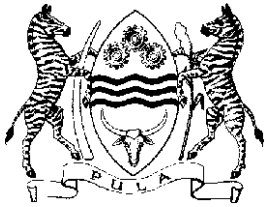

REPUBLIC OF BOTSWANA

BOTSWANA GENERAL CERTIFICATE OF SECONDARY EDUCATION

TEACHING SYLLABUS

CHEMISTRY

Ministry of Education
Department of Curriculum Development and Evaluation

FOREWORD

The Ministry of Education is pleased to authorise the publication of this senior secondary syllabus which marks a watershed in the development of the public education system in Botswana and signals another milestone of progress in fulfilment of the goals set by the Revised National Policy on Education, Government Paper No. 2 of 1994.

In this era of widespread and rapid technological change and an increasingly inter-dependent global economy, it is essential that all countries foster human resources by preparing children adequately for their future. Survival in the coming millennium will depend on the ability to accommodate change and to adapt to environmental needs and emerging socio-economic trends. It is the wish of government to prepare Batswana for future growth and adaptation to ongoing change in the socio-economic context; specifically the transition from an agro-based economy to the more broadly based industrial economy which we are aiming at.

The senior secondary programme builds on the Ten Year Basic Education programme and seeks to provide quality learning experiences. It aims to prepare our students for the world of work, further education and lifelong learning. However, secondary education must also pay attention to the all round development of the individual. It should provide not only for the acquisition of those skills needed for economic, scientific and technological advancement. It should also provide for the development of cultural and national identity and the inculcation of attitudes and values which nurture respect for one's self and for others.

Critical to the success of our secondary education programme is the recognition of individual talents, needs and learning styles. Hence, the role of the teacher in the classroom has changed. S/he must be a proficient manager and facilitator; a director of learning activities. S/he should be conscious of students' needs to take on board a measure of accountability and responsibility for their own learning. S/he must also take into account the widening range of ability of the student body and the different levels of achievement which they aspire to. This means active participation for all and the creation of rich and diverse learning environments.

It is important then that we value the students' own experiences, build upon what they know and reward them for positive achievement. At the same time, we must be prepared to offer them guidance and counselling at all levels; assisting them to make the best decisions in keeping with their own interests, career prospects and preferences. In that way we shall prevail in nurturing at the roots of our system, the

national ideals of democracy, development, self-reliance, unity and social harmony.

This syllabus document is the outcome of a great deal of professional consultation and collaboration. On behalf of the Ministry, I wish to record my appreciation and thank sincerely those who contributed to and were involved in the production of this syllabus.

P. T. Ramatsui
Permanent Secretary
Ministry of Education

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Mr B. Ncaagae (Chairperson)	**Maikano Community Junior Secondary School**
Mr H. Hlomani	**Examinations, Research and Testing Division**
Ms. C. Makobo	**Regional Inservice Co-ordinator (Serowe)**
Mr M. Mtonga	**Madiba Senior Secondary School**
Mr M. Kgosibodiba	**Gaborone Senior Secondary School**
Mr I. Baaitse	**Naledi Senior Secondary School**
Prof. A.A. Taiwo	**University of Botswana (Dept. of Maths and Education)**
Ms. R. Gabaitsekgosi	**University of Botswana (Dept. of Chemistry)**
Mr M. Motswiri	**University of Botswana (Dept. of Maths and Education)**
Mr E. Oommen	**Legae Academy**
Mr Daan van Alten	**Molepolole College of Education**
Mr G. Mokgabisi	**Dept. of Secondary Education**
Mr Z. Makhumalo	**St. Joseph's College**
Mr M. Motlhabi	**Ledumang Senior Secondary School**
Mrs S. Makgothi	**Curriculum Development Division**

The Curriculum Development Division served as secretariat to the Task Force. Curriculum Development Division wishes to thank members of the Task Force for their role in the development of the syllabus.

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consultation with teachers was done to check the relevance of the syllabus and identify problems teachers and learners might have with the interpretation of the syllabus.

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Introduction

Senior Secondary Science is a two-year programme designed for learners who have completed Junior Secondary education. It is designed to provide learners with scientific knowledge, skills and attitudes needed for understanding and responsible participation in the society. It also prepares the learners for tertiary education, vocational training and provides them with foundation skills for employment.

