ammonia solution - Zinc nitrate solution and copper(II) chloride solution - Sodium sulphate solution and lead nitrate
b. understand oxidation and reduction reaction, and appreciate that the two processes always occur together.	In groups, learners carry out: • An activity/experiment to demonstrate oxidation or reduction by - Burning magnesium in air - Passing hydrogen gas over heated copper(II) oxide - Adding magnesium or zinc powder onto a solution of copper(II) sulphate solution and warming the mixture • a discussion to explain oxidation and reduction in terms of; - addition and removal of oxygen. - removal and addition of	a) Observe learners carry out oxidation and reductions reactions, and appropriately stating observable changes that take place during the processes when: • Burning magnesium in air • Passing hydrogen gas over heated copper(II) oxide • Adding magnesium or zinc powder onto a solution of copper(II) sulphate solution and warming the mixture

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	hydrogen. - removal and addition of electron transfer	b) in a conversation, learners explain the terms 'oxidation' and 'reduction' in terms of: - addition and removal of oxygen. - removal and addition of hydrogen. - removal and addition of electron oxygen gain and loss.
c. understand the changes that take place during the electrolysis of some compounds.	▪ In groups, learners carry out a discussion on the following and make reports; - properties of electrolytes and nonelectrolytes - Why solid salts of ionic compounds do not conduct electricity but their molten or aqueous forms are good conductors of electricity - The meaning of the term electrolysis and with help suitable example of a molten salt (eg sodium chloride) explain how it takes place - The circuit for electrolysis and draw	In a conversation, ask learners to: • Explain: - the difference between an electrolyte and a non-electrolyte, giving an example of each. - why an ionic compound like sodium chloride conducts electricity when molten or in aqueous solution but not when solid. • draw a labelled diagram to explain

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	its labelled diagram. ▪ In groups of about 3 to 5 carry out an activity to investigate the electrolysis of solution of some salts and use your findings to: - Identify the products at each electrode - State what is observed at each electrode and name type reaction taking place - With help of appropriate equations explain the observation at each electrode and the general redox reaction - (E.g. you may use solutions of the following salts; copper(II) sulphate sodium chloride, acidified water any others of your choice). ▪ In groups, list and discuss: - Effect of the factors that affect preferential discharge of ions during electrolysis. - Application of electrolysis	- the electrolysis of molten and aqueous lead(II) bromide - How an electrolytic cell works.

Hint to Teacher

i) Examples on precipitation, reduction-oxidation (redox) and electrolysis reactions may not be limited to those given here. The teacher can choose simple or appropriate examples to illustrate the processes.

ii) Teacher should emphasise chemical separation of ions using sodium hydroxide solution.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 108 -192, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Three) Pages 111-127, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lumbert Anew Cetificate Chemistry

Topic 11: Energy Changes during Chemical Reactions

Duration: 5 Hours

Competency

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

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
The learner should be able to: a. recognise the difference between endothermic and exothermic reactions and understand that substances store chemical energy in their bonds.	In small groups, carry out an experiment to classify chemical reactions as endothermic or exothermic by dissolving 50g of the substances in equal amounts of water and note the temperature changes in each case (e.g. Sodium hydroxide, Sodium hydrogen carbonate, Ammonium nitrate, etc.)	1. Engage the learners through questions to explain their observations of the experiments for energy changes 2. Evaluate the written reports of the experiments they have conducted
b. understand that exothermic and endothermic reactions occur in our everyday lives and are of great significance.	▪ In groups, learners research and discuss examples of important everyday reactions (such as fermentation, respiration, cooking, burning, etc.) in which energy is either absorbed or given off.	1. Observe the learners conduct the experiments on chemical energy transformation into heat energy and light energy by burning substances. 2. Ask the learners to give examples where chemical energy is transformed into electrical energy. 3. Ask the learners to

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
	▪ In groups, perform experiments to identify the energy transformations specific reactions, such as burning ethanol or paraffin (e.g. the change from chemical energy to heat and light when wood burns).	illustrate using a diagram the flow of energy in an ecosystem.
c. recognise that the burning of fuels is an exothermic process producing useful energy. d. understand the concept of heat of reaction and interpret energy profiles of chemical reactions.	▪ In groups, learners carry out an investigation to compare the heat given out when different fuels burn. Then they identifying the sources of error in the investigation. ▪ In groups, learners work out to problems on heat changes using stoichiometric relations ▪ In groups, learners construct and interpreting energy profile for a reaction.	1. Observe learners carrying out an experiment to demonstrate that ethanol releases energy when it is burnt. 2. Engage learners through questions to describe the qualities of a good fuel. 3. Observe the learners drawing an energy profile diagram for exothermic and endothermic chemical reactions. 4. Engage learners through questions to explain heat of reactions giving examples.