Subjects for the Senior Secondary programme are divided into groups: core and optional. All the Science subjects fall into one optional group: Sciences. There are four categories of Science offered in the group and learners are expected to choose one of these. These are:

- **Single Science;**
- **Double Science;**
- **Pure Sciences (Biology, Physics and Chemistry);**
- **Human Social Biology (only offered to private candidates)**

The syllabuses have been developed on the assumption that each Science will be allocated 160 minutes per week. The syllabus gives the approximate time allocation in weeks for each module.

Rationale

The Science Programme for the two years of senior secondary education is expected to facilitate the holistic development of the learner in a global context. The programme intends to instil a sense of appreciation for science and to make sure that the learners can cope in a technologically changing world. The programme will help learners to explore and apply the scientific knowledge, skills and attitudes acquired to address environmental, social, economic and political issues in their day-to-day lives. Through this programme learners will get an opportunity to explore and understand the natural world (life processes, physical phenomena and nature of substances).

Science is an experimental discipline and its method of inquiry allows learners to appreciate the practical impact of science on their lives and society as a whole. The Science programme will equip learners with skills that will be of long term value and encourage

them to participate in lifelong learning. In the process the learners will exercise their creativity and develop skills such as critical thinking, innovativeness, communication, analysis, observation, recording, drawing conclusions, making judgement etc.

The syllabuses will also expose learners to the practical applications of Science. This will contribute towards popularising Science and developing an interest in, and positive attitudes towards Science among all learners.

The Senior Secondary Science syllabuses recognise the importance of offering key concepts and principles of Science in Physics, Chemistry and Biology to provide learners with a more unified view of the Sciences and awareness of the connections among them and technology.

Aims of Senior Secondary Programme

On completion of the two year secondary programme learners should have: -

1. **acquired knowledge, developed confidence and ability to assess their personal strengths and weaknesses and be realistic in choosing appropriate career/employment opportunities and/or further education and training.**
2. **developed skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.**
3. **developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving and nurturing.**
4. **acquired attitudes and values, developed basic skills and understanding to allow for execution of rights and responsibilities as good citizens of Botswana and the world.**
5. **developed information technology skills as well as an understanding and appreciation of their influence in day-to-day activities.**
6. **acquired knowledge, attitudes and practices that will ensure good family and health practices, including awareness and management of epidemics (such as HIV/AIDS), that prepare them for productive life.**
7. **developed pre-vocational knowledge and manipulative skills that will enable them to apply content learnt and attitudes and values developed to practical life situations in the world of work.**
8. **developed an understanding of and acquired basic skills in business, everyday commercial transactions and entrepreneurship.**
9. **developed foundation skills such as problem solving, critical thinking, communication, inquiring, team work / interpersonal to help them to be productive and adaptive to survive in a changing environment.**

Aims of Senior Secondary Science

On completion of the 2 year Senior Secondary Science Programme, each student is expected to have:

1. **developed the ability to assess personal achievement and capabilities realistically in pursuit of appropriate career/employment opportunities and/or further education.**
2. **developed manipulative skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.**
3. **become confident citizens in a technological world to make informed decisions in matters of scientific interest.**
4. **developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving, developmental and nurturing.**
5. **developed an understanding of the applications of science and of the technological, economic, ethical and social implications of these.**
6. **developed an understanding of the significance of information and communication technology in the day-to-day life situations and the world of work.**
7. **acquired knowledge, attitudes and practices that will promote good family life and health including awareness and management of epidemics such as HIV/AIDS practices that prepare them for productive life.**
8. **developed positive attitudes such as open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards scientific skills**
9. **developed an interest in and an enjoyment of science and science related-work.**
10. **developed an understanding of key concepts and principles of science as they are experienced in everyday life.**
11. **developed abilities and skills that are relevant to the study, safe practice and application of science (such as experimenting and investigating).**
12. **developed problem solving, critical thinking, communication, inquiry and teamwork/interpersonal skills to help them to be productive and adaptive to cope in a changing environment.**

13. developed an appreciation of the role of science in improving the quality of life.

14. recognised the usefulness of science, and limitations of the scientific method.

15. promoted an awareness that the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

Aims of Senior Secondary Chemistry

On completion of the 2 year Chemistry Course, each student is expected to have:-

1. acquired a systematic body of scientific knowledge and developed an understanding of Chemistry including its strengths and limitations in order to:

1.1 develop the ability to assess personal achievement and capabilities realistically in the pursuit of appropriate career/employment opportunities and/or further education.

1.2 become confident citizens in a technological world, to make informed decisions on matters of scientific interest.

1.3 develop an understanding of the applications of chemistry and of the technological, economic, ethical and social implications of these.

1.4 recognise the usefulness of Chemistry, and limitations of the scientific method.

2. developed an understanding of key concepts and principles of Chemistry as they relate to everyday life experiences in order to:

2.1 develop an understanding of the significance of information and communication technology in the day-to-day life situations and the world of work.

2.2 appreciate the role of Chemistry in improving and maintaining the quality of life.

2.3 develop an awareness that the applications of Chemistry may be both beneficial and detrimental to the individual, the community and the environment.

3. developed abilities and skills that are relevant to the study of Chemistry to help them to be productive and adaptive to cope in a changing world, such as:

3.1 safe practice

3.2 application of scientific skills such as experimenting and investigating

3.3 problem solving skills

3.4 critical thinking skills

3.5 communication skills

3.6 inquiry skills

3.7 team work/interpersonal skills

3.8 manipulative skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.

4. developed positive attitudes towards Chemistry such as:

4.1 open-mindedness

4.2 inventiveness

4.3 concern for accuracy and precision

4.4 objectivity

4.5 integrity

4.6 initiative

5. developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving, developmental and nurturing.

Recommended teaching methods

The syllabus encourages a learner-centred approach as emphasised in the curriculum blueprint. This involves laying emphasis on science process skills, problem-solving skills, and the acquisition of hands-on experience which should increase the participation and performance of all groups e.g. groups of different abilities, learners with special needs, girls and boys. Teachers should approach the teaching-learning process in a learner-centred way. The teacher should use a variety of methods to achieve this e.g. inquiry, demonstration, practical work, project work, case study, field trips, discussions, computer guided learning etc.

In order to facilitate a learner-centred approach there should be pre-planning of activities to be done and there should be adequate working space to accommodate these activities.

Teaching methods should expose learners to practical applications of Chemistry in everyday life. The local environment should be used to provide context to the syllabus. They should present Chemistry in an interesting and challenging way that should popularise it and encourage learners to opt to pursue Chemistry and Chemistry-related fields for careers.

Domains

Chemistry experiences to be provided to learners should aim to cover the following domains: knowledge and understanding; handling information, application and solving problems; investigation and experimental skills and attitudes in Chemistry. These domains should provide guidance in assessment of learners.

Learners should be able to demonstrate:-

1. knowledge and understanding of

1.1 concepts, laws, theories and principles of Chemistry .

1.2 scientific vocabulary, terminology, convention (including symbols, quantities and units).

1.3 applications of science and of their technological, economic, ethical and social implications.

1.4 the significance of information and communication technology in the day-to-day life situations and the world of work.

1.5 good family life and health practices that prepare them for productive life.

2. handling information, application and solving problems to

2.1. solve problems as they relate to day-to-day life situations including some of a quantitative nature

2.2. use information to identify patterns, report trends, draw inferences, make predictions and propose hypotheses

2.3 locate, select, organise and present information from a variety of sources

2.4 translate information from one form to another

2.5 manipulate numerical and other data

2.6 present explanations for phenomena, patterns and relationships

3. investigation and experimental skills

3.1 follow a sequence of instructions

3.2 use appropriate techniques, apparatus and materials

3.3 handle instruments, apparatus and materials safely

3.4 make and record observations, measurements and estimates

3.5 interpret and evaluate observations and data

3.6 plan investigations and/or evaluate methods and suggest possible improvements

3.7 convert acquired skills into creative innovations

4. attitudes in Chemistry such as

4.1 open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards scientific skills

4.2 respect for life

4.3 awareness and appreciation for the environment

4.4 promotion of indigenous Chemistry and technology

4.5 recognition of the usefulness of Chemistry, and limitations of scientific method.

4.6 promotion of an awareness that the applications of Chemistry may be both beneficial and detrimental to the individual, the community and the environment.

Assessment

To ensure that learners attain the set aims, the course will be assessed through a variety of continuous assessment techniques. Projects, tests, experiments, surveys etc. will be used. The outcome of these will be used to improve instruction and guide progression.

At the end of the course a terminal examination will be administered. Continuous assessment in the form of coursework will also contribute to certification. Where it is not possible to offer coursework, alternative papers to test the same knowledge, skills and attitudes will be used.