Hint to the Teacher

1. Demonstration of heat of combustion can be done using a paraffin burner.
2. Provide numerous numerical problems to the learners for practice.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 3) Pages 67 -92, MK Publishers.
2. Walugere, R. Fountain Chemistry for secondary Schools (book Three) Pages 88-106, Fountain Publishers Kampala- Uganda
3. Ngaruiya, George, Kimaru, Joan, Mburu, Paul Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lumbert Anew Certificate Chemistry

Topic 12: Rates of Chemical Reactions

Duration: 6 Hours

Competency

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

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
The learner should be able to: a. understand the concept of rates of chemical reactions using simple laboratory demonstrations.	In small groups, learners discuss the chemical reactions which occur quickly or slowly in everyday life e.g Acid/Carbonate reactions, Electropositive metal with water, and corrosion of metals &Rusting of iron.	Ask learners to write a report on the examples of chemical reactions that take place very slowly and very fast.
b. understand the effect of various factors on the rate of chemical reactions using laboratory experiments.	In groups, learners; ▪ investigate the effect of varying the concentration of reactants on the rate of a reaction. ▪ Investigate the effect of particle size on the rate of a reaction. The following three sets of reactions, X, Y and Z may be used, where dilute hydrochloric acid and calcium carbonate react. X dilute hydrochloric acid + a large piece of calcium carbonate Y dilute hydrochloric acid + calcium carbonate powder Z dilute hydrochloric acid + calcium carbonate	1. Observe learners carrying out experiments to find the effect of concentration, particle size, temperature and catalyst on rate of reaction and ask probing questions to check understanding 2. Ask learners to explain their observations of how the rates of reactions vary with changes in concentration,

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
	chippings ▪ Investigate the effect of temperature on the rate of a reaction and make reports ▪ Investigate the effect of a catalyst on the rate of a reaction using different reactions	temperature, particle size and presence of a catalyst. 3. Ask learners to write a report of the findings and represent them graphically
c. explain the importance of reversible reactions in industrial processes.	▪ In groups, learners discuss the concept of reversible reactions and identify examples of such reaction for industrial use ▪ Research on the industrial manufacture of ammonia and represent them using flow charts ▪ In groups learners discuss the uses of ammonia and make reports.	Ask learners to present the major reactions in the manufacture of ammonia using a flow chart to show the different steps in the industrial manufacture. Assess how learners communicate

Hint to the Teacher

Provide numerous practical opportunities for the learners to appreciate the concept of reaction rates.

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 4) Pages 1 -25, MK Publishers.
2. R. Walugere Fountain Chemistry for secondary Schools (book Four) Pages 26-41, Fountain Publishers Kampala- Uganda
3. George Ngaruiya, Joan Kimaru, Paul Mburu Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lumbert A, New Certificate Chemistry

Topic 13: Industrial Processes

Duration: 8 Hours

Competency

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

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
a. recognize the oxides of sulphur and describe how they can be formed naturally and artificially. b. explain the effect of oxides of sulphur on the environment. c. describe the industrial manufacture of sulphuric acid and identify its uses. d. understand the methods by which chlorine can be obtained in the laboratory and industrially. e. describe the manufacture of hydrogen chloride and hydrochloric	▪ In groups, learners prepare sulphur (IV) oxide using a variety of sources and investigate its properties ▪ Learners gather information and write an essay on how sulphur dioxide, SO_2, causes environmental pollution. ▪ In groups, learners discuss and draw a flow chart to show the stages in the manufacture of sulphuric(the contact process) ▪ Discuss uses of sulphuric acid in daily life such as in the making of paints, detergents, fertilizers and accumulators ▪ In groups, learners discuss the laboratory	1. Assess the learners on the ability to describe the process of manufacture of sulphuric acid and outline the uses of the acid in everyday life. 2. In a conversation, ask learners to explain why every step in the extraction of iron is important and assess how the learners communicate.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
acid and identify their uses. f. understand the processes involved in extracting and purifying metals i.e. iron and copper.	preparation of chlorine and represent it using suitable equations ▪ In groups learners discuss the reactions and uses of chlorine and make reports ▪ Learners search for the uses of hydrogen chloride and hydrochloric acid and make reports ▪ In groups, learners discuss the extraction of iron and draw flow charts with essential chemical reactions showing the extraction of pig iron from iron ore in the blast furnace ▪ Learners discuss the extraction of copper and represent it using flow chart ▪ In groups, learners discuss the uses of iron, copper and explain why each metal is used in these ways.	
g. understand the production of sodium hydroxide and chlorine by the	▪ In groups, learners discuss how both chlorine and sodium hydroxide are produced	Assess the learners' ability to describe the process of manufacture of sodium hydroxide

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
electrolysis of brine in the mercury cathode cell.	industrially and represent it with equations. ▪ In groups, learners brainstorm the main uses of sodium hydroxide and make a report	and chlorine and how they state the main uses of the products.

Hint for the Teacher

i) The extraction of sulphur for use in production of sulphur dioxide is not required
ii) Extraction of nitrogen from air and the preparation of oxides of nitrogen not needed
iii) Manufacture of nitric acid not required
iv) A formal diagram of the cell for manufacture of chlorine and sodium hydroxide is not required
v) Emphasise those reactions that lead to obtaining industrial product for everyday use

References

1. Emanuel Otim, MuwangaLwanga and Jimmy Afidra, MK Secondary Chemistry (Student's Book 4) Pages 28 -80, MK Publishers.
2. Walugere R., Fountain Chemistry for secondary Schools (book Four) Pages 48-84, Fountain Publishers Kampala- Uganda
3. Ngaruiya, George, Kimaru Joan, Mburu Paul Longhorn Secondary Chemistry
4. Arthur Atkinson Certificate Chemistry
5. Holderness and Lumbert A New Certificate Chemistry

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