Examination syllabuses will be developed by the examining body to provide teachers with guidelines on objectives to be tested.

Organisation of the syllabus

The syllabus is organised around broad content areas subdivided into topics. Each topic consists of general objectives which give rise to specific objectives. The specific objectives describe what learners are expected to do. These objectives are divided into core and extended. The extended specific objectives are highlighted in *bold italics*. All learners are expected to follow the core specific objectives. The extended objectives provide more challenging work for those learners able to benefit from it.

Experimental/Investigation Skills

Topic	General Objectives	Specific Objectives

(Through out the course learners should be given opportunities to perform these skills)	**apply basic skills for scientific investigation:**	**- follow a sequence of instructions** **- identify apparatus and materials useful for scientific activities**
	Using and organising apparatus and materials:	**- practise accepted safety procedures** **- apply appropriate techniques in manipulating laboratory equipment and materials**
	Collecting data	**- make observations using the senses** **- collect qualitative and quantitative data** **- measure and make estimations** **- accurately record an observation**
	Handling experimental observations and data	**- record data on a table or chart** **- predict outcome of an event based upon previous observations** **- identify relationships among phenomena** **- draw and interpret graphs or tables** **- interpolate or extrapolate conclusions when given appropriate data** **- identify conditions which cause or influence change** **- distinguish among independent, dependent or controlled variables** **- draw conclusions**

MATTER (4 weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should
Particulate nature of matter	understand the nature of matter in terms of particles	- explain states of matter in terms of particle arrangement and movement - explain changes of state of matter in terms of the Kinetic Particle Theory - describe diffusion of particles in fluids - describe the dependence of rate of diffusion on molecular mass - *demonstrate diffusion in gases*

Atomic structure	**acquire an understanding of the structure and characteristics of atoms**	**- describe the structure of an atom in terms of neutrons, protons and electrons** **- state the relative charges and approximate relative masses of protons, neutrons and electrons** **- define atomic number (proton number)** **- define Mass number (nucleon number)** **- use and interpret symbols such as $^{12}_{6}C$** **- describe the build up of electrons in "shells"** **- draw the structure of atoms of elements 1 to 20 in the periodic table showing the electron arrangement and the nucleus** **- explain the significance of valency electrons and the noble gas configuration** **- define isotopes (give examples of hydrogen, carbon and chlorine isotopes)**

Periodic Table	**be aware of the periodic table as a method of classifying elements**	**- extract information from the periodic table** **- translate from element name to symbol and vice versa** **- describe periodic trends like the change from metallic to non metallic character, electronegativity across a period (period III can be used to illustrate this)** **- state the relationship between period number and number of main shells** **- state the relationship between Group number and number of valency electrons** **- *include trend of atomic radius across a period***

	use trends in the periodic table to acquire knowledge and understanding of properties of elements	**- describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and in reaction with water** **- predict the properties of other elements in Group I, given data, where appropriate** **- describe chlorine, bromine and iodine in Group VII as a collection of di-atomic non metals showing a trend in colour, reactivity (as well as displacement reactions) and physical state at room temperature and pressure** **- predict the properties of other elements in Group VII, given data, where appropriate** **- describe the transition elements as a collection of metals having high densities, high melting points, variable valencies, forming coloured compounds and which, as elements and compounds, often act as catalysts** **- describe elements in Group VIII or 0 as being unreactive** **- describe the uses of the Noble Gases in providing an inert atmosphere e.g. argon in lamps, helium for filling balloons, etc.**

Chemical Bonding	**acquire knowledge and understanding of the structure of matter in terms of bonding between particles**	**- state the significance of valency electrons** **- describe the formation of ions by electron loss or gain** **- define an ionic bond as an electrostatic force of attraction between oppositely charged ions** **- describe the formation of ionic bonds between metallic and non-metallic elements, e.g. in NaCl, $CaCl_2$,** **- describe properties and find out uses of ionic compounds** **- describe the formation of covalent bonds between non-metallic elements leading to the noble gas configuration, e.g. H_2, Cl_2, N_2, HCl, H_2O, CH_4, C_2H_4, CO_2, etc.** **- define a single covalent bond as a shared pair of electrons** **- deduce the electron arrangement in other covalent molecules** **- construct 'dot' and 'cross' diagrams to show the valency electrons in covalent molecules** **- represent an electron pair by a dash in structural formulae** **- describe properties of covalent compounds** **- describe metallic bonding as a**

CHEMICAL REACTIONS (9 Weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should
Energy changes	understand chemical reactions and explore their nature using the investigative approach	- state that substances contain a certain amount of energy stored in bonds - describe the meaning of exothermic and endothermic reactions - carry out experiments which show exothermic and endothermic reactions - describe examples of endothermic reactions e.g. photosynthesis, use of silver salts in photography - describe examples of exothermic reactions e.g. respiration, combustion of fuels, reaction of reactive metals with water

	be familiar with the energy changes that take place during chemical reactions	- ***make simple calculations involving energy changes (including energy diagrams)*** - ***describe bond breaking as endothermic ΔH (+ve)*** - ***describe bond formation as exothermic ΔH (-ve)*** - ***describe activation energy as the energy required by some particles to break bonds for reactions to occur*** - ***demonstrate the production of electrical energy from simple cells***

Rate of reaction	**investigate the qualitative effect of several variables on the rate of chemical reaction.**	**- investigate the effect of a given variable on the rate of reaction** **- represent and interpret data obtained from experiments concerned with rate of reaction** **- investigate effect of concentration, temperature, surface area, use of catalyst and pressure on the rate of chemical reaction** **- explain the effects of the above factors in terms of collisions between the reacting particles** **- explain how explosive combustion with fine powders (e.g. in flour mills) and combustible gases (e.g. in mines) occur** **- find out some everyday instances of speeding up or slowing down reactions and identify the changing variable in each of the reactions** **- compare enzymes with other catalysts** **- state uses of enzymes in baking, brewing, dairy industry** **- describe practical applications of the effect of temperature on rates of enzyme-catalysed reactions in food preservation e.g. freezing, refrigeration, cooking** ***- conduct an experiment to illustrate catalysis***

Reversible reactions	**understand that some reactions can be reversed by changing reaction conditions**	**- define oxidation in terms of electron loss and increase in oxidation number** **- define reduction in terms of electron gain and decrease in oxidation number** **- define an oxidising agent as a substance that gains electrons from another substance** **- define a reducing agent as substance that losses electrons to another substance** **- use aqueous potassium iodide, acidified potassium chromate (VI) and acidified potassium manganate (VII) to test for oxidising and reducing agents** **- identify and describe examples of commonly occurring redox reactions e.g. rusting, respiration** ***- describe the concept of equilibrium*** ***- state the idea that some reversible reactions reach a state of dynamic equilibrium*** ***- represent a reversible reaction using symbols*** ***- predict the effect of changing pressure, temperature and concentration on a reversible reaction at equilibrium***

Redox Reactions	**understand concept of oxidation and reduction**	- ***identify a redox reaction; reducing agent and an oxidising agent in a redox reaction equation***

Electrolysis	**understand the process of electrolysis of compounds in the molten state or in aqueous solution**	**- describe electrolysis as a process of decomposition of a substance using electrical energy** **- identify electrodes (anode and cathode) and electrolyte from an electrolytic cell** **- explain electrolysis in terms of migration and discharge of ions** **- carry out electrolysis of the following: concentrated hydrochloric acid, concentrated aqueous sodium chloride, dilute sulphuric acid between inert electrodes; aqueous copper (II) sulphate using carbon electrodes and copper electrodes; molten lead (II) bromide** **- state importance of electroplating** ***- describe the factors influencing preferential discharge of ions at the electrodes*** ***- describe the electrolytic refining of copper and gold.*** ***- carry out simple electroplating of metals using copper*** ***- state and use Faraday constant*** ***- calculate the quantity of charge passed during electrolysis*** ***- calculate the mass/volume of substance liberated during***

Acids, bases and salts	**acquire information about acids, bases and salts and investigate their properties**	**- define an acid as an hydrogen ion, H^+, donor** **- define a base as an hydrogen ion, H^+, acceptor** **- describe the meaning of weak and strong acids and alkalis** **- investigate the properties of strong and weak acids** **- investigate properties of strong and weak alkalis** **- explain the difference between strength and concentration** **- investigate the effect of acids and alkalis on indicators such as methyl orange, universal indicator, litmus** **- describe pH as a measure of the degree of acidity or alkalinity of a solution** **- determine the pH of a solution using universal indicator** **- investigate the characteristic properties of acids in reactions with metals and bases (including alkalis and carbonates)** **- test for and identify hydrogen and carbon dioxide** **- investigate the characteristic properties of bases in reactions with acids and ammonium salts** **- give applications of acid/base**

STOICHIOMETRY (8 weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should
Chemical formulae and equations	understand the stoichiometry of chemical formulae and equations	- represent elements, ions and the formulae of compounds with symbols - determine formulae of compounds from the charges of ions or from models and diagrams - interpret symbolic equations - construct balanced chemical equations with state symbols including ionic equations.

The Mole	**understand the mole concept**	**- define one mole of a substance as the amount of that substance containing 6.02 x 10^{23} particles (Avogadro's number, N_A)** **- define the relative atomic mass, A_r, and the relative molecular mass, M_r** **- calculate the relative molecular mass of a compound with known formula.** ***- convert moles into other units (and vice versa) like grams (mostly for solids), cm^3 (mostly for liquids) and dm^3 for gases (knowing that the molar gas volume at room temperature and pressure = 24 dm^3***

Chemical calculations	**perform simple chemical calculations**	**- deduce empirical and molecular formulae, given the relevant information** **- calculate percentages like composition, purity and yield** **- calculate stoichiometric reacting masses and volumes of matter** ***- collect and measure the volume of a gaseous product of a chemical reaction*** ***- carry out experiments to determine the formula of a binary compound e.g. MgO, CuO***

Quantitative analysis	**perform simple quantitative analysis**	**- measure volumes of liquids using a volumetric flask, pipette and burette** **- make solutions of different concentrations by dilution from a given standard solution** **- calculate concentrations (mol/ dm^3) in aqueous solutions.** **- calculate the amount of solute present in a solution of given concentration** **- carry out simple acid-base titrations and titration calculations** **- do calculations involving volumetric analysis** **- use volumetric analysis to solve simple problems** ***- make standard solutions of different concentrations using pipettes and/or graduated flasks***

METALS AND NON-METALS (8 weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should

Properties of metals	**acquire practical skills and knowledge of general physical and chemical properties of metals.**	**- describe the general physical and chemical properties of metals** **- describe the reactivity series as related to the tendency of a metal to form its positive ion** **- carry out simple displacement reactions to demonstrate the relative reactivities of metals** **- place the common metals (potassium, sodium, calcium, magnesium, aluminium, *carbon*, zinc, iron, lead, *hydrogen*, copper, silver, gold) in order of reactivity** **- use the series to show the pattern in the reactions of these metals with water or steam, dilute hydrochloric acid** **- justify the position of carbon and hydrogen in the reactivity series** **- explain the existence in nature of some metals as "free elements" e.g. gold** **- investigate the action of heat on the oxides, hydroxides, carbonates and nitrates of the listed metals** **- account for the apparent unreactivity of aluminium as it forms a film of oxide** **- describe alloys as a mixture of metals or of metals and non-**

Extraction of metals	**acquire understanding and knowledge of the chemical processes involved in the extraction of aluminium, zinc, iron and copper.**	**- name the important ores of the metals aluminium, zinc, iron and copper** **- identify the methods of extraction of the metals listed above depending on their position in the reactivity series** **- describe the chemical reactions involved in the extraction of iron and aluminium** **- outline the general principles of steel making** ***- state percentages of constituent elements of the alloys***

Uses of metals and alloys	**be aware of the uses of common metals and alloys in terms of their properties and availability.**	**- list the uses of aluminium e.g. in the manufacture of aircraft because of its strength and low density, in food containers because of its resistance to corrosion** **- list the uses of zinc (galvanizing iron, in cells)** **- list the uses of copper (electrical wires and cooking utensils)** **- list the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)**
Non-metals **Chlorine**	**acquire an understanding of the preparation, properties and uses of chlorine**	**- describe the preparation of chlorine from concentrated hydrochloric acid using an oxidising agent** **- state the test for chlorine** **- state the uses of chlorine (sterilising water, manufacturing plastics, making domestic bleaches etc.** **- describe properties of chlorine** **- *describe the bleaching action of chlorine***

	understand the uses of some important compounds of chlorine and its manufacture	**- name some sources of sodium chloride e.g. sea water, salt pans (give examples of some places in Botswana)** **- describe the importance of sodium chloride as a source for chlorine, sodium hydroxide and common salt** **- describe extraction of sodium chloride from soda ash (focus on local process at Botswana Ash in Sowa Town)**

Sulphur	**acquire knowledge of sources and uses of sulphur and properties of its important compounds**	***- list the sources of sulphur*** ***- describe the preparation of sulphur dioxide*** ***- state the important uses of sulphur dioxide (bleach in the manufacture of wood pulp, food preservative by killing bacteria)*** ***- describe the manufacture of sulphuric acid from sulphur by Contact process (conditions and reactions)*** ***- describe the properties of dilute sulphuric acid*** ***- state the important uses of sulphuric acid (in the manufacture of detergent and fertilisers, car batteries and as a dehydrating agent)***

Carbon and carbonates	**acquire knowledge of the different forms of carbon**	**- state diamond and graphite as allotropes of carbon** **- relate the structures of diamond and graphite to their uses** **- describe the processes involved in the extraction and refining of diamond in Botswana** ***- compare the structure of graphite, diamond and silica [silicon (IV) oxide]*** ***- describe the similarity in structure of diamond and silica [silicon (IV) oxide] and of their properties related to their structures.***
	acquire knowledge of formation and uses of important carbonates	**- list the uses of sodium carbonate and calcium carbonate** ***- describe the manufacture of sodium carbonate by Solvay process***

Nitrogen	**acquire knowledge of sources and uses of nitrogen**	**- name the sources of nitrogen and hydrogen in making ammonia** **- state the uses of ammonia** ***- describe the essential conditions for making ammonia by the Haber process*** ***- describe the essential conditions for making nitric acid by the Ostwald process***

CHEMISTRY IN THE ENVIRONMENT(7 weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should
Water	acquire knowledge about the physical and chemical properties of water	- investigate physical properties of pure water - carry out a chemical test for water - explain the following terms hydration, hydrolysis, drying, dehydration deliquescence, efflorescence and hygroscopic - investigate the existence of water of crystallisation

	appreciate the effect of dissolving property of water in producing hard water and pollution	**- describe the process that results in hard water (name salts causing hard water)** **- distinguish temporary hardness of water and permanent hardness of water** **- *measure the hardness of water*** **- describe physical and chemical process of softening hard water** **- describe how a detergent works** **- describe pollution of water in terms of dissolved substances, accumulation of toxic substances and effect of detergents** **- investigate effects of pollutants in water** **- explain the consequence of water pollution** **- *describe pollution of water in terms of biological oxygen demand (BOD***

Air	**appreciate the delicate balance of air in volume and quality**	**- state the proportions of different components of clean air by percentage volume** **- *describe the separation of oxygen and nitrogen from air by fractional distillation*** **- explain the effect of increased carbon dioxide concentration in the atmosphere** **- name the uses of oxygen in health and in industry** **- state the importance of the ozone layer**

	be aware that people's action on the environment can result in air pollution and appreciate the need to control it	**- name the common pollutants in the air as carbon monoxide, sulphur dioxide, oxides of nitrogen and lead compounds** **- state the source of each of the common pollutants** **- explain why it is dangerous to run a petrol engine in a closed garage or use a coal fire in a closed room** **- explain the presence of oxides of nitrogen in car exhausts** **- explain the problems caused by burning coal** **- describe the adverse effects (include chemical reactions) of common pollutants on buildings, health, vegetation, ozone layer, etc.** **- describe methods controlling pollution such as acid rain, toxic waste, etc.** ***- state uses of catalytic converters and unleaded petrol in reducing pollution from car exhausts***

Recycling	**appreciate the role of recycling in conservation of natural resources and reducing the problem of pollution**	**- describe some of the problems caused by the chemistry industry** **- explain the importance of recycling** **- identify methods of recycling of various substances (e.g. paper, metals, glass, water)** **- find out advantages of using recyclable materials**
Sources of energy	**be aware of the chemical processes taking place when fuels are burned**	**- state that fuel releases energy when it is burnt** **- state that fuel burning is an exothermic reactions** **- state that energy released was stored in the bonds of the fuel molecules** **- state that carbon monoxide is produced when carbon-containing fuels burn in a limited supply of oxygen** **- describe how charcoal can be made from wood** **- use data and information to compare two fuels**

	appreciate the finite nature of fossil fuels and the need to find alternative sources of energy	**- explain energy conservation methods used in the home** **- discuss the advantages and disadvantages of various energy sources** **- describe one use of plants in producing a fuel** **- describe the use of plant and animal waste in producing fuel** ***- relate the structure of silicon to its ability to trap solar energy***

CARBON CHEMISTRY (5 weeks)

Topic	General Objectives	Specific Objectives
	Learners should	Learners should
Homologous Series	understand the importance of carbon and organic compounds	- explain the ability of carbon atoms to form chains, branched chains and rings - describe the general characteristics of an homologous series - name and draw the structures of unbranched alkanes, alkenes, alkanols and organic acids containing up to five carbon atoms - identify alkanes, alkenes, alkanols and organic acids given their structural formulae - *identify structural isomerism up to five carbon alkanes* - *relate structural isomerism to physical properties*

Alkanes	**be aware of the sources of alkanes and their impact in our every day life**	**- describe burning and substitution reaction with chlorine of alkanes (exemplified by methane) and name the products** **- name fossil fuels, natural gas and petroleum as the main sources of alkanes** **- describe fractional distillation of petroleum** **- name the main alkane constituents in the fractions** **- name the uses of the fractions as: petrol fraction as fuel in cars; paraffin/kerosene fraction as fuel in stoves, lamps, diesel fraction for fuel in engines, kerosene as fuel in aircraft , lubricating fraction for lubricants and making waxes and polishes and bitumen/asphalt for making roads**

Alkenes	**know uses of alkenes and how they are manufactured**	**- describe the manufacture of alkenes by cracking** **- describe properties of alkenes in terms of burning, polymerisation, addition reactions with bromine, hydrogen and steam.** **- distinguish unsaturated hydrocarbons e.g. alkenes from saturated hydrocarbons e.g. alkanes by molecular structures and by using aqueous bromine** **- describe the formation of poly(ethene) as an example of addition polymerisation of monomer units** **- list some uses of poly(ethene) e.g. plastic bags**

Alkanols	**acquire basic knowledge about alkanols including formation, properties and uses**	**- describe the fermentation of simple sugars to produce ethanol (and carbon dioxide) and its importance in brewing and baking** **- prepare ethanol by fermentation** **- describe formation of ethanol by catalytic addition of steam to ethene** **- relate physical properties of alkanols to number of C atoms e.g. boiling point** **- describe the properties of ethanol in terms of burning and oxidation** **- list some uses of alcohols as solvents, as fuels and as constituents of alcoholic beverages**

Alkanoic acids	**acquire basic knowledge about organic acids including properties and uses**	**- describe the formation of alkanoic acids [exemplified by the formation of ethanoic acid by the oxidation of ethanol by atmospheric oxygen and by acidified potassium chromate (VI)/potassium manganate (VII)]** **- explain properties of ethanoic acid as a typical weak acid** **- name some commonly occurring alkanoic acids, their sources and uses e.g. tartaric acid, ethanoic acid, ascorbic acid, citric acid** ***- describe the reaction of ethanoic acid with ethanol to give an ester (ethyl ethanoate***
Macromolecules	**be aware of macromolecules as large molecules built from small units**	**- explain that different macromolecules have different units and/or different linkages** **- describe formation of macromolecules from small units (monomers)**

Synthetic condensation polymers	**be aware of the formation of synthetic polymers and their impact in everyday life**	**- list some typical uses of condensation polymers and link their properties to uses** **- describe the pollution problems caused by non-biodegradable polymers e.g. plastics, nylon** **- list some typical uses of man-made fibres** **- investigate advantages and disadvantages of synthetic and natural fibres** ***- describe uses of different macromolecules as related to their general structure and properties e.g. PVC, Polystyrene, Polypropene*** ***- interpret polymerisation reactions in terms of simple graphical formulae*** ***- describe the formation of nylon and terylene using simplified structure***

Natural macromolecules	**understand the impact of natural macromolecules in our daily life**	**- name proteins, fats and carbohydrates as the main constituent of food** **- describe the hydrolysis of proteins to amino acids** **- prepare soap by hydrolysis of fats** **- describe complex carbohydrates as macromolecules formed by the condensation polymerisation of smaller carbohydrate units called sugars** **- describe the hydrolysis of complex carbohydrates (e.g. starch) to give simple sugars** ***- describe proteins as possessing the same linkage (amide) as nylon but with different units*** ***- describe fats as esters possessing the same linkage as Terylene but with different units*** ***- demonstrate how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents (refer to R_f factor) or UV light*** ***- describe, in outline, the usefulness of chromatography in separating and identifying the products of hydrolysis of carbohydrates and proteins***